# CONCEPTUAL DESIGN OF DRIVETRAIN SYSTEM FOR BECA MELAKA

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‘I have read this thesis

and from my opinion this thesis

is sufficient in aspects of scope and quality for awarding

Bachelor of Mechanical Engineering (Automotive)’

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Date : ……...

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**This report is presented in**

**fulfilment of the requirement for the degree of**

**Bachelor of Mechanical Engineering (Automotive)**

**Faculty of Mechanical Engineering**

**University Technical Malaysia Melaka**

**JUNE 2017**

**DECLARATION**

"I declare this report is on my own research except for summary and quotes that I have mentioned its sources"

Signature : ……..

Name of Author : MUHAMMAD FARIS BIN HASSAN

Date : …….

**DEDICATION**

Dedicate to my beloved mom, Mrs. Mismah Binti Taslim and my dad,

Mr. Hassan Bin Ayob

## ACKNOWLEGEMENT

First of all, thanks to Allah S.T.W for His blessing to me in completing my final project. I have finally managed to complete it successfully. Thus, I would like to take this chance to express my gratitude to all people who have been involved directly and indirectly in the process to complete this project. Without the cooperation and support of all parties, I cannot carry out this project properly and successfully.

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## ABSTRACT

Beca Melaka is one of the historical transportation method in the Melaka City. At the present moment, the traditional tricycle is powered by human effort, using conventional single gear-chain system. The current system has been proven able to handle robust operation, but required a lot of the driver's energy to move on inclined road condition. In this project, a new drivetrain system is develop to assist Beca drivers to move their tricycle especially on inclined road condition with less human effort. The new drivetrain proposed utilized a hybrid combination of the existing mechanical single gear-chain system with electric D.C motor system. The 24 N.m electrical D.C motor is powered through a rechargeable lead-acid battery rated at 12 V, 40 Ah. Using a customized gear coupling system (at gear ratio of 11:33) linking the existing gear with the input of motor, the new drivetrain design is able deliver up to 71.6 N.m of torque to move maximum 290kg of load through 12 degree road gradient at maximum 15 km/h. The overall drivetrain system design started with conceptual design of potential solutions, followed by concept design selection using Analytic Hierarchy Process (AHP) method. Later, the final concept design selected was modeled into 3D and 2D CAD drawings using SOLIDWORKS software. Finally, drivetrain system sizing was conducted to determine the required electric motor, battery and the customized gear coupling system specifications. The simple and compact final Beca Melaka hybrid drivetrain design developed in this project is expected able to provide more efficient performance to the tricycle, and help current Beca drivers to carry their passenger with less human energy especially on inclined road conditions.

# ABSTRAK

Beca Melaka merupakan salah satu kaedah pengangkutan sejarah di Melaka. Pada masa ini, beca tradisional dikuasai oleh tenaga manusia yang menggunakan sistem rangkaian gear tunggal konvensional. Sistem semasa terbukti dapat mengendalikan operasi yang mantap, tetapi memerlukan banyak tenaga pemacu untuk bergerak pada keadaan jalan yang berbukit. Dalam projek ini, sistem pemacu baru dibangunkan untuk membantu penunggang beca untuk menggerakkan beca mereka terutamanya pada keadaan jalan yang berbukit dengan menggunakan tenaga yang sedikit. sistem pemacu baru yang dicadangkan ini menggunakan gabungan sistem hibrid mekanikal gear tunggal sedia ada dengan sistem motor D.C elektrik. Motor elektrik 24 N.m D.C dikuasakan melalui bateri asid plumbum yang boleh dicas semula pada 12 V, 40 Ah. Menggunakan sistem gandingan gear yang disesuaikan (pada nisbah gear 11:33) menghubungkan gear sedia ada dengan input motor, reka bentuk simstem pemacu baru ini dapat menyampaikan tork sehingga 71.6 Nm untuk memindahkan beban maksimum 290kg melalui kecerunan jalan 12 darjah dengan 15 km / j maksimum. Reka bentuk sistem pemacu ini keseluruhan bermula dengan reka bentuk konsep penyelesaian berpotensi, diikuti dengan pemilihan reka bentuk konsep menggunakan kaedah Proses Hierarki Analitik (AHP). Kemudian, reka bentuk konsep akhir dipilih menjadi 3D dan 2D CAD lukisan menggunakan perisian SOLIDWORKS. Akhirnya, saiz sistem dilakukan untuk menentukan motor elektrik, bateri dan spesifikasi sistem gandingan gear yang disesuaikan. Reka bentuk sistem pemacu hibrid Beca Melaka yang ringkas dan padat yang dibangunkan dalam projek ini dijangka dapat memberikan prestasi yang lebih cekap kepada roda beca, dan membantu pemandu Beca pada masa ini untuk membawa penumpang mereka dengan tenaga manusia yang kurang, terutama pada keadaan jalan yang berbukit.

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## LIST OF SYMBOLS

| | | |
|---|---|---|
| P | = | Power required (in watts) |
| kr | = | Rolling resistance coefficient |
| M | = | Mass of bike + rider |
| s | = | Speed of the bike on the road |
| ka | = | Wind resistance coefficient |
| A | = | Frontal area of the bike and rider |
| v | = | Speed of the bike through the air |
| d | = | Air density |
| g | = | Gravitational constant |
| i | = | Gradient (an approximation²) |
| Rw | = | Radius of wheel/tire |
| Vmax | = | Desired top speed |
| ta | = | Desired acceleration time |
| α | = | Maximum incline angle |
| Crr | = | Working surface |
| ta | = | Time required to achieve maximum speed [s] |
| Tw | = | Wheel torque |
| V | = | Nominal voltage |
| F | = | Force |
| $T_T$ | = | Total torque for rear tire |
| $F_r$ | = | Frictional force |
| $F_N$ | = | Normal force |
| $F_r$ | = | Force on rear tire |
| r | = | Radius of tire |
| W | = | Watts |
| A | = | Amps |
| rpm | = | Radius per minute |
| $\omega_{rs}$ | = | Angular speed of the rear sprocket |

## LIST OF APPENDICES

# CHAPTER 1

## INTRODUCTION

### 1.0 Introduction

This project is intended to meet one of the requirements for Bachelor's Degree that aimed to enhancing the knowledge and skills of the students in their respective fields, especially identifying the problem and study the methods to solve the problem. This year, the title that are chosen was "Conceptual Design of Drivetrain System for Beca Melaka". This project aims to produce a new design concept on a beca in Malacca drivetrain system without changing the authenticity.

Among the goals of this project is to produce detailed drawings that ultimately will be selected as the best design concept selection. The new design will also be generated when problems are known. To start this project, investigation into the problems that have been faced by the riders riding was required. Following this, a great deal of research was been done into many different systems available to be incorporated into the previous spot drivetrain. At the end of this project, the results will provide a solid foundation for the future generation to implement this research

The new design of the drivetrain system will have features solutions faced by rickshaw drivers when going uphill. Rickshaw drivers will feel comfortable when using it.

## 1.1 Problem Statement

As we know, there are various modes of transportation in Melaka. But such, which attracts tourists each visit in Malacca is the traditional transport rickshaws. Every rickshaws that is in Malacca has its attractions. With the addition of the decorations on the rickshaws capable of attracting the attention of many tourists. Despite the modifications made have a specific purpose, but by something like this, to some extent affect the physical rickshaws. Problems arise when the rickshaw being cycle in the hilly terrain. Due to the weight of the accessory that is placed in the rickshaws, rickshaw drivers have to use more energy in order to climb the hilly roads. Based on the traditional rickshaw in Melaka, the current rickshaw used single-gear and chain drivetrain system to propel the vehicle. The current drivetrain however is ineffective for hill-climbing purpose, whereby the rickshaw cyclists need to put extra cycling energy to move the vehicle with passengers. The efficient drive unit also needs to be installed in the rickshaw to ensure that the rickshaw can be used for the best performance with less hustle. Therefore, the gap or any opportunity to improve needs to be identified and overcome.

## 1.2 Objective of Project

There are four main objectives which are:-

i. To develop conceptual designs of drivetrain system for beca Melaka.
ii. To identify best concept design selection.
iii. To develop 3D CAD model and working drawing of the drivetrain system.
iv. To determine the theoretical performance of the drivetrain system.

## 1.3 Scopes of Study

The scopes of this project are:

i. To develop conceptual designs of drivetrain system for beca Melaka using TRIZ design method.

ii. To perform best concept design selection using Analytic Hierarchy Process (AHP) Method.
iii. To develop 3D CAD model and working drawing of the drivetrain system using SOLIDWORKS.
iv. To analyse the theoretical performance of the drivetrain system using analytical/simulation method.

## 1.4 Limitation of Study

The study is limited to the design of a new drivetrain which can coupled with the existing beca to provide improve vehicle climbing performance especially at full load. Starting with research of related drivetrain system to gain more understanding of the theory of the drivetrain used on the beca. After done with research of the new design, it need to design an appropriate drivetrain system that the new system can reduce the force when cyclist going up the hill. The scope of this project supports the objectives of the project where it is about how to organize a market survey carried out towards the user and rickshaw pullers. Besides, the project is also to provide a complete design specification of the beca including product design, concepts design, methods used and complete drawings for fabrication purposes later.

## 1.5 Expected Result

In the end of the project, the expected results are development of new drivetrain system which are able to solve the problem that have been faced by the beca rider that are giving to much energy and effort to climbing the hill.

## 1.6 PSM Project Flow Chart

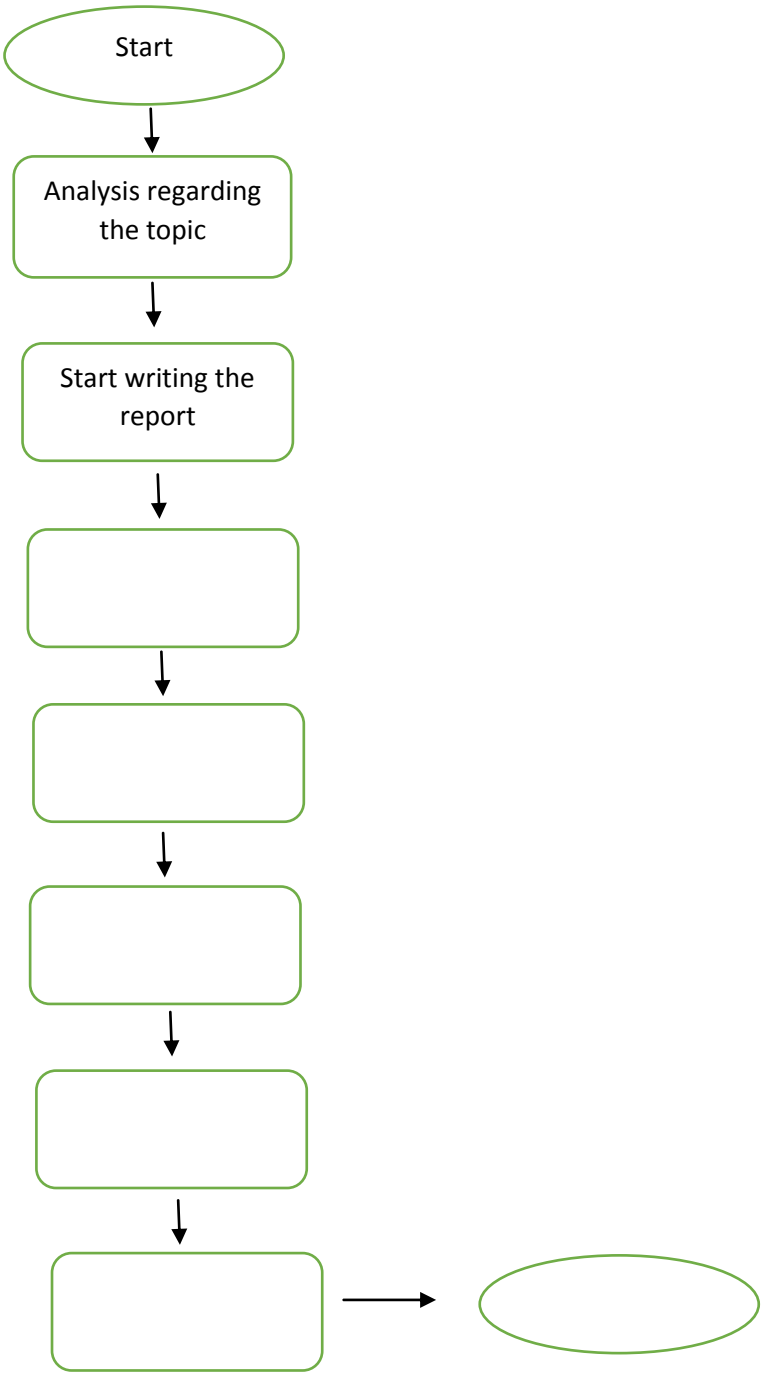


Figure 1.1: PSM Project Flow Chart

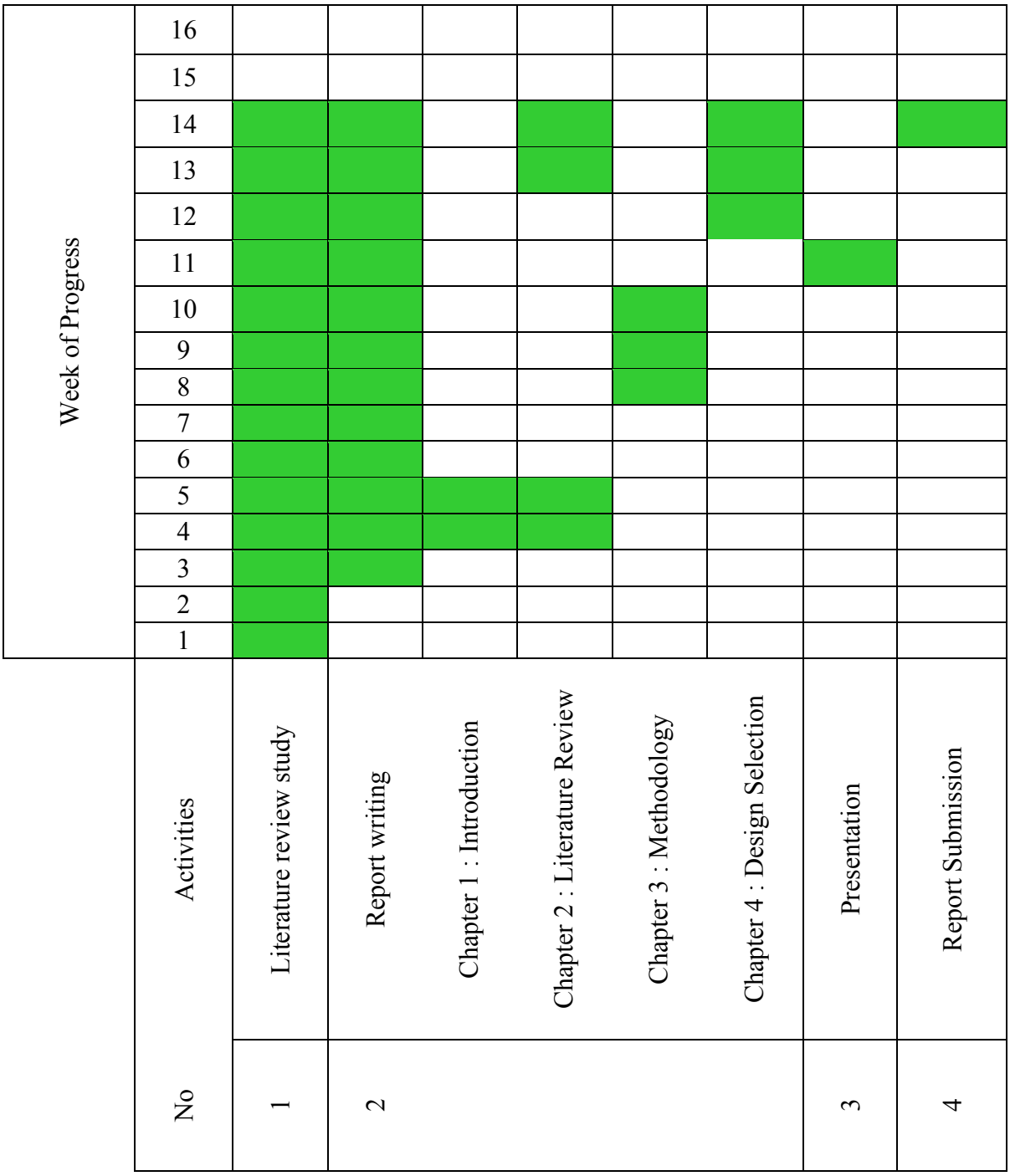


Figure 1.2: Gantt chart of the Progress for PSM I

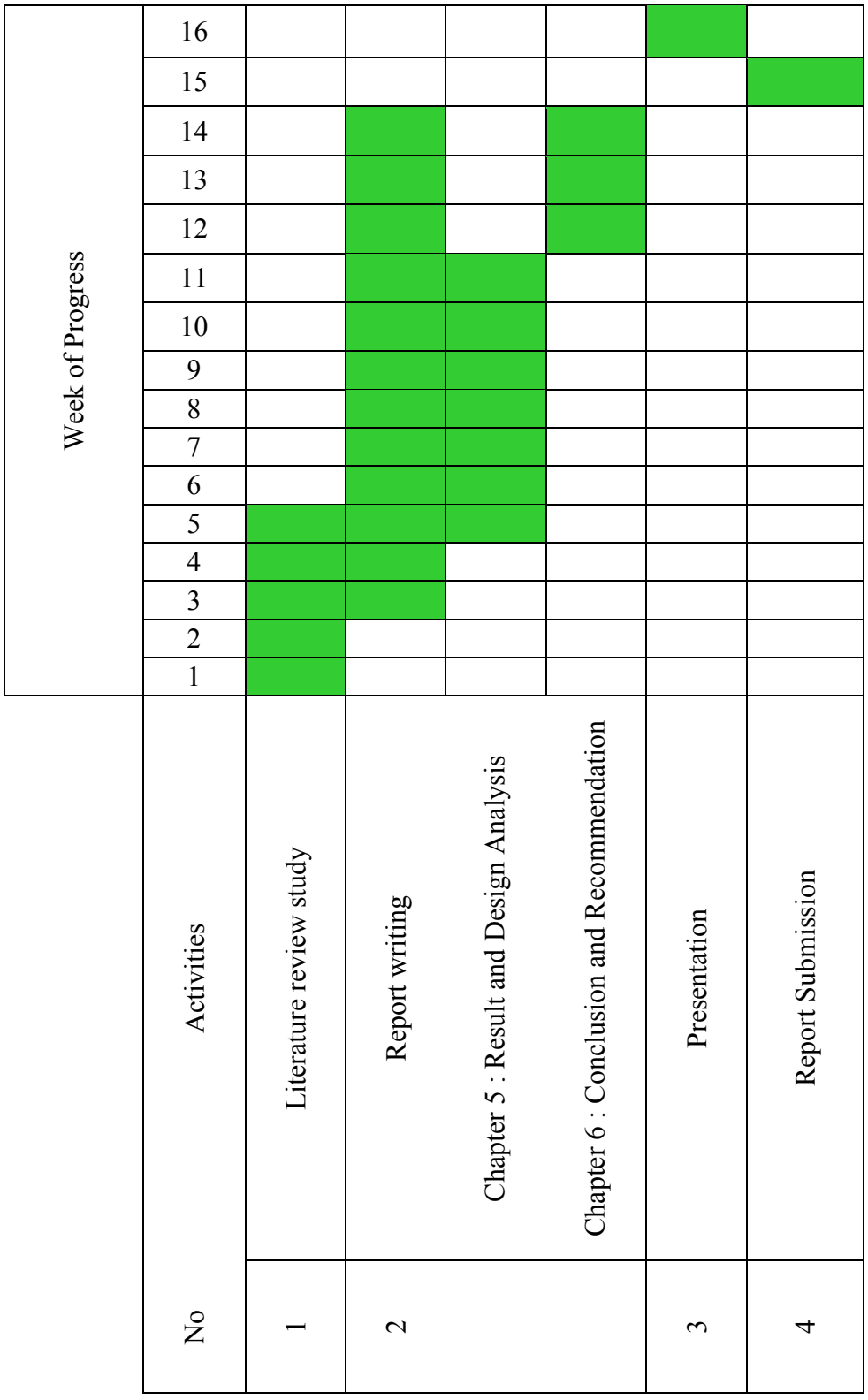


Figure 1.3: Gantt chart of the Progress for PSM II

# CHAPTER 2

## LITERATURE REVIEW

### 2.0 Introduction

This study involves the search for information by reading the information according with the title of this project. There are a variety of mechanical design process used in industry in different ways. In addition, this study also made to the existing products in the market to get ideas and innovating products so as to achieve the objectives set. Rickshaw is a vehicle that uses human energy to move. Generally, beca have two seats for passenger other than the driver or rickshaw itself. There are various types of rickshaws are available in the country and the sloppy design is in accordance with each country. Beca contained in passenger design is divided MHS has left the rider while pedalling a bicycle rider. Traditionally, this beca were use at the area with many tourists and rickshaw was carrying tourists around the surrounding area than in the past sloppy goals which bring customers into place to reach, such as drivers nowadays. In the state of Malacca, there are many places that can be visited historical relics. So as to maintain the tradition of initiatives rickshaw in Malacca, this service continues even to this day can be one of the attractions for tourists who want to come here. Beca ride service bringing tourists to some extent can be one of the factors contributing to the economy of the country. Besides, it is also helpful in providing job opportunities whether young or old to venture into this job. Problems arise when the rickshaw being cycle in the hilly terrain. Due to the weight of the accessory that is placed in the rickshaws, beca drivers have to use more energy in order to climb the hilly roads