CHAPTER 4

Gamification in Hand Rehabilitation Following Stroke

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4.1 INTRODUCTION

Ischaemic heart disease and stroke are widely recognised as the leading causes of mortality on a global scale, contributing to 16% and 11% of the total deaths, respectively (World Health Organization, 2020). Stroke is a non-traumatic brain injury, and its effect on patients varies depending on which part of the brain is injured. A stroke can result in prolonged disabilities and brain damage; stroke can lead to death in more severe cases. According to World Health Organization (WHO), in the 2018 World Health Ranking report, deaths due to stroke have reached 13,799 deaths or 9.80% of total deaths in Malaysia and ranked third as the disease that causes the most death after lower respiratory infection in Malaysia (World Life Expectency, n.d.).

A stroke may also lead to impairments of body function, such as upper limb impairment that limits the hand functionality of a patient due to significant loss in neuromusculoskeletal or deviation in the nervous system. Weakness or paralysis is the typical upper limb impairment as a direct sequence of damage to the primary motor cortex, which generates the movement impulses. The deficiency in movement signals to the spinal cord causes a delay in the

initiation of muscle contraction, which causes stroke patients to have difficulty moving and coordinating their hands and fingers, impacting their daily activities. Strokes are classified into five types (Kwakkel et al., 2013), as below:

(1) Early hyperacute (a stroke that is 0–6 hours old)
(2) Late hyperacute (6–24 hours)
(3) Acute (24 hours to 7 days)
(4) Subacute (1–3 weeks)
(5) Chronic (more than three weeks)

The process of recovering from a stroke is different for each person. It requires perseverance and consistent treatment from both the patient and the caregiver. Those who participated in a rehabilitation program and showed an improvement in their upper limb movement quality within four weeks after stroke have a 90% chance of recovery (Kwakkel et al., 2013). A study by Welmer et al. (2008), discovered that more than 50% of 18 months of post-stroke patients had limited fine hand use, while a study by Tyson & Selley (2007) addressed the effectiveness and intensity of rehabilitation interventions.

The stroke treatment and rehabilitation aim to help the patients to relearn their skills and gain strength after a stroke affects the brain. For example, motor-skill exercises improve post-stroke patients' muscle strength and coordination, and range of motion therapy helps regain the patient's range and motion. Moreover, Functional Electrical Stimulation (FES) is a method to relieve the patients' muscles by applying electricity to the weakened muscle and easing muscle tension (Scano et al., 2022).

4.2 REHABILITATION TECHNOLOGY

4.2.1 IoT-based Rehabilitation Devices

The Internet of Things (IoT) refers to a network that facilitates the connection of many entities to the internet, enabling the interchange and transmission of data. This connectivity is achieved by the utilisation of technologies such as RFID, infrared sensors, GPS, laser scanners, and other sensor devices (Chen et al., 2012). Consequently, it possesses the capability to discern, determine the location of, trace, oversee, and effectively regulate incoming and outgoing data. Moreover, with the continuous advancement of information technology, IoT is becoming increasingly interconnected with the field of medicine. IoT is considered to be the predominant technology that facilitates the connection of various medical services and devices, enabling them to integrate seamlessly into a community-based intelligent rehabilitation system (Li et al., 2011). IoT network is established through a network of networked devices within healthcare systems. These gadgets possess the capability to monitor patients and execute automated detection processes, even in the absence of medical expertise.

Rehabilitation exercises can be done at the hospital by trained professionals and at home with the caregiver's help. The latter will benefit the patients as they can relearn the skills where they will be most helpful. However, due to the complex rehabilitation needs of a stroke patient, the home-based programme sometimes faces limitations in terms of the availability and intensity of rehabilitative interventions. Many IoT-based devices, particularly performance monitoring, have been developed to assist caregivers in delivering aid to patients during home-based rehabilitation programs. For example, a full-