PROPOSE AND DESIGN A TRICYCLE WITH CLEANING MECHANISM

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A report submitted
in fulfilment of the requirements for the degree of
Bachelor of Mechanical Engineering (Design & Innovation)

Faculty of Mechanical Engineering

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DECLARATION

I declare that this project report entitled “Propose and Design a Ticycle with Cleaning Mechanism” is the result of my own work except as cited in the references.

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APPROVAL

I hereby declare that I have read this project report and in my opinion this report is sufficient in terms of scope and quality for the award of the degree of Bachelor of Mechanical Engineering (Design & Innovation).

Signature	:	.....
Name of Supervisor	:	.....
Date	:	.....

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DEDICATION

To my beloved mother and father.

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ABSTRACT

Cleanliness is very important to human and every country. One of the goals of Melaka is to become a 'zero waste' state but there is still a lot of rubbish in public area such as park, sidewalk, and parking lot. Waste in public area can influence the health of people nearby and also the image of a country. This project was carried out to propose and design a human-powered tricycle with cleaning mechanism to clean the city. Searching online, studying internet article, and reviewing past research were employed to collect the information. This project is conducted by following the engineering design steps, which are conceptual design, design selection, parametric design, detail design, cost analysis and design analysis. In conceptual design stage, four conceptual designs were generated by using morphological chart. In design selection stage, the best design among four conceptual designs was selected by using Pugh selection method. In parametric design stage, the pulley and gear ratio were determined in order to get the desired output. In detail design stage, the materials used for each part of the design were determined which are aluminium, plastic, steel and synthetic material. The dimensions of each part of design were also determined and converted into 3-Dimension by using CATIA V5R21 software. The total cost to fabricate a tricycle with cleaning mechanism is RM 627.20 which included raw material, manufacturing and purchase cost. In design analysis stage, CATIA V5R21 FEA was employed to analyze the critical part of final design and result shows that the final design is safe to use. The design analysis result shows that the tricycle with cleaning mechanism has good sweeping effectiveness only when it is moving at the speed between 2km/h and 5km/h.

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ABSTRAK

Kebersihan adalah sangat penting kepada manusia dan setiap negara. Salah satu matlamat Melaka adalah untuk menjadi sebuah negeri yang tiada sampah tetapi masih terdapat banyak sampah di kawasan awam seperti padang, laluan pejalan kaki, dan tempat letak kereta. Sampah di kawasan awam boleh mempengaruhi kesihatan orang yang berdekatan dan juga imej negara. Projek ini telah dijalankan untuk mencadangkan dan mereka bentuk basikal roda tiga yang menggunakan kuasa manusia dengan mekanisme pembersihan untuk membersihkan bandar. Mencari internet, membaca artikel internet, dan mengkaji laporan penyelidikan masa lalu telah digunakan untuk mengumpul maklumat. Projek ini dijalankan dengan mengikuti langkah-langkah reka bentuk kejuruteraan, iaitu reka bentuk konsep, pemilihan reka bentuk, reka bentuk berparameter, reka bentuk terperinci, analisis kos dan analisis terhadap produk. Dalam peringkat reka bentuk konsep, empat reka bentuk konsep telah dihasilkan dengan menggunakan carta morfologi. Dalam peringkat pemilihan reka bentuk, reka bentuk yang terbaik telah dipilih dengan menggunakan kaedah pemilihan Pugh. Dalam peringkat reka bentuk berparameter, nisbah takal dan gear ditentukan untuk mendapatkan output yang dikehendaki. Dalam peringkat reka bentuk terperinci, bahan yang digunakan untuk setiap bahagian reka bentuk telah ditentukan iaitu aluminium, plastik, keluli dan bahan sintetik. Dimensi bagi setiap bahagian reka bentuk juga ditentukan dan ditukar kepada 3-Dimensi dengan menggunakan perisian CATIA V5R21. Jumlah kos untuk membina satu basikal roda tiga dengan mekanisme pembersihan ialah RM 627.20 termasuk kos bahan, kos pembuatan dan kos pembelian. Dalam peringkat analisis terhadap produk, CATIA V5R21 FEA telah digunakan untuk menganalisis bahagian kritikal produk dan keputusan menunjukkan bahawa reka bentuk tersebut adalah selamat untuk digunakan. Hasil analisis reka bentuk menunjukkan bahawa basikal roda tiga dengan mekanisme pembersihan boleh menyapu berkesan hanya apabila ia bergerak dengan kelajuan yang antara 2km/h dan 5km/h.

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LIST OF ABBEREVATIONS

CATIA	Computer Aided Three-Dimensional Interactive Application
HOQ	House of Quality
QFD	Quality Function Deployment
r.p.m.	Rotation per minute
3D	Three-Dimension

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LIST OF SYMBOL

ζ	=	Bristle tip height
L	=	Bristle length
$\emptyset$	=	Bristle mount angle
R_b	=	Mount radius
β	=	Brush tilt angle
Δ	=	Brush penetration
N_1	=	Speed of driver in r.p.m.
N_2	=	Speed of driven in r.p.m.
d_1	=	Diameter of driver
d_2	=	Diameter of driven
t	=	Thickness of belt
N	=	Rotational speed in r.p.m.
w	=	Angular velocity
d	=	Diameter
t	=	Number of teeth
τ	=	Torque
D	=	Diameter of wheel
P	=	Perimeter of wheel
v	=	Velocity of tricycle
w_1	=	Angular velocity of gear (wheel) in r.p.m.
w_2	=	Angular velocity of gear (rear brush) in r.p.m.
w_3	=	Angular velocity of pulley (rear brush)
w_4	=	Angular velocity of pulley (front brush)

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n	=	Gear ratio
$\emptyset$	=	Pressure angle
P_d	=	Diametral pitch
N_1	=	No. of teeth of gear (wheel)
N_2	=	No. of teeth of gear (rear brush)
d_1	=	Pitch diameter of gear (wheel)
d_2	=	Pitch diameter of gear (rear brush)
d_3	=	Diameter of pulley (rear brush)
d_4	=	Diameter of pulley (front brush)
C	=	Centre distance
a	=	Addendum
b	=	Dedendum
d_b	=	Base circle diameter
d_a	=	Addendum circle diameter
d_d	=	Dedendum circle diameter

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CHAPTER 1

INTRODUCTION

1.1 BACKGROUND

Cleanliness is one of the most important aspects for human. However, it is also one of the biggest issues in Malaysia. With speedy increasing of urban population, waste in streets escalated as usage levels of sidewalk and road increase. Statistics show the urban population in Malaysia increase more than 50% in the last few decades and number of cities in peninsular Malaysia increase 400% from year 1957 to 2000 (Tarmiji, 2011). Malaysians like to throw their rubbish in the rivers and on the streets while driving because they are more worried about the cleanliness of their vehicles rather than public areas. With low awareness level about littering among Malaysians, rubbish on the roads increase every year. Waste on the streets can influence the health of residents nearby and also the dignity or image of a country (Nur Imani, 2016).

With the increase of vehicular traffic and road usage levels, it is necessary to carry out street sweeping program. Based on the study of quantifies broom sweeper litter pick up ability, increasing the frequency of sweeping operations by using sweeper machine from monthly to weekly does not improve the cleanliness of drainage system. Problem discovered was that large waste stuck at the suction head of the sweeper fell into the drain when the sweeper went over a drain inlet. However, large amount of waste did removed by sweeping operation. This indicates that mechanism of cleaner is much more important than frequency of sweeping operation (Lippner & Moeller, 2000).

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Melaka green technology council and Melaka green technology corporation have been established on 23 May 2011 and 1 October 2013. The blue print is to become a green technology city by year 2020. Therefore, it is necessary to develop a green technology device that can effectively collect the rubbish on the streets. Push sweeper is a cleaning device that manually-operated without using electricity. It uses the rotation of wheel to spin the hard brush and collect the rubbish by using the gear transmission concept. It is one of the simplest and modest mechanism devices that help people to collect debris in short time (Solis, 2013).

In the past, people collected rubbish on the street by using broom and dustpan which took very long time and waste manpower. With booming development of technology, cleaning tool has been evolved from broom and dustpan to vacuum cleaner, floor sweeping machine, electric road cleaner and dust cleaning robot. But all these high technology cleaning products require electricity to operate and some of them will emit unhealthy gas such as carbon dioxide. For electric road cleaner, it emit 12.6 gram of carbon dioxide per kilometre (Avinash, 2014).

However, these high technology cleaning products are not suitable to be used in some areas such as park, playground, sidewalk and street. This is because they are very expensive and also quite costly to be operated since they consume large amount of electrical energy. Manual push sweeper is the most suitable cleaning product to be used to collect rubbish in public area since it does not make noise and save energy. Nowadays, it is not just used for collecting debris in industry and public areas, most of the resident also use it for cleaning house and garden.

Manual push sweeper is very useful compare to other cleaning products. However, every product has its own disadvantages and will be modified again and again in the future. The weakness of manual push sweeper is its slow moving speed. Its moving speed is

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dependent on the user walking speed. Therefore, it takes very long time to clean a big city. Until now, people still use manual push sweeper to clean a large area this is because there is still no modification and improvement to be made regarding on this product. Hence, tricycle sweeper with high moving speed has high potential to be developed and very useful for future generation.

1.2 PROBLEM STATEMENT

One of the goals of Melaka green city action plan (GCAP) is to put Melaka on the path to become a 'zero waste' state. However, there is still a lot of rubbish in public area such as park, sidewalk and parking lot. The Figure 1.1(a) and 1.1(b) show the rubbish in playground and street at the location Jalan Delima 5, Taman Bukit Melaka.

(a) (b)

Figure 1.1: (a) Rubbish in playground

(b) Rubbish in street

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Unfortunately, most of the cleaning devices are not suitable to clean the rubbish in city because the city area is very large. If high technology cleaning product such as electric road cleaner or street cleaning machine is used, large amount of electrical energy, petrol and fund will be wasted. Besides that, it also emits unhealthy gas (carbon dioxide) which is not friendly to environment. Nowadays, people use the environment friendly product such as manual push sweeper to clean the rubbish in city. It is the most suitable cleaning device to be used in public area since it only use human energy and does not make any noise. However, it takes very long time to clean the rubbish in city due to its slow movement speed. It is manually operated and moved by user, its movement speed is as slow as human walking speed. A lot of manpower has been wasted due to this problem.

1.3 OBJECTIVE

The objectives of this project are as follows:

1. To propose a suitable cleaning device to clean the city.
2. To design a human-powered tricycle with cleaning mechanism.

1.4 SCOPE OF PROJECT

This project focuses on designing a human-powered tricycle with cleaning mechanism that can clean the rubbish effectively in public area. The main considerations of this project are the product's materials, structure, cleaning mechanism, working principle, and how it will aid the user. Other aspects such as the marketing price and the production of the cleaning tricycle will not be covered in this project.

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CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

In order to propose a new design of tricycle with cleaning mechanism, some research on the invention of the tricycle since early stage of the century has been made. The purpose of studying the type of tricycle transmission mechanism is to understand and generate some ideas on designing the tricycle mechanism. The characteristics of the bristle brush material were studied in order to choose the most suitable material for bristle brush to get the maximum sweeping effectiveness. Journal on brush parameter for different type of waste has been reviewed in order to design a tricycle with cleaning mechanism that can sweep different type of waste effectively. The purpose of studying gear and belt drive system is to design an effective and desired cleaning mechanism.

2.2 HISTORY OF TRICYCLE

In 17^{th} century, a watch-maker named Stephan Farffler, was the first person who built a three-wheeled and hand-power vehicle in order to maintain his mobility as he was disabled. By 1820, there were many tricycles in Germany, France and England, but they were just prototypes and never been used as a transportation product. In 1860, riding a bicycle had become a trend, hobby and mainstream pastime. But people always pursue safety, therefore, tricycle was developed in 1877. In March 1877, a sewer-machine maker named James Starley developed a tricycle in Coventry England. It was the first rotary

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