



**PORTABLE LIFT WHEELCHAIR FOR DISABLED PEOPLE TO
TRANSFERRING FROM WHEELCHAIR TO CAR SEAT BY
USING HOUSE OF QUALITY**



**BACHELOR OF MECHANICAL ENGINEERING TECHNOLOGY
(AUTOMOTIVE TECHNOLOGY) WITH HONOURS**

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**Faculty of Mechanical and Manufacturing Engineering
Technology**



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**Bachelor of Mechanical Engineering Technology (Automotive Technology) with
Honours**

(2022)

**PORTABLE LIFT WHEELCHAIR FOR DISABLED PEOPLE TO
TRANSFERRING FROM WHEELCHAIR TO CAR SEAT BY USING HOUSE OF
QUALITY**

NORFIRDAUS AZIMI BIN ROSLAN

A thesis submitted
in fulfilment of the requirements for the degree of
**Bachelor of Mechanical Engineering Technology (Automotive Technology) with
Honours**



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2022

DECLARATION

I declare that this thesis entitled “ Portable Lift Wheelchair For Disable People To Transferring From Wheelchair To Car Seat By Using House of Quality ” is the result of my own research except as cited in the references. The Choose an item. has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

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APPROVAL

I hereby declare that I have checked this thesis and in my opinion, this thesis is adequate in terms of scope and quality for the award of the Bachelor of Mechanical Engineering Technology (Automotive) with Honours.

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DEDICATION

This commitment is dedicated to my beloved father, Roslan bin Abd Salam and beloved mother, Pakhitah Mohd Nor. Not forgetting to all my supportive family, friends, and my cherish supervisor Assoc. Prof. Ts. Dr. Muhammad Zahir Bin Hassan.



ABSTRACT

A wheelchair is a wheeled chair for use as a mode of transportation by someone unable to walk due to sickness, accident, or disability. This thesis detail research into the development of modelling and control mechanisms for a multipurpose wheelchair that can be used as a mobile transporter for the elderly and disabled. The study aims to help people with physical disabilities in their lower extremities to transfer its body to car seats without the need for human assistance. Transferring a patient to the car seat is the most difficult obstacle for wheelchair users. Since not all public places cater to those who need less effort, especially wheelchair users, they must rely on the assistance of others. Given this case, wheel seats that can lift their seat height are needed. This study aims to propose a design of a Portable Lift Wheelchair that can ascend or descend a seat, making it easier for wheelchair users to transfer ts body to a car seat easier. The mechanism that developed the wheelchair system is made up of a manual wheelchair seat for positioning according to the height of the passenger seat in a certain car. The wheelchair user must rotate the mechanism rotation bar to adjust the wheelchair seat height. As a result, the wheelchair will be able to lift its seat upward parallel to the passenger seat.



ABSTRAK

Kerusi roda merupakan kerusi beroda yang digunakan sebagai medium pengangkutan oleh seseorang yang hilang daya berjalan disebabkan oleh faktor kesihatan, kemalangan ataupun hilang upaya. Kajian ini dilakukan bertujuan untuk membina dan mereka bentuk bagi mewujudkan kerusi roda pelbagai guna yang boleh digunakan untuk orang kurang upaya atau orang yang berumur dalam memudahkan urusan harian mereka. Tujuan kajian ini adalah untuk membantu pesakit yang mempunyai masalah fizikal pada bahagian bawah badan untuk mengalihkan badan mereka ke kerusi kereta bahagian penumpang tanpa bantuan orang lain. Mengalihkan badan ke kerusi penumpang kereta merupakan satu cabaran bagi pengguna kerusi roda. Memandangkan tidak semua tempat mempunyai kemudahan bagi Orang Kurang Upaya khususnya yang berkerusi roda, maka mereka memerlukan dan berharap pada pertolongan orang lain. Oleh itu, tempat duduk pada kerusi roda yang boleh diangkat lebih tinggi dari kebiasaan amatlah diperlukan dalam mengalihkan pengguna kerusi roda kedalam kereta. Tujuan kajian ini dijalankan adalah untuk mereka semula bentuk kerusi roda yang sedia ada kepada yang lebih baik yang diberi nama “Portable Lift Wheelchair” yang boleh digunakan untuk mengangkat dan menurunkan tempat duduk kerusi roda dalam memudahkan urusan memindahkan pengguna kerusi roda kedalam kereta. Alat yang digunakan dalam kerusi roda untuk mengangkat tempat duduk untuk diselarikan bergantung pada ketinggian tempat duduk kereta. Oleh itu, pengguna perlu memusing alat yang direka khas dalam melaras ketinggian kerusi roda untuk mengangkat tempat duduk kerusi roda selari dengan tempat duduk kereta.

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LIST OF SYMBOLS AND ABBREVIATIONS

d	-	Diameter
PWD	-	Person With Disabilities
PLW	-	Portable Lift Wheelchair
HOQ	-	House of Quality
mm	-	Millimeter
Kg	-	Kilogram
cm	-	Centimeter
ISO	-	International Standardization Organization
%	-	Percent
Iswp	-	International Society of Wheelchair Professionals
Lbs	-	Pound by Weight
etc	-	Et cetera
Mpa	-	Megapascal
°C	-	Celcius
g	-	Gram
K	-	Kilo
G	-	Giga
Pa	-	Pascal
m	-	Meter
Ti	-	Titanium
“	-	Inch
CAT	-	Centre for Assistive Technology
IWRF	-	Wheelchair Rugby Federation
WHO	-	World Health Organization

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CHAPTER 1

INTRODUCTION

1.1 Background

A wheelchair is considered one of the most popular items for people with disability problems. A wheelchair is a wheeled vehicle that is intended to take the place of walking. The unit may either be driven by an engine or by the seated occupant manually spinning the rear wheels. However, a manual wheelchair has a limitation on its function, such as the seat cannot be adjusted. To lift the patient, caregivers need to use their energy and need to tilt their body forward to assist in lifting the manual wheelchair user. These phenomena can cause an injury to the caregiver in the long term.

1.2 Problem Statement

Wheelchairs were used to move a patient from one point to another point that was used for the caregiver to easily relocate the patient. Its basic operation or features are limited to only moving from one point to another point with the patient in it. However, it causes an issue when the patient needs to move from the wheelchair to car passenger, which can cause a spine effect in the long term to a caregiver. The spine is our body's central support structure that is most important in our body besides the head. The spine is our body that keeps us connected with other parts of the body for example chest, shoulder, legs, and arm. In statistics, 453258 persons registered as Person with Disabilities (PWD) at the Department of Social Welfare in 2017 (Mahidin, 2018).

To lift the patient into a car, a wheelchair seat needs to adjust its height according to the selected height of the car seat, and it needs to be adjustable either need to increase or decrease its height.

Other than that, the wheelchair seat should also be adjustable to the backward for easily the caregiver to maneuverer the patient to the car seat.

1.3 Research Objective

The objective of this research is as follows:

- a) To develop a new feature of wheelchair which is Portable Lift wheelchair (PLW) to lift a patient up from the wheelchair into the passenger car seat.
- b) To evaluate a new proposed PLW design using the House of Quality technique.
- c) To conduct structural performance of the PLW design using CATIA V5R21 software based on the different types of material based on design developed in.

1.4 Scope of Study

To specify the task for this further study, the design of Portable Lift Wheelchair (PLW) is conducted by using CATIA V5R21. However, before Portable Lift Design is sketched using CATIA V5R21. The House of Quality (HOQ) method is used to determine which concept sketches are the best based on the customer requirement approach. Some material is used to develop the strength of PLW when a force by a user is given to several parts that have been designed by using CATIA V5R21. The developed design will then be further analyzed using CATIA V5R21 to determine structural integrity and the effect of certain materials on the new PLW design model.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Wheelchair seems to be basic equipment for disabled people, older and usually temporary disabilities people. However, improper wheelchair selection can cause lower effectiveness of rehabilitation, lower patient's functional abilities (Mikołajewska, 2012). The basic function of a wheelchair is to move the patient from one point to another point in a safe condition without collapse or fell that can cause serious injury. For this safety in design regulation, World Health Organization (WHO) has set a standard or rule to produce a wheelchair to keep the patient who rides a wheelchair in good condition. One of the most common standards is International Standard Organization (ISO) which is ISO 7176-8:2014 that is used to study the requirements and test methods for static, impact, and fatigue strengths (Standard 11266, 2014). There are several standards that manufacturers need to follow to allow a company to market its product. In general, ISO 7176 is the test method that can also be used to verify the manufacturers' claims that a product exceeds the minimum requirements of this part such as it specifies the test methods for determining whether the requirements have been met. It also specifies requirements for disclosure of the test results (Standard 11266, 2014). The typical design that is used nowadays is shown in **Figure 2.1** below.

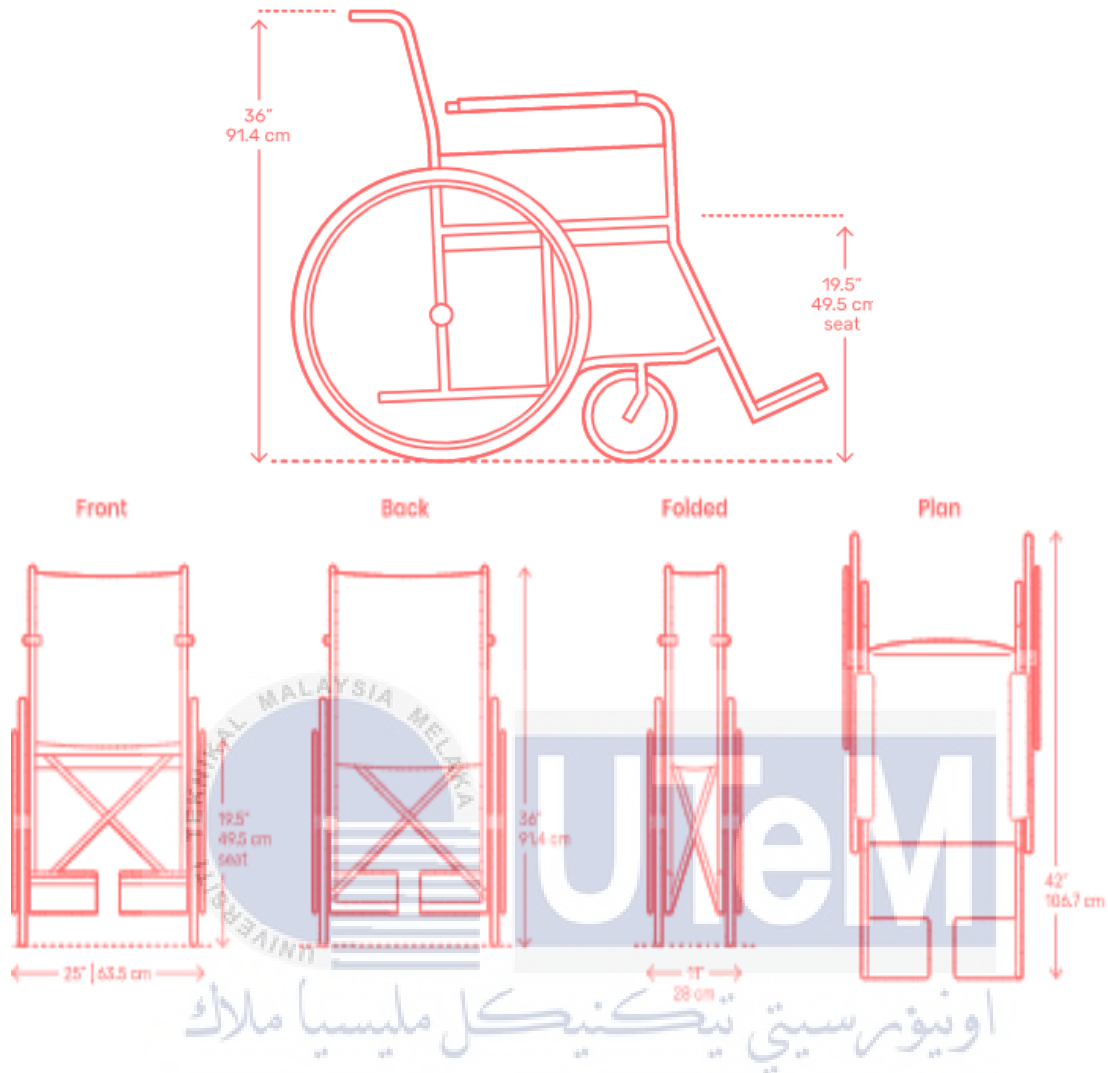


Figure 2.1 Dimension of Wheelchair

(Bryan, 2020)

In statistics, the registered Person with Disabilities (PWD) at the Department of Social Welfare, Malaysia in 2017 was 453,258 persons. PWD in the physical category recorded the highest number which was 35.2 percent followed by the other category which is visually impaired, hearing, learning disability, speech, mental, etc. (Mahidin, 2018).

For this purpose, in Japan, most of them use wheelchairs in daily life. Representative nursing care in daily life entails basing, evacuating, and feeding patients. Transfer when basing,

evacuating, and other processes cause back pain to caregivers. Therefore, a wheelchair with a lifting function is designed to assist caregivers (Mori et al., 2012).

2.2 Wheelchair Development

2.2.1 Castor Test

Wheelchair castor fail can cause physical, social, and economic consequences for a wheelchair user. These failures occur despite established wheelchair test methods and regulations, suggesting that the existing tests may not be sufficient to screen poorly designed castors (Mhatre et al., 2020). Older people are more likely to be wheelchair dependent in the community (Zepeda et al., 2016). Several test procedures are found. The testing protocol is found and applied to 8 different castor models and tested under four conditions which are shock, corrosion + shock, abrasion + shock, and abrasion + corrosion + shock. To address the primary goal of developing the testing protocol, community data and failed castor samples were collected by the International Society of Wheelchair Professionals (ISWP). **Figure 2.2** shows some failures to the castor at a certain model.



Figure 2.2 Wheel Failure

(Mhatre et al., 2020)

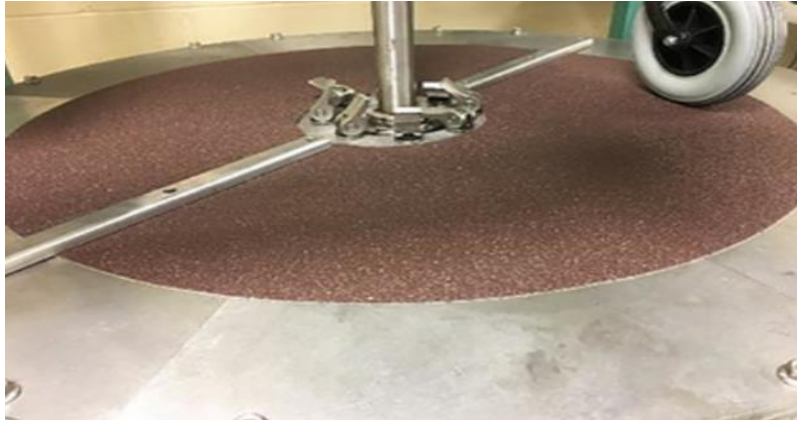


Figure 2.3 Abrasion Simulation by Attach Sanding Disc To The Table

(Mhatre et al., 2020)

To run castor test on abrasion simulation, 20 and 36 rough value sandpaper was used to assess on its own by attaching them to the table that will turn around to simulate rough surface in real life **Figure 2.3**. For this experiment, castors were loaded with at least 9.07 kg as the community result data was collected and acceleration was recorded for a one-minute duration to avoid one-off results. Contact between ground and tire can cause friction. Friction can cause tyre abrasion. Abrasion was calculated as the change in diameter of outer tyres over a specified time interval (Mhatre et al., 2020). **Figure 2.4** show different castor that has been used on the wheelchair.



Figure 2.4 Castor Model for Testing

(Mhatre et al., 2017)

From the experiment conducted on evaluation and design, these failure has a risk for wheelchair failure and wheelchair user like being injured fell off from wheelchair, slipping, etc. Some other failures may happen such as tire locking while rolling, bolts missing, and tire breaking due to the road surface(Mhatre et al., 2017).To prevent failures, the proper design and improvement are needed to make sure the quality of the product is in good condition (Mhatre et al., 2020).

2.2.2 Quality Of Life Effect on Low-Cost Wheelchair.

In the developing world nowadays, people with disabilities do not have equal and adequate access to education, employment, or medical care. A wheelchair is a form of assistive technology that can ease their daily activity (Devitt et al., 2013). Their physical or mental condition is compounded by a lack of financial and technological resources and burden with both family and state (Shore & Juillerat, 2012). This study examines the impact of a simple, denoted chair on health, quality of life.

This study used the survey method, the survey was distributed to 620 disabled recipients with different style wheelchairs in 3 different countries. India, Chile, Vietnam country are chosen in this study because their lifestyle or sample represents both rural and urban populations in varying parts of the world. The wheelchair distributes and will follow up after 12 months from the date that the chair is given.

After 12 months, final participants for the 12-month follow-up only 519 participants who are 189 from 204 in Vietnam, 201 from 206 in India, and 129 from 210 in Chile, and the rest could not be located. As a result, in Chile 53% from 129 of attrition was due to death and 16% could not use the wheelchair because their health was getting worse. Others, 16%, could