

# CHAPTER 1

## INTRODUCTION

### 1.1 Introduction

The growth of technology and its development has become a hot topics all over the world. The race in producing new technologies that fit into the life of many ages has resulted the innovation of serious games as the assistive technology tool. The rehabilitation field in the healthcare sector has been using serious games as a medium for persons with disabilities to perform their exercise and therapy routine sessions. Despite the advantages of serious games in assisting users to experience a real-life environment, some gaps that need to be addressed while developing the games.

In this chapter, the problem background is explaining the significance of the research and supported with evidence. Hence, the problem statement is precisely highlighting the issue that needs to be solved followed by research questions and objectives which discussed in the next sections. Subsequently, the next subsections are well-explained on research hypotheses and scopes. The second last subsection will show the proposed method used for this research on each research objectives. Lastly, the conclusion of the chapter is written in the last section, the summary.

### 1.2 Problem Background

Nowadays, technology has been widely used in every country in the world. The sophisticated development and growth of technology is keep improving every day.

Along with the tremendous development of technology, it helps people to live a better

life. A lot of sectors all around the world gain lots of advantages from the growth. One of the earliest sectors that received the advantages of technology development and growth is the healthcare sector. As it aims to make life changes in the community, it is important to come up with brilliant ideas to sustain the relevance of technology in every age.

As the healthcare sector is one of the crucial sectors that has been a world-wide topic for the past decades alongside with the growth of technology, it requires comprehensive tools to ensure the continuity of people's participation in the community (Azlan, 2019). The participation from the community is including the people who are disabled. Persons with disabilities received various benefits from the development and growth of technology to ensure they improve their lives. One of the ways, persons with disabilities gaining their privileges from technology is by receiving the best treatment to sustain their motivation.

Rehabilitation is one vital field in the healthcare sector that contributes to sustaining interaction between persons with disabilities and society. It is a term that described a range of disability responses to improve body function. Rehabilitation is an essential field to help people with disabilities regain self-esteem and improve their quality of life. Assistive technology is one of the findings from the development and growth of technology. It is known as a technology that has various types of equipment which can be used during the rehabilitation sessions (Bowker et al., 2006). Hence, assistive technology is invented to help persons with disabilities to undergo the therapies and exercises comfortably.

In Malaysia, it can no longer be denied that Malaysians have been equipped and surrounded by technology for more than 15 years. There are a lot of fields that require the enhancement and improvement by using technology as a medium to transform a

better life. As the healthcare sector is one of the most important sectors in the country, the transformation of using technology has been started earlier. Rehabilitation centers become the selected place to apply the use of assistive technology to improve persons with disabilities outcome (M. A. Ahmad et al., 2019).

The invention of assistive technology has led to the development of serious games. Serious games are an example of tools often used and deployed as an adjunct activity to non-recreational purposes like therapy and education. In assistive technology, serious games come with multi-modal functions that use the combination of text, audio, video and images. It has immersive characteristics that help assistive technology such as robotic, virtual reality, and simulator to bring new experiences for persons with disabilities to perform their rehabilitation therapies and exercises (Li et al., 2018; Merilampi et al., 2017).

One of the gaps found in the existing serious games for health care is the developmental focus that does not lead to generating motivation and usability experience for users (Ushaw et al., 2017). As assistive technology comes intending to facilitate users, it is important to promote positive outcomes from the development of serious games for rehabilitation. User experience is an essential field of study to ensure the relationship of emotions and behaviours in users in continuing. Hence, with the intervention of motivation and usability factors in developing serious games needs to be done to assure the continuity of positive feedback among users in rehabilitation.

There are few researchers from previous studies have highlighted the importance of having the motivation and usability attributes in helping the patients to sustain and maintain their focus and attention to the exercises and therapies held by the rehabilitation centre (Bonnechère et al., 2016; Hellweger et al., 2015; Merilampi et al., 2017, 2019). However, few outlined attributes that can turned out to be similar for both

factors though they have their own roles in user experience fields. Alongside of searching the best model to be applied for this research, none of the models are combining motivation and usability as the main factors. Though two different models can be used as references for user experience factors, yet not all models can be implemented together.

As this research is focusing on enhancing the user experience model through motivation and usability factors, here are examples of previous research that use only one specific user experience model in their studies. The exploration of serious games for rehabilitation using user experience is focusing on usability factors (Mubin et al., 2020) meanwhile (Merilampi et al., 2018) is focusing on the importance of motivation in serious games for rehabilitation. Hence, the research aims is to bridge the gaps in serious games development for rehabilitation and user experience model by focusing on the relationship between motivation and usability factors as it is important to use both factors to develop serious games for rehabilitation.

### **1.3 Problem Statement**

An attempt to increase the quality of recovery for persons with disabilities starts with rehabilitation therapy that use assistive technology. With the help of the assistive technology, persons with disabilities can increase, improve, and maintain their functional capabilities throughout the rehabilitation sessions and therapies (Bowker et al., 2006). Serious games provide a real-life environment and create different experiences from the standard rehabilitation therapies and exercises (M. A. Ahmad et al., 2019; Merilampi et al., 2017). Hence, serious games brings more satisfaction for persons with disabilities to experience the treatment comfortably.



The reinforcement of serious games is notably known as one of the methods for users to adapt to a new environment while doing the therapy and exercise sessions. With that, it brings a new user experience for persons with disabilities to go through rehabilitation. Recently, serious games act as an aid to daily exercises during rehabilitation sessions. Interactive and immersive serious games are the important modes that focuses on social interaction to promote the enjoyment and a real life experiences for users (Bond et al., 2019; Jerčić et al., 2018; Pramana et al., 2018; Tageldeen et al., 2017).

Unfortunately, not all persons with disabilities can play serious games as one of the ways to gain motivation and upgrade their health as they need specific characteristics in making the engagement with computers and robots (Baur et al., 2018; Elor et al., 2019; Novak et al., 2014; Prahm et al., 2017; Vugts et al., 2016). The recent development of serious games for rehabilitation purposes is not focusing on sustainability on motivation and usability for persons with disabilities during the exercises (Merilampi et al., 2018, 2019). Hence, the significance of the research is to highlight the importance of motivation and usability based on the previous research on the development of serious games for rehabilitation.

In Malaysia, the development of technology that focuses on rehabilitation is in the making. There is a lot of previous research mentioning the importance of having motivational and best-developed assistive technology using serious games as a medium to improve the life quality of disabled persons. However, there is no specific serious games were developed aiming to provide health by sustaining performance through motivation. As user experience is a study to emphasize user's feelings in terms of quality, context, and relationship with other people, it is important to highlight the effect of using serious games for rehabilitation (Tokkonen & Saariluoma, 2013).

Motivation and usability factors in serious games are important in building self-esteem (Kusec et al., 2018; Merilampi et al., 2018; Siegert & Taylor, 2004). Self-management is a way to empower a person to be as fit as a fiddle by remaining active and taking more responsibility for their health condition. It requires knowledge, motivation, as well as easy-to-use and safe to facilitate performances while using serious games for rehabilitation (Merilampi et al., 2018). However, it is not an easy way to have a self-care without the help of proper exercises and motivation booster especially for person with disabilities.

Several strategies have been proposed to improve patients' motivation and exercise intensity during rehabilitation, yet not many invented real-life serious games to explore the potential ways to reach the goal (Novak et al., 2014). Thus, it is important to understand the needs of user experience though it will leads to many perspectives that can be combined as one (Law et al., 2009). The social impact of serious games on user experience shows a significantly higher in terms of empathy, positive feeling, and behavioral involvement where social interaction is intended (Pereira et al., 2019). Consequently, motivation and usability are two factors in user experience that keep coming up in the previous researches from (Baur et al., 2018; Merilampi et al., 2017, 2019; Olens, 2012).

There are more than 50 keywords have been mentioned in the recent studies from the year of 2015 until 2020 on motivation and usability factors in serious games. As a result, some of the research focuses on measuring users' perspectives and experiences with the use of serious games for rehabilitation (Merilampi et al., 2018, 2019). Over the years, user experience becomes a key concept in designing an interactive products. However, the term itself lacks a proper theoretical definition and is used in many different ways especially in academic and industry (Basri et al., 2017).

There are a lots of models for measuring user experiences such as Nielsen's Usability Model, The ARCS Motivation Model, The International Standardization Organization (ISO), The Intrinsic and Extrinsic Motivation and Technology Acceptance Model (TAM). Despite the invention and innovation of each model coming with different objectives, there is no specific model that covers both motivation and usability factors in user experience (Hussain et al., 2016). The invention of assistive technology brings lots of benefits to the rehabilitation field by using serious games as tools to undergo therapies and exercises.

User experience on the other side becomes the main term to explore set of emotions, behaviors, and attitudes towards people with disabilities while they interact with computers and robots (Hashemi & Herbert, 2015). Hence, it is important to have focus research on motivation and usability factors in user experience using serious games for rehabilitation as it brings an impact on persons with disabilities in their daily life.

#### **1.4 Research Questions**

The questions below are the gaps found and need to be solved from the statements above.

1. What are the attributes of motivation and usability factors in user experience on serious games?
2. What are the relationships between motivation and usability factors that affect user experience in serious games?
3. How to enhance the new user experience model for serious games using motivation and usability factors?

## 1.5 Research Objectives

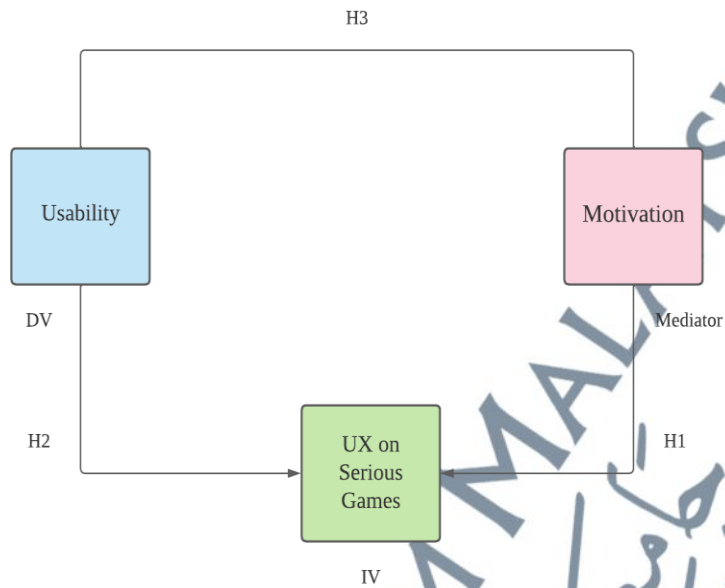
The objectives as follows are clearly stated to overcome and solve the problems.

1. To identify attributes in motivation and usability factors in user experience that influence on serious games.
2. To determine the relationship between motivation and usability factors towards user experience on serious games.
3. To enhance the new user experience model on serious games for rehabilitation.

## 1.6 Research Hypothesis

This section is the continuity of the second research objectives which focuses on exploring the relationship between user experience factors and serious games. The hypotheses are proposed with three main concerns. Figure 1.1 shows the the chart of relationships that refers to the second research objective. The research hypotheses are formed based on motivation and usability factors towards user experience on serious games for rehabilitation. Following Table 1.1 displays a set of relationships which explains three hypotheses from Figure 1.1.





**Figure 1.1: Relationships from Research Hypothesis**

**Table 1.1: List of Main Relationships**

No	Hypotheses
H1	Motivation factor is significantly affecting user experience in serious games
H2	Usability factor is significantly affecting user experience in serious games
H3	Usability factor is depending on the motivation factor as a mediator that significantly affects user experience in serious games

Table 1.1 shows the hypothesis 1 which uses the motivation factor to correlate with user experience on serious games meanwhile hypothesis 2 is focusing on the usability factor in the relationship with user experience on serious games. The final hypothesis on the other hand, focuses on user experience in serious games as the independent variable with the motivation factor acting as a mediator and a causal

antecedent of usability factor. Hence at the end of the calculation, the third research objective is started to be formulated.

## 1.7 Research Scope

The study sought to examine the relationships between motivation and usability factors in user experience towards serious games for rehabilitation.

**Table 1.2: Research Inclusion and Exclusion Criteria**

Scopes	Inclusion Criteria	Exclusion Criteria
Venue	A rehabilitation centre in Malaysia where the assistive technology and serious games are used as the medium for persons with disabilities to undergo rehabilitation sessions	A rehabilitation centre that uses standard rehabilitation with no participation of assistive technology and serious games as the medium to undergo rehabilitation sessions
Respondent	Patients who are healthy enough to perform the sit-to-stand exercise prescribed by the physiotherapists and who can follow English instructions	Patients who are unable to perform a sit-to-stand exercise and unable to understand English instructions
Gender	Male and female	None of these two
Age	20-50 years old	None of the mentioned age
Group	Patients who are selected by the physiotherapists are from the spinal cord injury, stroke,	Patients without these four diagnoses and has clear

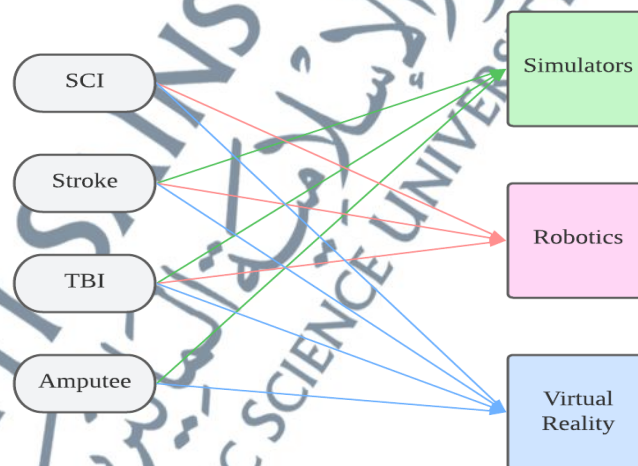
	traumatic brain injury and amputee patients who have less neurology impairment	neurology impairment are not selected
Assistive Technology using Serious Games	Robotic, simulator, and virtual reality	None of these three technologies
Design method	Survey design and quantitative method via questionnaire. 15 samples from respondents are taken for each assistive technology	None of the criteria

Table 1.2 explains the inclusion and exclusion criteria for the whole research. The research is held in SOCSO Tun Abdul Razak Rehabilitation Centre which is located in Malaysia. The main reason for choosing this rehabilitation centre is depending on the use of technology while undergoing therapies and exercises. There are lots of rehabilitation centres in Malaysia, yet SOCSO Tun Abdul Razak Rehabilitation Centre is the only centre that use serious games in each rehabilitation sessions. The rehabilitation centre is equipped with various types of assistive technology that use serious games for exercises. The assistive technologies are robotic, simulator, and virtual reality.

Next, the selection of respondents for this study was based on the prescription and suggestions from the experts in the physiotherapy field. Hence, patients who are able to perform sit-to-stand exercises and are healthy enough to play serious games while undergoing rehabilitation are selected for this study. They are the selected respondents who understands simple English instruction from the games and have less

neurological impairment. There is no minimum requirement for gender in this research, thus the respondents are both male and female gender range in age from between 20 to 50 years old. As the respondents are prescribed and suggested by the physiotherapists, they have been divided into four (4) groups based on their capabilities and diagnosis of health.

The four (4) groups are coming from spinal cord injury (SCI) patients, stroke patients, amputee patients, and traumatic brain injury (TBI) patients. As SOCSO Tun Abdul Razak Rehabilitation Centre is using three (3) different types of assistive technology that use serious games for rehabilitation, the four (4) response groups are likewise split based on the specific assistive technology according to their abilities. The division of respondents from the groups is explained precisely in Figure 1.2 below.



**Figure 1.2: Division of Respondents in Each Assistive Technology**

The last inclusive criterion for this research is focusing on the design method.

The design method used is survey design and quantitative-based method. As the survey design and quantitative-based method are used in this research, all respondents are



ended up answering the questionnaire after completing all the therapy sessions. Each respondent will only play with the selected assistive technology prescribed by the physiotherapists. The research is held in the middle of the coronavirus attack, hence there are limitations in getting more respondents in that period. As a result, each assistive technology is generated 15 samples, totalling 45 respondents from 4 different groups of diagnosis.

### **1.8 Research Significance**

The research is aimed to study and contribute to the community especially on persons with disabilities and the technology community. The importance of choosing a rehabilitation centre as the place to make the contributions is to make sure the continuity of motivation for persons with disabilities to undergo the exercises daily. The importance of sustaining the motivation among the patients with various types of impairment in the rehabilitation centre has become more challenging without the help of assistive technology that implies serious games as tools to do the therapy. Hence, with the energy and time given, the contributions to the rehabilitation centre where the whole research is taking place are one of the important focuses.

As the purpose of research is to enhance the user experience model using motivation and usability factors in serious games for rehabilitation, it is important to identify the attributes of motivation and usability factors. The identification of attributes is to show the relationship between user experience and serious games and the impact produced by both. Hence, the third research objective is achieving its target. The enhancement of the user experience model is aimed to assist serious games developers in developing motivational games with an additional of few attributes in usability.

This research contributes to generating new ideas for improvement and progression in the technology community. Hence, the significance to perform the research is to help benefits the growth of technology among people who are undergoing rehabilitation sessions to improve their daily life.

## 1.9 Research Structure and Organization

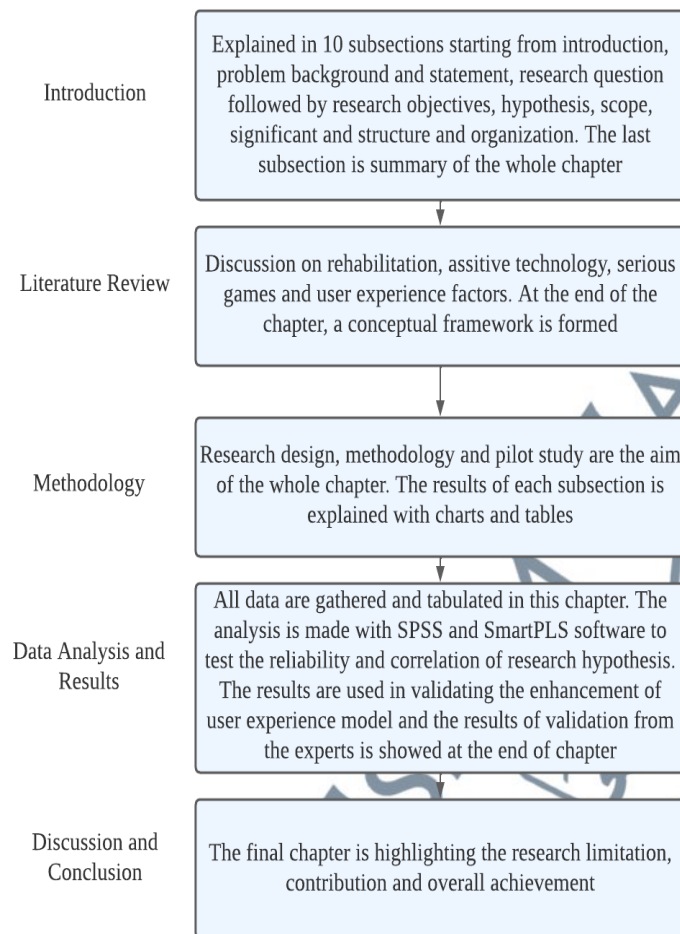
The structure of this research is organized based on the research questions and objectives. The proposed methods are used to achieve the objectives of this study. Table 1.3 shows the constructed research methodology model that explains the specific method for research objectives and questions.

**Table 1.3: Research Structure and Proposed Methods**

Research Questions	Research Objectives	Methods
What are the attributes of motivation and usability factors in user experience on serious games?	To identify attributes in motivation and usability factors in user experience that influence on serious games.	Literature Review
What are the relationships between in motivation and usability factors that affect user experience in serious games?	To determine the relationship between motivation and usability factors towards user experience on serious games.	Hypotheses design, Survey design and quantitative method, Statistical Packages for Social Sciences (SPSS) used for reliability test, Partial Least Square - Structural Equation Modeling (PLS-SEM) for

		correlation test using SmartPLS software
How to enhance the new user experience model for serious games using motivation and usability factors?	To enhance the new user experience model on serious games for rehabilitation.	PLS-SEM

Table 1.3 shows the methods used in each research question to reach the objective of the research. For the first research question, the method used is a literature review from previous research. The second objective is completed using hypothesis design followed by survey design and quantitative design. For this objective, it involves calculation using SPSS software for reliability tests and SmartPLS software for correlation tests on PLS-SEM. Finally, the last objective is obtained using the PLS-SEM method. Figure 1.3 shows the thesis organization from Chapter 1 until Chapter 5 which summarizes the whole activities in this research.



**Figure 1.3: Thesis Structure and Organization**

Chapter 1 explains the introduction and research background where research questions and problem statement were derived. The objectives of the research were clearly mentioned to answer the research questions and yet followed by the view of the relationship based on two user experience factors. The whole chapter 1 is showing the general information of the whole research where the research structure and thesis organization were explained before the summary.

In chapter 2, the main concepts of the research are generated from the relevant literature reviews. The systematic review is used to identify the overview of rehabilitation, serious games, and user experience factors. The attributes of user



experience factors are recognised from the relevant previous studies. The justification for proposition of the questionnaire and the selection of the assistive technology is explained in this chapter. The next chapter is the methodology chapter which discussed on research design, methodology and the results of the pilot study. In this chapter 3, the significant reason for choosing PLS-SEM is explained.

Chapter 4 consist of data analysis where all attributes from motivation and usability factors and relationship are determined. The results from questionnaires are tabulated in the form of four main analyses: Cronbach's Alpha, Internal Reliability, AVE, and Path Coefficient. At the end of this chapter, there will be a discussion on model validation from the experts. The post model is proposed and followed the recommendation based on the results of PLS-SEM and the expert. The last chapter in this research is chapter 5 where the aim is to discuss the research limitation, contribution, and overall achievement.

### **1.10 Summary**

As a result of technology advancement, assistive technology is presently being developed all over the world. The use of assistive technology in the healthcare sector especially in the rehabilitation field leads to the invention of serious games for rehabilitation. Serious games act as an adjunct tools of assistive technology that aimed to bring new experiences to persons with disabilities to undergo therapies and exercises. However, there are limitations on serious games for rehabilitation when it comes to user experience. Motivation and usability factors are used in this research as suggested in the previous studies.

Hence, the research questions and objectives are derived from the problem background and statement involving user experience and serious games for rehabilitation in Malaysia by referring to the previous studies. The research hypotheses are derived based on the second objective which is to determine the relationship between user experience factors on serious games for rehabilitation. There are three (3) main hypotheses that require many methods to measure the correlation. The following subsection in this chapter is explaining the research significance, scope and thesis organization by grouping the information using tables and figures.

