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APPLICATION OF TRIZ AND ANP IN SELECTING THE BEST CONCEPT DESIGN AT THE CONCEPTUAL DESIGN STAGE FOR AN AUTOMOTIVE PART

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

By

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FACULTY OF MANUFACTURING ENGINEERING

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UNIVERSITI TEKNIKAL MALAYSIA MELAKA

BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

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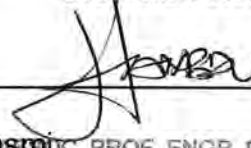SESI PENGAJIAN: **2015/16 Semester 2**

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I hereby, declared this report entitled "Application of TRIZ and ANP in Selecting the Best Concept Design at Conceptual Design Stage for an Automotive Part" is the results of my own research except as cited in references.

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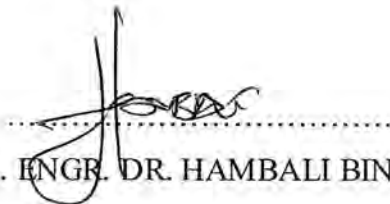
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ABSTRAK

Kajian ini adalah untuk memilih dan menyelesaikan isu yang berlaku kepada penyerap kejutan yang sedia ada dalam kereta dengan menggunakan Theory Inventive Problem Solving (TRIZ) dan juga Proses Analisis Network (ANP). Kerosakan penyerap kejutan akan mengakibatkan kerata susah untuk berhenti, menjadikan tayar kereta haus dan juga meluncur ketika membuat belokan. Kerosakan ini akan membahayakan individu yang menggunna jalan raya. Kaedah yang dicadangkan dalam kajian ini adalah untuk menyelesaikan masalah dengan teknikal dengan menjana 3 konsep reka bentuk daripada cadangan TRIZ. Selain itu, projek ini juga bertujuan untuk memilih pilihan dengan mengira kepentingan kriteria terhadap unsur yang diambil kira dalam peringkat concept reka bentuk. Soal selidik akan dilakukan terhadap 20 perkerja dalam syarikat penyerap kejutan ini dan data yang diambil akan dimasukkan sebagai pekara yang menentukan pemilihan konsep. Melalui kaedah TRIZ dan ANP ini, konsep terbaik untuk penyerap kejutan yang sedia ada pada kereta dapat diselesaikan. Selain itu, melalui kaedah TRIZ dan ANP dalam menyelesaikan masalah yang berlaku terhadap penyerap kejutan juga dapat menyelamatkan nyawa manusia daripada kemalangan jalan raya akibat kerosakan penyerap kejutan kereta. Kesimpulannya, dengan menggunakan TRIZ, 3 konsep berjaya dijanakan dan konsep terbaik dipilih dengan menggunakan ANP.

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ABSTRACT

This study is to select and solve the current issue of existing shock absorber of a car by using Theory of Inventive Problem Solving (TRIZ) and also Analytical Network Process (ANP). Malfunction of shock absorber will make the car to have the difficulties to stop, uneven tyre wear and slide when making turn which may endanger road users (A.   ). The propose method is used to solve problem in technical way by generating 3 concept design according to the suggested inventive principles of TRIZ. Meanwhile another propose method is used to solve problem by calculating the importance of the criteria of element which is needed to consider in the selection conceptual design. From data collected through questionnaire from 20 employees in car suspension field are used as the input for weighting the element in the criteria. Going through these methods of ANP and TRIZ, the problem solving and decision making in the conceptual design stage will result the best concept design which can solve current issue of shock absorber which may endanger life of road user. This study concluded that through utilization of TRIZ, 3 concept are generated and one best concept are selected by using ANP.

DEDICATION

Special thanks for my beloved parents and whole family members that given me support throughout my university path, and also for my respectful Lecturer and my Supervisor, thank you for guided me for upon completing my degree in manufacturing engineering. Last but not least, for my friends, I am thankful for your support and also all members who involve upon completing my final year project.

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Thank from the bottom of my heart to all my friend that aided me upon completing my final year project. Thanks to their support to let me break through obstacles and help me been through this final year project.

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LIST OF ABRREVAITIONS, SYMBOLS AND NOMENCLATURES

TRIZ	-	Theory of Inventive Problem Solving
AHP	-	Analytical Hierarchy Process
ANP	-	Analytical Network Process
lc	-	Critical Length
K	-	Stress Intensity Factor
Kc	-	Critical Value
σ	-	Stress
F	-	Force
A	-	Area
C.I	-	Consistency Indicator
C.R	-	Random Indicator

CHAPTER 1

INTRODUCTION

This chapter included the background of the study, problem statements, objectives of the study, and the scope of study. The background of the study is mainly described about initial stage for a product development to generate new conceptual design for a automotive product. For the main objective, the motives of this study is to solve a problem occurs on the piston rod of a shock absorber by generate a few concept and select the most appropriate concept for overcome the problem. Final sub-topic for this chapter highlight the focus and limitation of the area of study.

1.1   Background of Study

The conceptual design stage is the starting stage in the early phase of product development process. Whereby this stage involve in many professional people from various field. This initial phase in the product development process involves the intellectual process of develop a research idea into realistic and appropriate research design. To be specific, conceptual design stage can be divided into four categories which are concept explanation, concept generation, concept selection and concept development. These four sub-categories in the conceptual design stage are to rally around inventors or designers in generating ideas for new inventions and also concept selection and even concept development in an organize way. At the very first stage of conceptual design was to generate idea for come out with new ideas. Besides that, Theory of Inventive Problem Solving (TRIZ) are one of the method that will be discuss in this project. TRIZ is a problem solving methodology based on logic, data and research, not intuition. It draws on the past knowledge and ingenuity of many

thousands of engineers to accelerate the project team's ability to solve problems creatively.

A part from that, among the available method applied in product development for the concept selection purposes are the Analytic Network Process (ANP). This method have the advantage in providing crucial solution in the decision making process where multiple attribute and design alternatives have to be analyzed simultaneously to suit the intended design specification and also able to be applied in group decision making.

In this project, a new conceptual design will be developed or improve from existing automotive part. Based on the project prerequisite, a new concurrent engineering approach using the integration of TRIZ and ANP will be applied in the development of conceptual design for automotive part.

1.2   Problem Statement

To experience a safety car ride, quality car ride and handling performance, car suspension are one of the major consideration factor. Greater quality of car suspension not only can improve quality of car ride and handling performance but also can reduce the risk of accident. Shocks and struts are the main component of the suspension system. By changing spoil or poor struts and systematically checking the whole system will help to sustain vehicle safety and control. Thus, to enhance the quality of the car suspension, TRIZ and ANP are applied to solve the problem at the conceptual design stage in the development for a new shock absorber.

1.3 Objectives

The main objective of the project is to determine the best concept design for automotive shock absorber. The objective are specify as follows:

   i.   To solve problem using TRIZ methodology by generate new concept design.
   ii. To select the best concept design using ANP methodology.

1.4 Scope of Study

This project cover the new idea generation for automotive part at the conceptual design stage. In order to generate new conceptual design for shock absorber, methodology such as ANP and TRIZ is use to yield for the best solution. Understanding of these methodology is important to continue the whole research. To specify the automotive part, research on current world of automotive is require to be done to make this research beneficial to human. Hence, of TRIZ and ANP methodology is used to complete the research and produce a useful solution for car shock absorber.

CHAPTER 2
LITERATURE REVIEW

This chapter discuss about literature review on methodology of problem solving method and decision making method and also on car shock absorber. Secondary sources such as books, journals papers, and online researches are used to acquire related information regarding the project. This chapter will offer a understanding about automotive absorber and the method about how to solve problems and making decisions.

2.1 Introduction of Car Absorber

Car absorber that also known as shock absorber is one of the fundamental function that used for absorb and reduce the force of kinetic energy that generated when the car is in acceleration, deceleration and crossing on the uneven road (Kus, 2012). There exists of two main group that can sub from shock absorber; Friction (solid elements) and Hydraulic (fluid element). Besides that, hydraulic shock absorber also divided into two different types, twin-tube and mono-tube. Figure 2.1 shows the two different kind of hydraulic shock absorber (Kennedy, 2003).
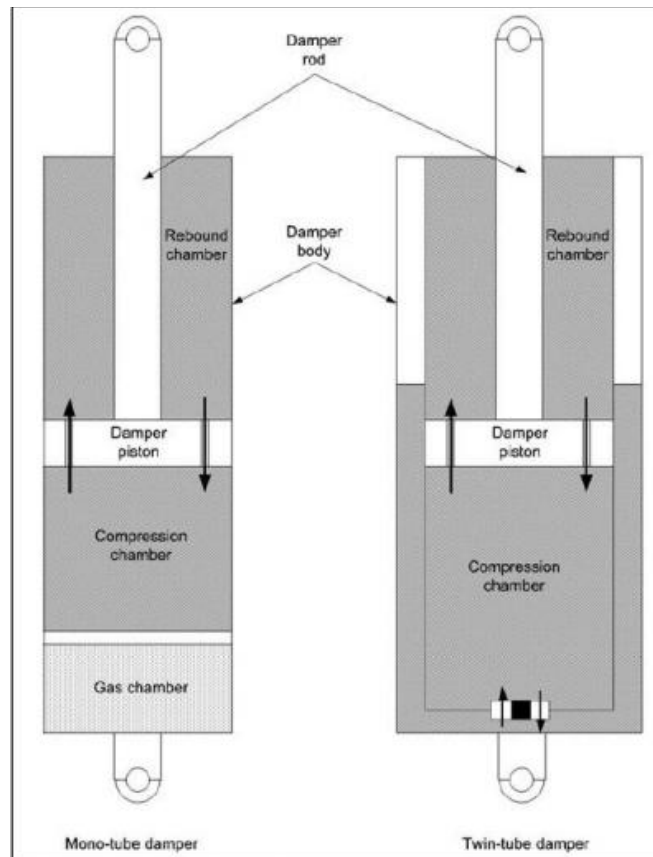
Figure 2.1: Schematics of two different shock absorber, Mono and Twin tube
(Farjoud, 2012)

In the mono-tube shock absorber, it is surround by the single wall and between this single wall it contain piston, pressurized gas and also oil. This mono-tube absorber commonly work with piston with a larger diameter than which is used in the twin-tube shock absorber, and the outcome of the damping are much more better. In contrast, the disadvantages of the mono-tube is that the prices is much more higher and the height of the mono-tube is higher than the twin-tube absorber.

2.1.1 Part of Shock Absorber

Generally, absorber are made up of few key parts, each part have own functionality. Those part are listed as follow (Atherden, 2004).

- Body
- Main Shaft
- Piston
- Adjusters
- Valve
- Reservoir

I. Body

The design of the body of the shock absorber are unique because it can carry out several functions that happen in the body. First of all the fluid that contain in the body of the shock absorber can support the damping force and the fluid are normally oil. The uniqueness of the main body is that the surface of the body able to resist the hydrostatic pressure that exert by the main shaft and this also prove that the sealing of the piston and the body of the shock absorber must capable to withstand the compression and extension forces while damping. Moreover, it is essential for providing support to the main shaft of the absorber so that it can maintain part that are uneven to the plunge axis. Nowadays, most of the shock absorber are attach with the coil spring and adjustable preload as well as the point to the frame. Figure 2.2 shows the example of shock absorber that available in the market.

Figure 2.2: Shock Absorber Body
(Anon, 2013a)

II. Main Shaft

The function of the main shaft are used to connect the piston which is link to the eyelet mount. While the eyelet of the shock absorber are connected to the car suspension and enable the movement for the unsprung mass to travel relative to the chassis. Normally the low speed rebound adjuster are houses by the main shaft and the main shaft should enable to endure instability forces by uneven road surface inputs.

III. Piston

There exists two oil chamber in the body of the piston. Between the chamber it contain two holes that enable the oil to flow through and the holes are known as ports. This design of ports are important to indicate that the high speed characteristic of the absorber. The place where the ports are situated are to make sure they are covered by valves in single direction flow so that the compression and rebound does not happened in the same time. At the end of the piston consists of the sliding seal that attach to the inner wall of the body. Figure 2.3 shows the example of a piston port for car shock absorber.