



UNIVERSITI TEKNIKAL MALAYSIA MELAKA

**DESIGN AND DEVELOPMENT OF SEATED FOOT PRESS
ASSISTIVE DEVICE FOR RETURN TO WORK REHABILITATION**

This report submitted in accordance with requirement of Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor Degree of Manufacturing Engineering (Manufacturing Design and Honours.)

by

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DECLARATION

I hereby, declared this report entitled “Design and Development of Seated Foot Press Assistive Device for Return to Work Rehabilitation” is the results of my own research except as cited in reference.

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APPROVAL

This report is submitted to the Faculty of Manufacturing Engineering of Universiti Teknikal Malaysia Melaka as a partial fulfillment of the requirements for the degree of Bachelor of Manufacturing Engineering (Manufacturing Design)(Hons).

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ABSTRAK

Process pemulihan dapat membantu pesakit strok untuk meningkatkan ketidakupayaan mereka menggunakan peralatan bantuan atau mesin di pusat pemulihan. Mesin tekan kaki duduk merupakan salah satu mesin yang digunakan oleh mereka untuk memperbaiki dan mengekalkan kekuatan otot kaki. Walau bagaimanapun, semasa latihan tekan kaki duduk, otot mereka berasa lemah, keletihan dan sakit disebabkan gerakan berulang-ulang serta menyebabkan penurunan pesat. Oleh itu, objektif projek ini adalah untuk mengenalpasti isu mesin tekan kaki duduk dan keletihan otot pesakit dengan memerhatikan dan menjalankan kajian di Pusat Pemulihan PERKESO (PRC). Sejumlah lapan borang soal selidik telah diedarkan kepada pesakit yang menggunakan mesin tersebut untuk mengetahui masalah mereka. Selepas memerhatikan masalah mereka, didapati mesin tersebut tidak mempunyai alat bantuan untuk membantu pesakit semasa latihan pemulihan. Oleh itu, alat bantuan untuk mesin tersebut direkabentuk untuk membantu pesakit semasa latihan. Spesifikasi reka bentuk alat bantuan ini adalah berdasarkan keperluan pesakit dan mengikut spesifikasi data antropometri lelaki dewasa Malaysia. Reka bentuk alat bantuan dipilih menggunakan kaedah pemeriksaan dan pemarkahan berdasarkan beberapa kriteria untuk memuktamadkan konsep yang terbaik sebelum menggunakan peranti SolidWorks. Alat bantuan ini terbahagi kepada dua bahagian iaitu tapak kasut percetakan 3D dan system plate. Perisian CES EduPack digunakan untuk memilih bahan-bahan yang terbaik untuk alat bantuan. *Polylactic acid* (PLA) digunakan untuk menghasilkan tapak kasut dengan menggunakan mesin Terlakur Model (FDM). Bagi system plate pula, beberapa process pembuatan seperti kimpalan, penggerudian dan proses penamatan digunakan. Akhir sekali, untuk menganalisis keberkesanan produk, ujian simulasi persekitaran dijalankan di Thor Fitness Gymnasium dengan dan tanpa menggunakan alat bantuan yang dicipta. Borang kajian penilaian produk turut diedarkan kepada responden. Dari keputusan itu, semua responden berpuas hati dengan produk tersebut kerana ia dapat membantu mereka untuk mengurangkan keletihan otot mereka dan penurunan pesat ketika latihan tekan kaki duduk.

ABSTRACT

The rehabilitation process is helped the stroke patients to improve their disability by using the assistive equipment or machine in the rehabilitation center. The seated foot press is one of the machines that used by the stroke patients who had a disability of their leg to improve and maintain the muscle strength. However, during the seated foot press exercise, their muscles will feel weak, fatigue and painful due to the repetitious motion and caused the rapid drop. Therefore, the objectives of this project are to identify the issue of seated foot press machine and the muscle fatigue of rehabilitation patients by observing and conducting a survey in PERKESO Rehabilitation Center (PRC). The total of eight questionnaires was distributed to the patients who have experience using the seated foot press at the gymnasium in order to know their problems. After observing their problems in the PRC, there was no assistive device for seated foot press to help patients assist them during the exercise. Therefore, an assistive device for seated foot press is developed to help the patients. The design specification of this design of assistive device is based on the patient's requirement. The proposed design is selected using screening and scoring method based on a few criteria to finalise the best design concept for the supporting device before visualize the design using SolidWork software. The selected design was divided by two parts which are 3D printing insole and fabricated plate system. CES EduPack software is used to select the best materials for the device and polylactic acid (PLA) material is selected to develop the insole using Fused Deposition Modelling (FDM) machine. For the plate system, other manufacturing process is used to fabricate the plate. The process involved were welding, drilling and finishing process. Lastly, in order to analyse the effectiveness of product, a simulated environment testing is conducted at Thor Fitness Gymnasium with and without using the device and a survey of product evaluation is distributed to the respondent in order to evaluate the product. From the result, all the respondents satisfied with the product that helps them to reduce their muscle fatigue and rapid drop.

DEDICATION

Only
my beloved father, Ahmad Bakhtiar bin Mustapa
my appreciated mother, Hashimah binti Abdul Razak
my adored sisters,
for giving me moral support, money, cooperation, encouragement and also understandings
Thank You So Much & Love You All Forever

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LIST OF ABBREVIATIONS

PERKESO	-	Pusat Keselamatan Sosial
PRC	-	PERKESO Rehabilitation Center
PLA	-	Polylactic acid
FDM	-	Fused Deposition Modeling
3D	-	3-Dimensional
SD	-	Standard Deviation
SEM	-	Standard Error of Mean
CV	-	Coefficient of Variation
QFD	-	Quality Functional Deployment
CAD	-	Computer Aided Design
STL	-	Standard Triangulated Language

CHAPTER 1

INTRODUCTION

This chapter discusses about the project background, includes the brief description about the seating foot press equipment and the usage of this equipment. Furthermore, problem statement, the objective, project scope, project planning and execution and rationale of the project and outline of the thesis are also presented in this chapter.

1.1 Background

Stroke is a major global health problem. Patrizia Poli et al. (2013) found that, there is estimated that 25% to 74% of the 50 million stroke survivors around the world require some assistance or are fully dependent on caregivers for activities in their daily activities after the stroke.

The rehabilitation process after an injury or surgery is an exercise conditioning program that helps the patients return to activities of daily living and also enjoy a more active and healthy lifestyle. The rehabilitation goal in post stroke subjects is to promote recovery of lost function and to allow independence into social and domestic life. Patrizia Poli et al. (2013) also stated that the number of people that require rehabilitation after stroke is growing rapidly from time to time, with increasing costs and pressure on health care budgets. They require continuous medical care and intensive rehabilitation often with a therapist in the rehabilitation center. Hence, there is an urge for new technologies improve the efficacy and effectiveness of their rehabilitation by introducing the assistive device in the rehabilitation process.

Therefore, in order to fully exploit this potential, this project intends to design and develop an assistive device of seated foot press in a PERKESO Rehabilitation Center (PRC) in the rehabilitation gymnasium. This is because there is no assistive device for seated foot press to assist the patients during their exercise. This may occur to a rapid drop of leg if they feel weak, painful and tired at their leg muscle, which is muscle fatigue that due to the repetitive motion. This device is to help the patients from any injuries and hazards when they reached the muscle pain and tiredness level. Assistive device and rehabilitative technology refer to tools, products or equipment that used to help a disable person to function more easily in their daily activities such as walking, running, communicate or to get dressed (FCTD n.d, 2012). Figure 1.1 shows the machine of seated foot press in a PERKESO Rehabilitation Center. Therefore, a survey is conducted to collect the information of the seated foot press and also to get a patient's requirement for designing the device. The survey is distributed to patients in PRC, especially at gymnasium department. The survey consists of information about the patient's illness or injury, which part of their body feels fatigued and their design requirement to design an assistive device. After fabricating the device, a tested is conducted to analyse the effectiveness of the device. Then, a survey of product evaluation is distributed to the respondents in order to get the feedback from them after using the assistive device.



Figure 1.1: The seated foot press machine (PERKESO Rehabilitation Center, 2016).

1.2 Problem statement

The process of recovering from a stroke commonly includes spontaneous recovery and need a treatment of rehabilitation. This rehabilitation helps the stroke survivors keep their

abilities and gain back the lost abilities to become more independent (Agency for Health Care Policy and Research, 1995). Seated foot press exercise is one of the treatment activities that used in the gymnasium in the rehabilitation center by using the seated foot press machine. However, due to the repetition activities while pressing the foot platform of the machine, the patient's muscle felt fatigue, weak and painful. Due to the problem, there is another severe injury occurred during the exercise which is leading to a rapid drop after repetitive motion. After observing this situation in the PRC, the issue was coming up through the seated foot press. The issue was this machine didn't have any supporting mechanism to support the leg of the patients in PERKESO Rehabilitation Center during the treatment.

1.3 Objectives

The objectives of this project are:

- i) To identify the issues of seated foot press and the muscle fatigue of rehabilitation patients due to the repetitive motion.
- ii) To design and develop an economical and mobile supporting device to solve the muscle fatigue problem for rehabilitation (PERKESO) clients.
- iii) To test and analyse the effectiveness of the development of the assistive device for seated foot press.

1.4 Scope of project

The scope of this project will be covered in the design of an assistive device seated foot press. The design work will include the application of three dimensional (3D) SolidWorks software. Besides that, this project aims to fabricate a supporting mechanism to support both legs of the patients. After designing and fabricating the prototype of supporting device, a test is conducted to determine the effectiveness of the prototype could reduce or solve the muscle fatigue of patients while using the machine with and without using the assistive device. Then, a survey of product evaluation is distributed during the testing to get the feedback about the prototype. Basically, this project will contribute to enhance the

functionality of the seated foot press of maintain and improve muscle strength as well to increase the comfort for patients. Moreover, it was developed to increase the safety and avoid any unexpected injuries while the seated foot press exercise at the gymnasium department in PERKESO Rehabilitation Center.

1.5 Project Planning and Execution

The Gantt chart is constructed to list all the related task and possible time to finish respective task from the start of the project until report submission. This project schedule is presented in Appendix A.

1.6 Rationale of Project

This PSM 1 report is compromised of a further four chapters as follows:-

- Chapter 2: Literature Review

Based on the reference gathered, this chapter will discuss the aspects of concept of seated foot press and assistive device for the rehabilitation patients.

- Chapter 3: Methodology

This chapter discusses the research methodology that was used to gather the data required to support the development and analysis of the study. This chapter includes the data gathering method, detail discussion and the steps of development assistive device of the seated foot press.

- Chapter 4: Result and Discussion

The design concept will be obtained. The analysis will be done to select the best design and next will be proposed to PERKESO Rehabilitation Center.

- Chapter 5: Conclusion and Recommendation

It will summarize the overall findings and discussion of the project. In addition, suggestions for continuing the work outlined in this study are presented.

CHAPTER 2

LITERATURE REVIEW

In this chapter, it will discuss about the literature review in order to study and understand the existing assistive technology for rehabilitation patient's system which is the fact later will be used as a guide to develop the application which is concentrate to the system and issues of seated foot press, the muscle fatigue during the seated foot press exercise, the anthropometry data of foot of Malaysian population in order to design the assistive device for seated foot press.

2.1 Introduction of Seated Foot Press

Rachel Nall (2013) stated that the seated foot press is basically used for a bodybuilder or athletes who want to improve or maintain their muscle strength, especially in the lower body. This machine is a common weight-training exercise that targets the precise muscle such as quadriceps muscles in front of each thigh. The targeted muscles are depending on how the position of the feet in the machine (M.L Rose, 2014). Figure 2.1 shows the targeted muscle, which is quadriceps muscle.



Figure 2.1: Quadriceps muscle
(Sources: <http://www.evolutionfit.it/esercizi/immagini/MAPPA-MUSCOLARE-QUADRICIPITI-Pressa-Orizzontale.jpg>)

2.1.1 System structure of Seated Foot Press

The machine consists of an adjustable seat with a wide foot platform that allows people to change their foot positions. It also has an adjustable weight stack at the end of the lever system. The stack can be adjusted to the desired weight (a stack, 20 lbs.) of user wanted by pinning the stack. Next, the seated foot press has a grip hand-hold on the both sides of the seat. It used for user to grip their hand on the sides of the machine during the extending their legs with foot pedal platform. The grip hand-hold can prevent the user from an unstable condition while using the seated foot press.

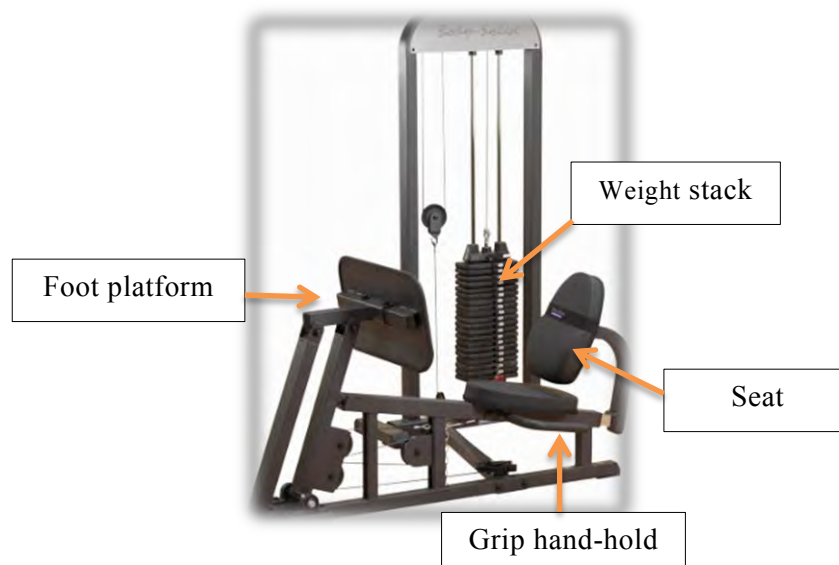


Figure 2.2: Structure of Seated Foot Press
(Sources: <https://bodysolid-europe.com/products/body-solid-leg-calf-press-machine-glp-stk?variant=7815025861>)

2.1.2 System operation

The operation of seated foot press consists of body position and movement. The users sit down at the machine and then place their leg wider than shoulder width on the foot pedal platform. Then, the users must grasp the grip hand-hold and maintain their good spinal position with the chest and head looking forward. The users need to make sure that they do not lock their knees so that it can prevent them from a knee injury. Next, adjust the weight of stack to desire weight by pinning a weight on the weight stack tightly. After that, the user is pushed the foot platform with their heels and go back to