A Model for Mobile Exergame Development to Promote Anti-Sedentary Behaviour

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Abstract The term “exergame” is the combination word of exercise and videogames. Exergaming is playing exergames or any other video games to promote physical activity. Contemporary lifestyle has become increasingly sedentary: little physical (sports, exercises) and much sedentary (TV, computers) activity. The nature of sedentary activity is self-reinforcing, such that increasing physical and decreasing sedentary activity is difficult. As the growth of smartphones devices increased over the years, it becomes easier for an individual to use any application in their mobile device anytime, anywhere. In this busiest lifestyle, a mobile application simplifies a person’s work or activity in their daily routine especially for working adults. Hence, a mobile exergame application has a high potential where it helps to give a break or little time form their work. This paper mainly focuses on a model development for a mobile exergame prototype which promotes anti-sedentary behavior. Therefore, a conceptual model has been proposed based on the literature review analysis on behaviour change models and also survey experiment findings. The survey experiment was done with existing similar mobile exergame application system and was conducted among office workers in UTM. The findings from the survey experiment help the result analysis and contribute to the model development for this study. Moreover, an overall finding suggest that by practising mobile exergame, an individual can expect a productive behaviour change which will motivate the user for a longer period of time.

Keywords: Exergame, Mobile Application, Prototype Behaviour Change Support System (BCSS)

1. INTRODUCTION

The number of health risk associated with sedentary lifestyle has increased in recent times. Sedentary lifestyle becomes more common in this digital era where it requires an adult to sit at one place to do their work without any major body movement. Some efforts have been taken to promote anti-sedentary behaviour of an individual lifestyle. However, a person has to comply with organizational rules and regulation where they have to stick in daily working routines in what they have been assigned. The problem is to solve the sedentary behaviour and the health risk associate within it efficiently by the use of technology in a person’s daily routine.

By identifying mobile application can provide an attractive way to attract human as a learning and awareness platform, it is easy to convey by providing or creating a useful mobile application system on discouraging sedentary behaviour's such as mobile exergames. Exergame was the most commonly used term primarily by researchers who do not have a health-related background. Since the term “exergame” is the most frequently used in the literature, media, and is a catchy word, it is proposed to continue using this term; however, we will take a deeper look at its definition. Yang (2010) stated that “exergaming” is the combination of exercise and video games”. A video game is “any game played on a digital device and encompasses a wide range of games played at arcades, on personal computers, or on dedicated game consoles such as mobile.

Besides that, Sofia et al., (2015) stated that, one of the population groups vulnerable to the health problems such as obesity and overweight are the individual between the age range of 20 to 30 years old. Whenever there is increased screen time there is usually a matching decrease in physical activity. Exergames have started to find their way into field-based settings, such as offices, schools, communities and homes, as a possible solution to curbing physical inactivity and obesity (Gao & Chen, 2014). However, the mobile exergames should also include Behaviour Change Support System (BCSS) characteristic for more productive outcomes.
Researches regarding mobile exergame have dominated the study of sedentary behaviours in recent years. The volume of mobile exergames research in the sedentary behaviour context expanding constantly, until it becomes more difficult to evaluate each and everything. Therefore, a problem statement for this study has also been identified which is “What is specific requirement needed for a model development on mobile exergame prototype?”

2. BACKGROUND

A sedentary lifestyle is defined as a sort of way of life where an individual does not get standard measures of physical activity that a normal human body requires in their daily routine to keep their body fit. According to the World Health Organization (WHO), 60 to 85% of the population worldwide does not take part in enough movement in their daily routine of life. Sedentary activities are divided into many categories where every activity has their own negative impacts. TV viewing has been the most commonly studied. Prolonged sitting time lowers energy expenditure and displaces time spent in light physical activities, which consequently leads to weight gain over time. Besides that, computer uses are increasingly common leisure-time sedentary behaviours, which have the potential to impact negatively on health outcomes. In this digital era, it is very common that an individual have to deal most of the time in front of computer screen as part of their work.

Furthermore, there is also other potential health risk that associates with sedentary activities such as certain types of cancer, diabetes, mental health, back/neck pain, muscle degeneration, osteoporosis and etc. Thus, to reduce this health problem, a person must take safety precaution where they can involve in light body movement everyday with the help of common technology such as smartphones. According to Poushter (2016), smartphone possession rates in rising and developing countries are ascending at a remarkable rate, climbing from a median of 21% in 2013 to 37% in 2015. The remarkable developments of the smartphone industry and fitness applications on mobile device have provoked the requirement for research and assessment of the reliability of fitness applications. It is the responsibility of health experts, mobile application designer, service provider, and local authority to make sure that quality and reliability of this fitness application are accessible for mass utilization (Subramanian, 2015).

Exergames are video games that require the player to be physically active. They can be generally divided into two classifications, which are indoor exergames that are typically being played in the limits of one’s living room, and mobile exergames, which keep running on a player’s smartphone and can be played both indoor and outdoor. While indoor exergames have possessed the capacity to build up themselves as a mainstream sort of video computer game, mobile exergames are still far and few between. The aim of an exergame is to have a positive impact on the player other than pure entertainment purpose. This is normally achieved by motivating the player through the game mechanics to perform a task (Dutz, Hardy, Knoll, Gobel, & Steinmetz, 2014).

Furthermore, Mandryk & Gerling (2015) also stated that, design principles for mobile exergame is very important because it can integrate physical activity into games while motivate the player include aspects such as providing feedback on activity levels, goal achievement, social sharing, and integrating activity into a user’s lifestyle. The researcher added that, a successful mobile exergame which has the potential to reduce the sedentary behaviour must comply with this set of five principal designs. The identified five principles are as following:

- Providing an easy entry into play
- Implementing achievable short-term challenges
- Providing users with appropriate feedback on
- Implementing individual skill matching to keep players engaged
- Supporting social play to foster interaction and increase exercise motivation.

2.1 Behaviour Change Support System (BCSS)

Approach

All games are intended to be influentially persuasive and reinforce compliance to keep the player playing. But, not all games which are design to be persuasive the user are developed with behavioural change in mind (Wartena, Kuipers, & Van Dijk, 2014). According to Kukkonen (2010), a Behaviour Change Support System (BCSS) is an information system that designed to form, alter or reinforce attitudes, behaviours or an act of complying without using deception, coercion or inducements. To achieve a successful results from BCSSs, the games should be designed by using persuasive systems design frameworks and models. This is because, a mobile exergame should motivate the user with the input of BCSS elements to engage the player for a long term. Figure 1 shows an example BCSS model by Wartena et al., (2014)

![Figure 1: Ludens Modi Varietas Model of BCSS (Wartena et al., 2014)](image-url)
According to Figure 1, the Ludens Modi Varietas model is a BCSS approach where it was developed from a model-based approach and the user experiences with important gaming structure. It has two different perspectives such as user’s and mediator (Wartena et al., 2014). The socio-technical system links the interactions between human and technology where the application will be executed. Meanwhile, social contexts take place outside of the scope of the system are also to be noted. Furthermore, it also contains four modes of archetypical such as:

- **Intervention:** The intervention is normally from the domain which the game will be executed and depending on the context of the game
- **Trigger:** A trigger gives feedback with persuasive features that increase the participation of the user
- **Participation:** Participation as one of the four essential properties of digital artifacts where it is also lies in different user-perspectives.
- **Assessment:** Assessment of skill, knowledge, attitude or behavioural change all can be core purposes of a game.

Since, this research study focus on model development for a mobile exergame prototype which also includes BCSS approach, therefore Ludens Modi Varietas model is the best example to adapt in where it has the entire basic and necessary element for a positive behaviour change for an individual.

3. METHODOLOGY

The objectives of this study are to develop a model for mobile exergame prototype based on the characteristic of Behaviour Change Support System (BCSS). The study began by searching the extant literature by a specific keywords and search items, in order to obtain as many relevant papers as possible. To ensure the quality of the results, the papers accessed were book chapters in online academic libraries selected journals. Around thirty papers were collected according to the keywords for further research and paper writing. The literature analysis helps to provide an understanding on how to promote anti-sedentary behaviour using mobile exergame and also provides some insight for behaviour change model approach for mobile exergame. Ludens Modi Varietas model on BCSS by Wartena et al., (2014) were partially adapted for the model development of this study.

Meanwhile, a survey experiment was also executed to complete the model development. The survey experiment was based on existing similar mobile exergame application and was conducted among office workers at School of Graduate Studies, UTM. The data collection for survey experiment is done by distributing the questionnaire with the selected respondents. Hence, a finalized conceptual model based on this survey experiment results has been proposed. Besides that, the results of the survey is analysed and reported accordingly.

### 3.1 Survey Experiment

The aim of this survey experiment is to gather more data on existing mobile exergame application system which is available on Google Play Store. Therefore, the findings obtained from this survey experiment will provide an understanding and contribute to the final conceptual model of mobile exergame prototype which helps to promote anti-sedentary behaviour.

A total of two similar mobile exergame applications were selected for this survey experiment, which is “Office Syndrome” and “Motion Sport” application. The reasons to choose both of this applications is because, it cater almost all the basic and necessary mobile exergame mechanics/features into it. Besides that, both of this application rated high in Google Play Store based on user reviews. Furthermore, both of this application belongs to the same category of “mobile exergame” with different perspective of user goal. Table 1 below shows the selected existing similar mobile exergame application for this survey experiment.

<table>
<thead>
<tr>
<th>Existing Mobile Exergame</th>
<th>Description</th>
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<tr>
<td>“Office Syndrome”</td>
<td>This application mainly designed for office workers who spend many hours in front of a computer for a prolonged period without sufficient movement. This application helps an individual to take a rest break and do the simple office stretching exercises.</td>
</tr>
<tr>
<td>“Motion Sport”</td>
<td>This is a fun-filled application where it focuses more on user movement. The motion technology of this application detects player’s movements through the mobile front-facing camera, allowing four different games into it to be played anytime, anywhere.</td>
</tr>
</tbody>
</table>

A total of seven office employees from Information Technology (IT) department at School of Graduate Studies, UTM have been participated in this survey experiment. The reason to choose them is because, the particular office employees deals with their computer/laptop most of their working hour for a prolonged period. Besides that, the data will be more accurate if office workers participate in this survey experiment. Those seven office employees were given an android mobile to test and play both of the selected existing mobile exergame application during this experiment. A set of questionnaires has been provided to them at the end of this experiment.
4. Data Analysis & Results

As mentioned earlier, a total of 7 office employees were selected to fill in the questionnaire which contains three sections in total. Those sections cover demographic and general information, Behaviour Change Support System (BCSS) factors, usability factors and feature’s/functions factors.

The results on Behaviour Change Support System (BCSS) factors for “Office Syndrome” application with question (a) until (e) as follows.

![Figure 2: Behaviour Change Support System (BCSS) Factors Result’s for “Office Syndrome” application](image)

Based on Figure 2, the graph shows the number of the respondents on Behaviour Change Support System (BCSS) factors for the “Office Syndrome” application. Respondents were asked to choose the extent to which they agree by ticking into provided five likert scales.

Based on the respondent’s response towards BCSS factors, it can be said that most of the respondents agree that “Office Syndrome” application can result in positive behavioural outcome. Besides that, some of them also agree that “Office Syndrome” application had the quality intervention element for a productive result in behaviour change.

Furthermore, almost all of the respondents agree that “Office Syndrome” application provides a way to trigger behaviour change of an individual, but some of them still unsure for this statement. To avoid respondents doubt in the statement, an attempt must be taken for design mobile exergame application with persuasive trigger principles.

Besides that, minority of respondents agrees that “Office Syndrome” application can engage user for long term participation and it enough contain assessment of skill for a person.

Hence, it can be conclude that “Office Syndrome” application needs to improve in term of design and development where it has to be comply with necessary elements such as intervention, trigger, participation and also assessment for a positive behaviour change. Meanwhile, the results for usability factors for “Motion Sport” application with question (f) until (i) as follows.

![Figure 3: Usability Factor Result’s for “Motion Sport” application](image)

Based on the respondent’s response towards in term of usability factors, it can be conclude that majority of the respondents impressed with the “Motion Sport” application. From the experiment done, almost all the respondents loved to play the motion sport game which is available on “Motion Sport” application. Respondents found that the application have all basic mobile exergame mechanics such as game elements and graphics. Although, majority of the respondents found that this application is comfortable to use in office environment. But, some of the respondents disagree that this application is comfortable to use in office environment. This is because, it involves upper body movement where respondents may feel uneasy to follow it.

Besides that, “Motion Sport” application provides clear instruction with before start playing. In addition, majority of the respondents also, found that this application have enough user interface design with necessary graphics, button and others. This will attract more users to download this application from Google Play Store.

From these findings, it can be said that “Motion Sport” application is better when compare to “Office Syndrome” application in term of usability factors. Meanwhile, the results from feature’s/functions factors for “Motion Sport” application with question (j) as follows.
From these findings, it can be said that, in “Motion Sport” application have all the necessary core functionality elements and supporting elements. From the experiment done, majority of the respondents loved to play this particular application mobile exergame because it has more gaming mechanism. Functions such as reminder, reward, gaming and timer have the highest number in term of usefulness based on majority response towards “Motion Sport” application. Therefore, it can be concluded that, to produce a successful mobile exergame application, a developer or researcher should not exclude these basic functions from the mobile exergame model which helps to promote anti-sedentary behaviour.

5. THE PROPOSED CONCEPTUAL MODEL

A conceptual model for mobile exergame has been proposed, based on the survey experiment findings. Figure 5 portrays the conceptual model for mobile exergame for this research study. This model will be a guide and reference to develop the prototype. As partially adapted from Ludo Modi Varietas model (Wartena et al., 2014) the Behaviour Change Support System (BCSS) approach consist of four modes, which is Intervention, Trigger, Participation and Assessment. Based on the survey experiment findings these four modes are very important for an individual behaviour change which could engage them for a longer period of time. Besides that, this research study focus only on certain mobile exergame mechanics to be develop within the prototype. The survey experiment findings suggest that reminder, reward, timer and gaming are the four functions based on the highest rated in number according to the respondents.

According to Figure 5, those four functions were categorized in each mode of BCSS approach. Gaming belongs to the mode of intervention in the model because the particular function evaluates the efficiency of any exergame which is also benefit for physical activity (Staiano et al., 2012). Besides that, reminder function belongs to trigger mode in the model because it helps to trigger or alert a user to engage with the activity that were provided in the mobile exergame application (Mandryk & Gerling, 2015).

Furthermore, reward function belongs in participation mode in the model. The reason is because, gaining rewards is always interesting for user and it able to ensure user participation for a longer time (Berkovsky et al., 2010). Meanwhile, timer belongs to assessment mode in the model. It is because setting a timer into a mobile exergame application would help a user to be more focus to perform any activity or assessment.

Thus, for this research study only four important mobile exergame mechanics were identified which should not be avoided from the conceptual model. It is then categorized into the relevant modes of BCSS approach. After ensuring the mobile exergame mechanics into BCSS modes, the user action is important because when user acts
repetitively towards the mobile exergame, they would experiment the psychological outcome together with some motivation changes. These will results as a behavioural outcome within a person whereby it can last for longer period of time. Thus, based on the survey experiment finding the new model for mobile exergame prototype has been proposed together with the adaption from the Ludens Modi Varietas Model of BCSS (Wartena et al., 2014).

6. CONCLUSION

This paper gives an overview on a model development for mobile exergame prototype which helps to promote anti-sedentary behaviour. To accomplish the research study, the initial steps and activities have been identified. The planning phase takes first place at the beginning of the study. A problem statement has been identified to conduct the study. The survey experiment findings suggest that a complete model for mobile exergame prototype should include Behaviour Change Support System (BCSS) factors and all necessary mobile application mechanics or function to produce a successful prototype. Besides that, there are also many research limitations and obstacles which create obstruction in the progress of the research activities. For example, there are very less mobile exergame application system which support behaviour change characteristic available in Google Play Store, a thorough research need to be done from the beginning of the project. Moreover, the scope of the mobile exergame application is too large, this study focuses solely in Android platform which target specific user. However, the proposed model for mobile exergame prototype in this research study needs evaluation for quality outcomes. Therefore, a mobile exergame prototype needs to be developed as a proof of concept. This would be a step for future work.

7. REFERENCE


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