UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DESIGN AND DEVELOPMENT OF BROADER VIEWING ANGLE DEVICE FOR MOTORCYCLIST TO IMPROVE SAFETY

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

by

NG AI XIN

B051210208

920123-06-5042

FACULTY OF MANUFACTURING ENGINEERING

2016

DECLARATION

I hereby, declared this report entitled "Design and Development of Broader Viewing Angle Device for motorcyclist to Improve Safety" is the results of my own research except as cited as references.

Signature	:	
Author's Name	:	Ng Ai Xin
Date	:	22th June 2016

APPROVAL

This report is submitted to the Faculty of Manufacturing Engineering of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Manufacturing Engineering (Manufacturing Design) (Hons.). The member of the supervisory committee is as follow:

……..

(Project Supervisor)

ABSTRAK

Kemalangan jalan raya sering berlaku pada masa kini. Sebahagian besar kemalangan maut melibatkan penunggang motosikal dan kebanyakan mangsa mengalami kecederaan pada bahagian kepala. Salah satu faktor yang mengakibatkan kemalangan jalan raya adalah kekurangnya pandangan pinggiran. Walaupun topi keledar dengan cermin pandang belakang yang terdapat di pasaran menambah baik kemalangan jalan raya, tetapi tidak ramai penunggang motosikal yang menggunakannya kerana harga topi keledar tersebut terlalu tinggi. Harga topi keledar tersebut tidak mampu ditanggung oleh penunggang motosikal dari golongan susah. Maka, topi keledar dengan ciri-ciri pandang belakang berkos rendah yang direka dengan elemen-elemen mampan diusulkan dalam projek ini. Pertama sekali, analisis pasaran dilakukan bagi mendapatkan suara pengguna sebelum konsep dihasilkan. Seterusnya diikuti dengan pelbagai alatan kualiti dan alatan pemilihan strategik seperti HOQ, kaedah AHP, perisian CES, SolidWorks and banyak lagi digunakan bagi memperoleh sebuah portfolio yang berjaya untuk penghasilan produk ini pada masa akan datang. Kaedah HOQ dipilih untuk mengenalpasti sasaran kejuruteraan yang paling utama bagi topi keledar baru ini. Kaedah AHP digunakan untuk memilih konsep yang terbaik. Konsep-konsep tersebut dihasilkan dalam bentuk lakaran tangan. Perisian SolidWorks digunakan untuk membuat lukisan 3D dan menganalisis topi keledar baru. Analisis FEA digunakan untuk menguji kebolehfungsian dan tahap keselamatan reka bentuk. Sementara itu, analisis ujian jatuh dilakukan bagi menganalisis kesan yang dihadapi topi keledar pandang belakang selepas berlakunya pelanggaran. Tambahan pula, prototaip dihasilkan dengan menggunakan mesin FDM, pencetak Up Plus 3D untuk tujuan gambaran dan ujian. Akhir sekali, ujian konsep periskop dijalankan terhadap mekanisme pandang belakang dengan menggunakan pen laser. Prototaip dapat berfungsi seperti yang sepatutnya. Pengguna dapat memandang belakang dengan menggunakan peranti sampingan periskop.

ABSTRACT

Road accidents frequently happen nowadays. The majority of the fatality accident involves motorcyclist and most of them encounter in head injuries. Lack of peripheral vision is one of the factors that affect the road accident or crashes. Although there are helmets with rear view mirrors that currently exist in the market provides good improvement on road accident, but limited usage of the helmet for motorcycle user due to the high price of the helmet. The price of the helmet are not affordable for poor motorcyclist. Thus, a low cost helmet with rear vision features made in sustainability element is proposed in this project. Market analysis is first carried out to gain the voice of target customer before the concept generated. Followed by numerous quality tools and strategic selecting tools like HOQ, AHP method, CES software, SolidWorks and others are used for giving a successful portfolio for further development of the product. HOQ method is adopted to determine the prioritized engineering target to be met by the new helmet; AHP method is used to select the best concept which generated via hand sketching; SolidWorks applied for 3D drawing and analysis of the new helmet. FEA analysis is applied to testing the workable and safety of the design. While Drop test analysis is used to analyze the impact of the rear-view helmet after collision happen. Furthermore, prototyping is carried out by using the FDM machine, Up Plus 3D printer for visualizing and testing purpose. Last but not least, the testing of the periscope concept in the rear-view mechanism is tested by laser pen. The prototype is worked as intended, i.e. the user can see the back view while using this periscope attachment device.

DEDICATION

Dedicated to

my beloved father, Ng Tian Kang

my appreciated mother, Su Kam Fong

and my adored siblings Ng Ai Wei and Ng Chong Ming

for giving me moral support, cooperation, encouragement and also understanding.

ACKNOWLEDGEMENT

First of all, I would like to use this opportunity to express my deepest gratitude and special thanks to Dr. Zulkeflee Bin Abdullah for taking part in useful decision and information, giving necessary advices and guidance to keep me on the correct path. This helped me in completing the Final Year Project on time and fulfill the requirements. I choose this moment to acknowledge his contribution gratefully.

It is my radiant sentiment to place on record my regards, deepest sense of gratitude to Encik Asari, Encik Fairus and Encik Hairrudin, technician for their precious guidance on prototype which were extremely valuable for my project and future life knowledge.

Nonetheless, a thousand thank you to my beloved family members for their supports in my studies and helping me throughout this project by providing encouragement, advices and also opinions when I faced with problem. Besides that, thanks for everyone that has direct and directly guide and help me throughout this project.

TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

ABS	-	Acrylonitrile Butadiene Styrene
AHP	-	Analytical Hierarchy Process
CAD	-	Computer-aided drafting
CES	-	Cambridge Engineering Selector
CI	-	Consistency Index
CR	-	Consistency Ratio
ECE	-	Economic Commission for Europe
FDM	-	Fused Deposition Modeling
FEA	-	Finite Element Analysis
GPS	-	Global Positioning System
HOQ	-	House of Quality
PE	-	Polyethylene
PP	-	Polypropylene
PVC	-	Polyvinyl Chloride
QFD	-	Quality function deployment
RI	-	Random Index
RM	-	Ringgit Malaysia
RMB	-	Renminbi
SDK	-	Software Development Kit
STL	-	STereoLithography
USD, $	-	United States dollar
3D	-	Three Dimensional
cm	-	Centimeter
g	-	Gram
Kg	-	Kilogram
mm	-	Millimeter
N/m^2	-	Newton per Metre Squared
%	-	Percent

CHAPTER 1
INTRODUCTION

1.1 Background

The tremendous increase in fatality accident on the road over the past few years had risen the awareness of Malaysian. Research shows that the majority of fatal accident on the road involves motorcyclist especially in South East Asia (Abdul Manan et al., 2012). The risk of serious injury is higher for motorcycle compared to car vehicle (DACOTA, 2013). Moreover, motorcycle accidents that resulting in head injury is considered a major cause of road death, accounting up to 70% percent of the total deaths (PDRM, 2009). Some of them encounter in non-fatal head injury with the protection of helmet.

Based on these facts, the motorcycle is deemed as one of the dangerous vehicles. However, motorcycles are still considered as main transportation for many people nowadays in the world. Furthermore, based on Yaw Adubofour Tuffour and Daniel Kofi Nti Appiagyei (2014) findings, there are up to 20 million motorcycles being used as public transportation service such as motorcycle taxi. There are many advantages and benefits impelled the use of motorcycle and hence the growth of motorcycle users. For instance, it acts as a fast, flexible and cheap transport (Chang L.Y., 2005). From the aspect of 'fast', it can avoid traffic jams or gives unobstructed passage. Besides, it saves time to travel with a short distance. One of the characteristics of motorcycle is flexible. It consumes just a small space compared to other transports. Furthermore, it saves a lot of expenses on petrol compared to other vehicles.

Due to the high risk fatality result of motorcycle users, protective head gear acts as an important feature. The protective head gear had been advised and manufactured by many companies. The helmet provides safety features such as high impact resistant helmet shell which covers the head. It provides suspension of cushioning system which firmly attached to the user's head. Moreover, there is legislation provision stated that all of the motorcyclist and his or her passenger have to wear the protective gear wear or suffer the penalty of fine or loss of motorcyclists' license if they violate this rule. Besides the problem of head protection, there is another safety problem that is involved, which is inadequate rear-view vision for the motorcyclist. Rear-view vision is obviously a necessity for a motorcyclist as it provides the ease for motorcyclist in turning, changing lanes or taking evasive action to escape possible rear end collision from a following vehicle. The mechanism avoids the safety hazard from the accident as its requirement is in satisfactory level.

Although the side mirror provides the rear vision for motorcyclist, but there is still some limitation. The side mirror is clamped on the motorcycle handlebars which can be projected outwardly and upwardly to reflect the scene behind. In this case, at least some of the viewing area by the motorcyclist themselves may be blocked. Moreover, the side mirrors do not function perfectly as intended while the motorcycle is in turning position.

Hence, a device was proposed in this project to overcome the safety issues that arise from riding a motorcycle. Narrow viewing angle of motorcyclist has always been a factor of motorcycle accidents. To overcome this shortage, a mirror helmet is proposed to serve as a safety tool to broaden the viewing angle of motorcyclists. It is a helmet which added a rear view mirror that ease motorcyclist by having a broader viewing. It possesses a similar concept of rear view mirror for car user. In general, the rear-view mechanism is attached to the helmet. It provides the vision of back scene that is clear and able to notify the users regarding the presence of other vehicles.

1.2 Objective

There are a few objectives that will be carried out through this project:

1. To design and fabricate a device on a helmet that can widen the back viewing angle of motorcyclist.
2. To design and fabricate a device on a helmet with lower cost that is affordable to motorcyclist and able to enhance the safety of motorcyclists.
3. To design and fabricate a device which has high sustainability and able to reduce impact to the environment.

1.3 Problem Statement

Motorcycles are typically used because of the benefit of low cost and characteristic of high flexibility. Hence, there is a rapid growth of sales of motorcycle in the world, especially in the developing countries such as India, Indonesia, China, Thailand and Malaysia (Kaltheier, 2002). However, there are researches that claim that the increase in the number of motorcycles influences the number of fatalities of motorcyclists on the road (Abdul Manan et al., 2012). Lack of peripheral vision is one of the factors that affect the road accident or crashes (Hayward and Marsh, 1988). Although the helmets with rear view mirrors that currently exist in the market provides good improvement on road accident, there is a limited usage of the helmet for motorcycle user due to the high price of the helmet. The price of the helmet are not affordable for poor motorcyclist. Thus, in this project, a low cost helmet with rear vision features will be proposed.

1.4 Scope

The proposed idea mainly focuses on the mechanism of the mirror helmet. Market survey will be carried out to investigate the requirement from motorcyclists. Besides that, the cost, material and process of the product will be covered in this project. There

will be also discussion and analysis of the product CAD model. SolidWorks will be used throughout this project for drawings. A functional prototype will be produced to demonstrate the ease of use of this product and the effectiveness of the product. High end technology such as screen and camera will not be used in this project due to low budget. Furthermore, marketing and mass production aspects are not covered in this project.

CHAPTER 2
LITERATURE REVIEW

In this chapter, detail statistic data from the related research journal will be carried out and the purpose of this project will be discussed. Several studies show that the growth of motorcycle sales is directly proportional to motorcycle fatalities. In other words, the higher the usage of motorcycle, the higher the rate of road accidents. Among all types of injuries, head injury is the major cause of road death which involved motorcyclist. Based on study report, the behavior of motorcyclist is one of the main reason that caused road crashes. In order to avoid other vehicles, motorcyclist tends to turn their head to increase their back viewing angle while across to another lane. From the aspect of technical prevention, it is found that helmet usage is the most important features for reducing the risk of head injuries in motorcycle crashes. Therefore, a further understanding of every aspect, e.g. helmet component's function, design of helmet and type of helmet need to be carried out to support further proposed design. The current problem motorcyclist encounters is the current helmet design which existing in market possess a visual limit for back viewing angle even with the aids of side mirrors. Hence, either Reevu or Skully helmet are invented to solve the problem. However, the price of those helmets is too high and unaffordable for many people. Therefore, this project is carried out to investigate on producing of a low cost helmet to meet the market requirement of the low-end customers.

2.1 Popularity of motorcycle

In many Asian countries, such as China, Indonesia, Malaysia, Taiwan and Thailand, motorcycle act as the main and popular transport mode of urban transportation

(Kaltheier, 2002). It has been chosen as the popular transport mode among Southeast Asian travelers due to its high affordability, flexibility, and maneuverability on congested roads (Jou & Chen, 2014). In the past two decades, the demand of motorcycle in these countries is rising continuously due to the low purchase cost, low running cost and convenient parking characteristic of motorcycle. At the same time, the growth of motorcycle users has been seen as disruptive to users of other travel modes (Tuffour, 2014).

In India, there are 69 percent of the total number of motor vehicles are motorized two-wheelers. In Thailand, this figure is between 70 percent and 90 percent, while about 60 percent in Malaysia (Mohan, 2002, Umar, 2002 and Suriyawongpaisal and Kanchanusut, 2003). Besides that, motorcycles accounted for 23.4 percent of all registered motor vehicles in 1987, and the number increased to 63.2 percent in 2001 in China. Currently, China leads the motorcycle trend and became the largest motorcycle market in the world, followed by India, the second and Indonesia, the third. Statistic Indonesia (2012) pointed out that there were 13.6 million motorcycles in 2000. The figure is increased to 32.5 million in 2006 and continue to rise into 76.4 million in the year of 2012 in Indonesia. Based on the trend, AISI (2009) has estimated that by 2015, there will be one motorcycle for every two persons in this country which has a population of about 240 million.

Besides that, there are statistic shows the trend of motorcycle usage in Taiwan. Ministry of Transportation and Communication provide a statistic which indicates that the number of motorcycles in Taiwan has continued to rise throughout the past decade (Chang H.L. & Lai, 2015). The high rate of motorcycle ownership, which has reached 645 per thousand people, has made Taiwan to achieve the highest motorcycle ownership rate in the world (Chang L.Y., 2005). The total number of motorcycles was about 2 million in 1977, but rapidly increased to 10 million in 1997 (Chang L.Y., 2005). Meanwhile, although the total number of motorcycles is still increasing, but due to the popularity of automobiles, the trend has been slowing down for the past few years (Jou & Chen, 2014).

2.2 Motorcyclist fatality

Motorcycle road accidents is not only being highlighted in Southeast Asian countries, it is also raised as a global transportation safety issue (Sàrl et al., 2013). In Columbia, motorcycle indicates 39 percent of the deaths from road crashes in the year 2010, and rose to 42% in year 2012 (Jimenez et al., 2015). Meanwhile, among 94 fatalities caused by the road accidents, 53.2% were involved motorcyclist in Taipei (Tsai et al., 2015). Figure 2.1 shows the statistical data of fatal and non-fatal injury rates that involving the motorcyclist and pillion rider by year from 2001 to 2008 which recorded in the United States. Motorcycle fatalities have increased to 55 percent from the years of 2001 to 2008. Moreover, Prevention (2012) shows that the numbers of motorcyclist increased from 120,000 injuries to 175,000 between the years 2001 to 2008. It represents that there are 1.20 per 100,000 persons expose to fatality in 2001 to 1.74 per 100,000 persons in 2008. According to this increasing number of fatal injury rate, it shows that a large number of motorcyclists get involved in tragic accident (Adler, 2013). This statistics justifies that necessary action should be implemented for continuous preventive actions and investigations measures in regards for reducing motorcycle road accidents.

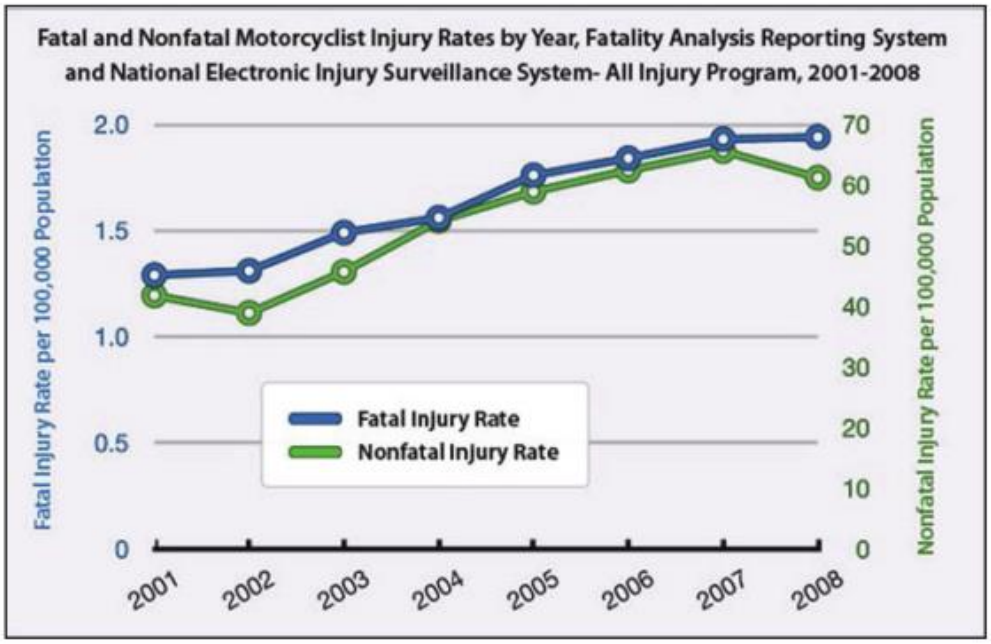

Figure 2.1: Motorcyclist Injury and Death by Year Recorded in United States (Sansone & Lauber, 2015).

Nonetheless, the same situation was found in Malaysia. Motorcycle road accidents that occurred in Malaysia exceed 400,000 cases per year and within this statistic, there are 7000 deaths were reported (Azhad, 2007). According to the statistic, Malaysia has the highest road fatality rate among the ASEAN region. Based on the road fatality contingency per 100,000 of the country's population, Malaysia constitutes more than 50 percent of the total number of fatalities. The number of road fatalities has shown a steady increase of 4 percent over the past seven years and rising to 6745 in 2009. Since the year of 1999, motorcyclists have led the statistical list of 4070 cases in contrast to other fatal cases among the road users (Abdul Manan et al., 2012). From the statistical investigation in Malaysia (Nasaruddin et al., 2012), there are several incidents that must concerned. The first concern is the numbers of motorcycles registered annually influence the country's population. Secondly, Figure 2.2 clearly shows that the increase in the number of motorcycle accidents is directly proportional with the increment of motorcycles being registered within a 20 year period which from year 1990 to 2010. While, according to Figure 2.3, motorcyclists own the highest road fatality which is 60 percent compared to car 22 percent risk of death, followed by pedestrian 9 percent, bicycle and lorry both 3 percent and 1 percent from van, bus and other road users (Abdul Manan et al., 2012). The differences in road accidents ratio and mortality rates between motorcyclist and other road users in Malaysia is clearly shown in these statistic documental data.

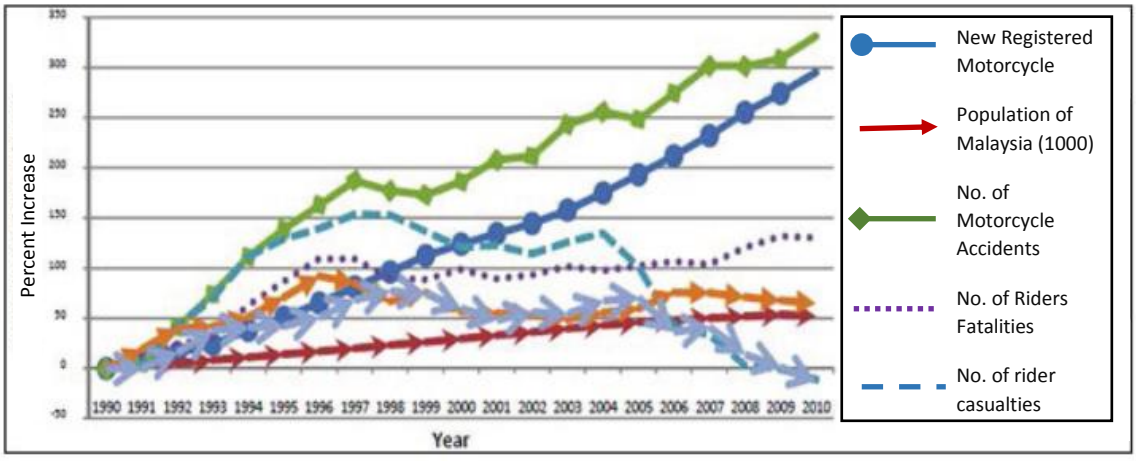

Figure 2.2: Graph of New Registered Motorcycle, Population of Malaysia, Road Fatalities and Casualties (Nasaruddin et al., 2012).