EMOTIONAL INTELLIGENCE MEASURES FOR CONCEPT CAR DESIGN IN MALAYSIA

By

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Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Degree of Doctor of Philosophy

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DEDICATION

This thesis is dedicated to

Hasnul Abdul Qayyum, Hada Nurqayyimah, Hada Nurqawiyyah
Backbones, who gave endless support throughout the ups and downs journey

Hj Andi Abdul Kadir, Hjh Niswa, Hj Hasnulhadi, Hjh Kamisah
Blessings, who always provides encouragement and dua's for us

Andi Mohamad Aksan, Andi Kaswia, Andi Sunny, Andi Abdul Ghani, Andi Fitriah, Andi Mohd Hafiz
Birds of a feather, who shared all the black and white

Supervisory and Examination Committee
Bright, who accommodates with knowledge and guide

The rest of my lovely family and friends
Bonding, which came with love, respect, and a bunch of memories

Everyone and Anyone Related
Thank you for everything
Indeed, we belong to Allah, and indeed to Him we will return
May Allah Bless

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Doctor of Philosophy

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August 2023

Chairman : Assoc. Prof. Raja Ahmad Azmeer Raja Ahmad Effendi, PhD
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Malaysia introduces several National Plans and Policies from an Industrial Design perspective as an effort for The Agenda 2030 on Sustainable Development Goals (SDGs) such as the Industry4WRD, National Transport Policy (NTP), and National Automotive Policy (NAP). All these policies emphasize smart culture and human well-being by adapting technology to human nature. High technology versus human value has become the main issue for the Malaysia Road Safety Plan (MRSP) since the fatality rate still concerning due to contemplating between technology usage and relying on smart technology during driving to combat these issues or otherwise. The exploration of this matter may be seen through Concept Car Design (CCD), with Artificial Intelligence (AI) implementation in the automotive industry beginning to introduce innovations like voice command and face recognition making futuristic concept cars growing rapidly. These cars are positioned as Emotional Intelligence (EI) cars, smart enough to understand user emotions, safe, and more convenient mobility experience. However, whether these concepts are viable is still extensively unexplored. Hence, the study aims to identify EI measures for CCD in Malaysia. Two phases of research design were proposed in this study. In Phase One, the Repertory Grid Technique (RGT) was used to understand how ten automotive designers perceive EI by comparing six of the selected concept cars (elements) and successfully elicited ten bipolar poles (constructs) of AI and EI. It was then rated with a scale of one to five in the grid form and analyzed using OpenRepGrid to explore the descriptive statistics, correlations, root mean square, and the visualization plot of the elements and constructs. As the results, EI measures on BMW Concept (M=3.4; SD=1.71), MINI Concept (M=3.0; SD=1.76), and Rolls Royce Concept (M=3.0; SD=2.11) presented the highest mean of (n=10) and all positively correlated (r = 0.96), extruded Emotional Intelligence with Conceptual Images, More Informative, Simple Interaction, Homelike, High Autonomous, Multipurpose Drive, Luxury, User-Friendly Application, and Leisure. The continuation of the study used these

three elements of the concept cars as stimuli in Phase Two of the Electroencephalogram (EEG) and Virtual Reality (VR) experiment. The experiment purposely analyzes the emotions of twenty subjects on CCD using sixteen channels of brain signal while using VR which consists of Video One (Current car accident experience) and Video Two (Concept Car - EI measures). MATLAB with the Mel Frequency Cepstral Coefficients (MFCC) for feature extraction and Multilayer Perception (MLP) as classifier used to analyze the Valence and Arousal emotions (Happy, Calm Fear, Sad). Most subjects started with negative emotions and turned positive after experiencing Video Two on the concept car. The results show the need for EI exploration and conclude EI measures as EI=User Experience (UX) + User Interface (UI) that create emotional connection, adapt user emotion, and enable better interaction are things to consider for EI measures for CCD in Malaysia. Indirectly, this contributes to the Next Generation Vehicle NAP National Plan and the future bridge of multidisciplinary studies to embark on life and emotion concerns.

Keywords: Artificial Intelligence, Concept Car Design, Electroencephalogram, Emotional Intelligence Measures, Repertory Grid Technique,

SDG: GOAL 9: Industry, Innovation and Infrastructure

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

PENGUKURAN KECERDASAN EMOSI DALAM REKABENTUK KERETA KONSEP DI MALAYSIA

Oleh

ANDI NURSYUHADA BINTI ABDUL KADIR

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Malaysia memperkenalkan beberapa rancangan dan polisi nasional dari perspektif Reka Bentuk Perindustrian sebagai usaha kearah agenda Agenda 2030 terhadap Matlamat Pembangunan Mampan (SDGs) seperti, Industry4WRD, Dasar Pengangkutan Negara (NTP) dan Dasar Automotif Nasional (NAP). Kesemua dasar ini memberi tumpuan kepada budaya pintar dan kesejahteraaan manusia dengan menyesuaikan teknologi dengan sifat manusia dan teknologi tinggi yang berlawanan dengan nilai manusia ini menjadi perhatian utama Pelan Keselamatan Jalan Raya (MRSP) memandangkan masih terdapat kematian yang berkaitan dengan penggunaan teknologi masih menjadi kebimbangan dan sejauh mana pergantungan terhadap teknologi pintar dapat menangani isu-isu ini atau sebaliknya. Penerokaannya dapat dilihat melalui Reka Bentuk Kereta Konsep (CCD), dengan implementasi Kecerdasan Buatan (AI) dalam industri automotif yang mula menjadi tipikal dan diterokai secara meluas dengan pelbagai inovasi seperti arahan suara dan pengecaman muka yang membawa kepada banyak kereta konsep futuristik. Beberapa kereta konsep ini disebut sebagai kereta Kecerdasan Emosi (EI) yang didakwa cukup pintar untuk memenuhi emosi pengguna, lebih selamat dan pengalaman mobiliti yang selesa. Walau bagaimanapun, sama ada konsep EI ini berdaya maju masih belum diteroka secara menyeluruh. Oleh itu, kajian ini bertujuan untuk mengenalpasti EI terhadap CCD di Malaysia. Dua fasa reka bentuk kajian telah dicadangkan dalam kajian ini. Dalam Fasa satu, Teknik Grid Reportari (RGT) digunakan untuk memahami bagaimana sepuluh pereka automotive mempersepsikan EI dengan membuat perbandingan enam kereta konsep terpilih (elemen) dan berjaya menghasilkan sepuluh kutub bipolar (konstruk) AI dan EI. Ianya kemudian dinilai dengan dengan skala satu hingga lima di dalam bentuk grid dan dianalisis menggunakan OpenRepGrid untuk meneroka statistik deskriptif, punca purata kuasa dua dan plot visual elemen dan konstruk. Keputusannya, pengukuran EI dalam konsep BMW (M=3.4; SD=1.71), konsep MINI (M=3.0; SD=1.76) dan konsep Rolls Royce (M=3.0; SD=2.11) yang

menunjukkan min tertinggi bagi (n=10) dan kesemuanya berkorelasi positif (r=0.96) mengeluarkan ciri EI bersama Konseptual Imej, Lebih Bermaklumat, Interaksi Mudah, Seperti Rumah, Autonomi Tinggi, Pemanduan Pelbagai, Mewah, Aplikasi Mesra Pengguna dan Santai. Kesinambungan kajian menggunakan tiga elemen ini sebagai stimuli fasa ke-dua dalam eksperimen Elektroensefalogram (EEG) dan Realiti Maya (VR). Eksperimen ini bertujuan untuk menganalisis emosi dua puluh subjek terhadap CCD. menggunakan enam belas saluran signal otak ketika menonton video di dalam VR yang mengandungi Video satu (kereta semasa dengan pengalaman kemalangan) dan Video dua (kereta konsep terpilih dengan pengukuran EI). MATLAB bersama Pekali Cepstral Frekuensi Mel (MFCC) digunakan sebagai pengekstrakan ciri dan perceptron berbilang lapisan (MLP) digunakan sebagai pengklasifikasi untuk menganalisis Valens dan Kebangkitan emosi (Gembira, Tenang, Takut, Sedih). Kebanyakan subjek bermula dengan emosi negatif dan berubah positif selepas mengalami Video dua. Keputusan kajian menunjukkan keperluan yang jelas terhadap eksplorasi EI dan menyimpulkan pengukuran EI sebagai EI = pengalaman pengguna (UX) + antaramuka pengguna (UI) yang menghasilkan ikatan emosi, memahami emosi pengguna dan menghasilkan interaksi lebih baik adalah perkara yang perlu dipertimbangkan dalam pengukuran EI terhadap CCD di Malaysia. Secara tidak langsung, ini menyumbang kepada plan nasional NAP tentang kenderaan generasi akan datang dan jambatan masa depan kajian pelbagai disiplin terhadap kehidupan dan pertimbangan emosi.

KATA KUNCI: Elektroensefalogram, Kecerdasan Buatan, Kecerdasan Emosi, Reka Bentuk Kereta Konsep, Teknik Grid Reportari

SDG: MATLAMAT 9: Industri, Inovasi dan Infrastruktur

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LIST OF ABBREVIATIONS

EI	Emotional Intelligence
CCD	Concept Car Design
NAP	National Automotive Policy
NTP	National Transport Policy
MRSP	Malaysia Road Safety Plan
SDGs	Sustainable Development Goals
RGT	Repertory Grid Technique
EEG	Electroencephalogram
VR	Virtual Reality
AI	Artificial Intelligence
UX	User Experience
UI	User Interface
CAD	Computer Aided Design
GUI	Graphic User Interface
MFCC	Mel Frequency Cepstral Coefficients
MLP	Multi-Layer Perceptron
HUD	Head Up Display
NxGV	Next Generation Vehicle
MOT	Ministry of Transport
MITI	Ministry of Investment, Trade and Industry
VNR	Voluntary National Review

CHAPTER 1

INTRODUCTION

1.1 Introduction

The journey of this curiosity began with the thoughts of what if in the future, the car could understand our emotions and become our friend to talk to, will the situation help our life to be safer and have a better daily experience on the road or vice versa. In this chapter, the exploration of the main concepts leads from that inquisitiveness and begins with a research background on how the significance of the Sustainable Development Goals reflects and pushes the National Industry 4.0 followed by the National Transport Policy and National Automotive Policy. These Policies contribute to the rapid development of technology spotted Artificial Intelligence (AI) in Autonomous Car and its exploration in Concept Car Design added the empathetic value as the emotion of AI in many automotive companies that claim it as an Emotional Intelligence Car. The necessity of dealing with the issues highlighted the research aims, research questions, scope and hypotheses, term definition, significance, and limitation of the study. It then closes with a summary of the thesis structure

1.2 Research Background

Chronologically from the worldwide concern on the Agenda 2030 about Sustainable Development Goals (SDGs) that was developed in September 2015, Malaysia along with 192 countries adopted the SDGs and worked with the roadmap from 2016 to 2020, followed by SDG Indicators 2018 and 2021, which also established Voluntary National Review (VNR) 2021 (Department of Statistics, 2018; Economic Planning Unit, 2021). Division (2018) mentioned that due to the increase in world population which potentially leads to urbanization and climate change, sustainable development studies will always be foregoing exploration even though there has always been discussion happening globally over the past 30 years. By referring to the seventeen goals of SDGs, the development of these goals must meet the balance in terms of social, economic, and environmental (Johnston, 2016).

Due to those reasons, the government and the private sector in Malaysia have made various collaborations to work on several National Policies to support sustainable development from a better perspective, especially from of industrial design point of view. The Industry4WRD as the National Policy on Industrial Revolution 4.0 proposed in 2018 targeted for advancement and convergence of technologies to support SDGs (Jayasooria et al., 2016). A year later, the Ministry of Transport Malaysia (2019) established the National Transport Policy (NTP) 2019-2030 as the means of collaboration between the government and the private sector which managed to spot eight (8) crucial trends to achieve. Trend 8 is about Intelligent Systems and Autonomous Driving potential to align with the

Connected Vehicles system as the main vision of the National Automotive Policy (NAP) 2020-2030.

The immersive experience is expected to have the ability to have independent operations without human supervision or intervention. Aside from having automatic emergency braking, adaptive cruise control, automated parking, and active lane control which are already becoming common features in current vehicle models, considered as half autonomous cars. In the era of digital industrial transformation, NAP 2020 drafted five objectives to be achieved and targeted by 2030. The next generation vehicle (NxGV) of Malaysia is expected to be autonomous, automated, connected with a fully Electric Vehicle Interoperability Centre (EVIC), and poses as Energy Efficient Vehicle (EEV) which promises users the safety and carbon emission reduction as shown in Table 1.1. This vision corresponds with SDG 9: Industry, Innovation, Infrastructure, SDG 11: Sustainable Cities and Communities, and SDG 13: Climate Action.

Table 1.1 : Objectives of the National Automotive Policy (NAP 2020)

• Develop NxGV technology ecosystem to make Malaysia the regional hub for NxGV production • Expand automotive sector participation in Maas • Ensure the local automotive industry is ready with a new paradigm closely related to IR4.0 development • Ensure the whole ecosystem benefits from the spin-off of NxGV implementation • Reduce vehicle carbon emissions by improving fuel economy level in Malaysia by 2025

Note: NxGV indicates next-generation vehicle

Adaptation of technology to human nature and all of these policies' vision also has become the primary focus of the Malaysia Road Safety Plan (MRSP) due to ongoing fatalities related to technology usage. Statistically, this concern keeps on persisting and still looking at how far reliance on smart technology can eventually overcome these issues, or on the flip side may see further deterioration. The Artificial Intelligence (AI) implementation in the automotive industry is currently being explored widely with various innovations such as having voice command and face recognition that led to the creation of more futuristic concept cars. Some of these concept cars were positioned as EI (EI) cars that claim to be smart enough to cater to and understand users' emotions, being a safer and more convenient mobility experience is seen as an added value. However, whether these EI concepts are viable, still extensively unexplored.

1.3 Problem Statement

Collectively all National Policies that have been discussed in previous section 1.2 point to a holistic Malaysia vision on smart culture and human nature. The

main concern of the Malaysia Road Safety Plan (MRSP) where the situation tends to lean towards high technology versus human value. The Ministry of Transport (MOT) has launched MRSP which has been officialized since 2006 as a continuous effort to counter road safety issues in Malaysia with two main objectives in mind, to set a direction of focus areas and set targets as a benchmark to be the strategic planning and becoming the main reference for all related authorities. To date, there are three editions of MRSP, the first one MRSP 2006-2010 was based on 4E (Education, Enforcement, Engineering, and Environment).

Meanwhile, MRSP 2014-2020 was the continuation version that is more in line with global efforts on SDGs with a target aimed to reduce 50% of road accident fatalities by 2020. Whereas the latest edition of MRSP 2022-2030 set another mission driving up to the year 2030, another 50% of total fatalities must be reduced as indicated in Figure 1.1. towards the vision “Malaysia, A Country with Zero Road Fatality” (MOT, 2022). Even though the aim target to reach seen to pose an enormous challenge onwards, it is still able to be made possible to achieve as one of the ways is to apply suitable design practices like designing Concept Car Design (CCD) to be much more understanding which later may assist the design progression to be more effective since human factor and concerns have been taken seriously as the fundamental for the next posterities until it translates to actual reality.

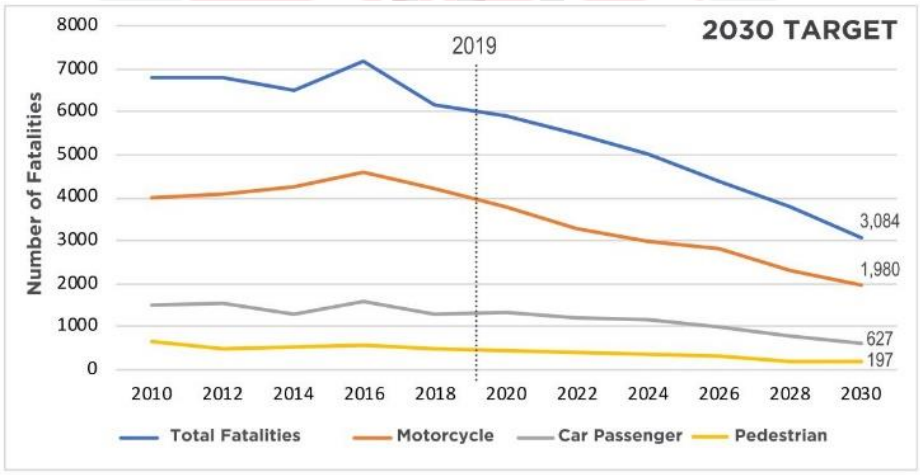

Figure 1.1 : 2030 Target of MRSP
(Source: Ministry of Transport, 2022)

A growing interest in Intelligent Systems, Autonomous Driving, and Connected Vehicle in the digital world also widely explored from a Concept Car Design (CCD) perspective which plays a significant role as a design-led future technique in the automotive industry especially for automakers to showcase innovative designs, new technologies, and future trends (Frizziero et al., 2023; Sarmiento

et al., 2016). The essential of CCD exploration is for gauging the public and grabbing market reactions towards acceptance of new ideas and meant for testing the feasibility of incorporating these ideas into future production models (Frizziero et al., 2023).

Aside from that, Sarmiento et al. (2016) have also highlighted two significant points in using CCD which addresses the importance of communication and increases the innovation capabilities of manufacturer to user. Presenting the vision of a concept car shares a concrete image of the foresighted future of that particular brand so that is easy for a broad audience to grasp, and also able to trigger conversations apart from generating various fresh ideas and opportunities from diverse stakeholders (Lv & Lu, 2012). These can be seen clearly in the summary of numerous news, reports and reviews of CCD in Table 1.2.

Table 1.2 : Summary Features of Concept Car Design

Date	Highlighted Features	Writer	Media
28 November 2013	**Volvo Concept**: Building emotive connection through design and experience	Volvo	Car Body Design
8 December 2016	**Honda NeuV**: Automated electric vehicles equipped with Artificial Intelligence that Honda claims will enable interface to artificially generate their own emotions	Steven Overly	The Washington Post
16 June 2016	**Vision Next 100 Series:** BMW (Ridesharing experience) Mini (Automated Interface) Rolls-Royce (Luxury feelings)	Chris Bruce	Motor1.com
16 October 2017	**Toyota Concept-I series:** Interface that understands people	Joe Clifford	Toyota UK Magazine
9 January 2017	**Nissan Vmotion 2.0:** Intelligent Mobility with Great Interface and Experience	Nissan	Nissan Motor Corporation
22 October 2021	**Lexus LF-Z:** Release Emotionally Intelligent interfaces that respond to viewer's emotions	Europe Newsroom	Lexus

Media reports indicate that the current practice in the automotive industry through various manufacturers develop their concept cars using a similar approach direction; by embracing Artificial Intelligence (AI) with great User Experience (UX) and User Interface (UI) to create Intelligent Mobility which could generate their very own emotion and personalities mainly to responds more

naturally to user's emotions and directly contributed to strong emotive connection, not only act as a car but rather more as a companion (Ceccacci et al., 2021; Frizziero et al., 2023; Lv & Lu, 2012). The vision of Concept Car Design (CCD) all direct to the question of what next comes after Artificial Intelligence is indirectly highlighted by the philosophy of EI which is defined as the ability to understand, use, and manage your own emotions in positive ways (Sfetcu, 2023). The overview of this definition parallels the features found in CCD as shown in Table 1.2 despite the concept of EI originating from the Psychology field.

Historically, the first term of "EI" began in 1964 and was attributed to Michael Beldoch, a Clinical Professor of Psychology in Psychiatry at Cornell University which later was used in a doctoral dissertation by Wayne Payne in 1985. The convergence of it began booming around 1990 when Peter Salovey and John Mayer published their landmark article entitled "EI" in the Journal Imagination, Cognition, and Personality (Sood, 2020). In the following years, this concept became popularized and became a phenomenon after the publication of EI: Why It Can Matter More Than IQ by Daniel Goleman, Psychologist and New York Times science Writer. Since then, the topic has been explored largely in psychology, education, and business fields. The EI refers to the ability to perceive, understand, and manage one's own emotions, as well as recognize and influence others' emotions which is commonly defined by these four attributes: self-awareness, self-management, social awareness, and relationship management (Mehta & Singh, 2013; Sood, 2020; Sfetcu, 2023).

Whilst in the context of CCD, EI refers to designing cars that can understand and adapt to user emotions, enabling better communication and interaction between humans and autonomous vehicles (Pamela, 2019; Aniah, 2021; Peng & Wang, 2023). This specific exploration from the academic perspective of Industrial Design merged with the concept of EI renders an interesting topic to be discovered through Pamela Pavliscak's Publication 'Emotionally Intelligent Design: Rethinking How We Create Product' (Pamela, 2019). In her book, she did mention regarding positive potential of Emotion AI exploration where it could manage to have an impact towards reducing accidents and creating safer communities. This could be achieved through the combination of the research concept from Affectiva's automotive AI which is designed to detect driver's fatigue level, distraction, and frustration (Braun et al., 2022). However, to oversee the issues present, a simple detection method only will not be sufficient without the implementation of EI measures in CCD.

1.4 Research Questions

Beginning from the large view on SDGs concern to specifically finding the issues to highlight especially from an Industrial Design perspective, here is the landing page on how chronologically the Emotional Intelligence (EI) measures for concept cars in dire need of extensive exploration. Leading all the curiosities to match missing puzzles of related research in their respective places. The

objectives of the next-generation vehicle, NxGV in National Automotive Policy (NAP) 2020 with the intention to counter the Malaysia Road Safety Plan (MRSP) require the exploration of EI measures for Concept Car Design (CCD) in Malaysia since the significance in the contribution is expected to be smart enough in making the driving experience the more convenient, safer and strong connection between the user and the car.

Hence, three research questions to be addressed in this research. The first research question is to know how automotive designers perceive EI measures on CCD. Since the exploration of the concept car is one of the cultures in the automotive industry, in-depth study to know how the practitioners interpret EI details. EI for CCD is expected to create immersive connections and influence user emotions, so the second question is the curiosity on what are their emotions on CCD. While the last question is what are EI measures for CCD in Malaysia?

Research Question 1

How do automotive designers perceive EI measures on Concept Car Design (CCD)?

Research Question 2

What are the car user emotions on Concept Car Design (CCD) that implement EI?

Research Question 3

What are EI measures to be used for Concept Car Design (CCD) in Malaysia?

1.5 Research Aims and Objectives

Based on literature support and the research gap, this study aims to develop Emotional Intelligence (EI) measures for Concept Car Design (CCD) in Malaysia, however, the exploration in this area is still yet to need further exploration to connect all the related dots. In order to achieve this aim, this research has three main objectives:

Objective 1

To understand how automotive designers perceive EI measures on Concept Car Design (CCD).

Objective 2

To analyze the Car User emotions on Concept Car Design (CCD) that implement EI measures.

Objective 3

To propose EI measures for Concept Car Design (CCD) in Malaysia.

1.6 Research Hypotheses

The following research hypotheses were set up to understand the relationship of each construct in the conceptual framework of EI measures for Concept Car Design in Malaysia;

H_1: There is a positive and direct significant relationship between Emotional Intelligence (EI) and Concept Car Design (CCD).

H_2: There is a positive and direct significant relationship between Emotional Intelligence (EI) with Car User Emotions towards Concept Car Design (CCD).

H_3: There is a positive and direct significant relationship between Emotional Intelligence (EI) Measures for Concept Car Design (CCD) in Malaysia

1.7 Definition of Terms

1.7.1 Emotional Intelligence Measures

Emotional Intelligence (EI) is the ability to recognize, understand, and manage own emotions and emotions of others. It involves the type of social intelligence of empathy, self-awareness, self-regulation, and the ability to build relationships (Sood, 2020). However, the EI definition in this study mainly refers to the implementation of EI specifically in car design. EI in cars could be seen as the ability of a vehicle to respond and adapt to the emotional state of its occupants (Mehta & Singh, 2013). The exploration of EI in cars is currently limited compared to Artificial Intelligence (AI) which has been widespread globally, nowadays, this concept of definition is actively discussed under many platform discussions since the success of EI implementation also depends on advanced technologies such as biometric sensors and AI (Aniah, 2021; Peng & Wang, 2023).

Taking an example, when sensors begin detecting the change in the emotional state of the driver through physiological signals such as face detection and heart rate, the car could adjust the driving experience accordingly through AI algorithm data that can predict the driver's emotional state and respond in real time. However, it is crucial to acknowledge that the development of EI in car design is still in its very early stages and several technical and ethical challenges must be overcome before it can be grown to be accepted as the mainstream technology (Knopp, 2023).

1.7.2 Concept Car Design

The potential benefits of EI in cars definitely would be exciting when introduced and will become a promising area of research and development in Concept Car Design (CCD). CCD is the design and development of the visual appearance and form of automobiles that are based on certain conceptual proposals (Lv & Lu, 2012). It is a crucial aspect of the automotive industry as the visual appeal communicates with the user and leads to the future design direction of the vehicle and is a major factor in customer purchasing decisions (Sarmiento et al., 2016).

The process of Concept Car Design involves plenty of design sketches, computer-aided design (CAD) models, and physical prototypes that are used to evaluate and refine the design. It also the creation combination of aesthetically pleasing that meet the needs and desires of the consumers. However, for the term definition of this study, the concept of car development considers future ideas on automotive design (Frizziero et al., 2023). Indirectly, the consideration of automotive styling in this research is to look in detail at EI measures in concept car development.

1.7.3 Repertory Grid Technique

The Repertory Grid Technique (RGT) is a research method used in the field of psychology and behavioral sciences. It is a tool to understand and explore an individual's perceptions, attitudes, and beliefs about a particular subject. RGT involves presenting a person with a set of stimuli or elements related to a specific topic and asking them to evaluate and categorize these elements based on their values and beliefs (Curtis et al., 2008).

The person is then asked to identify the key dimensions or attributes that distinguish one element from another and to provide a desired rating for each element based on these constructs. The resulting data can be used to construct a grid or a matrix that indicates the relationship between the elements and the constructs. This grid can provide insight into an individual's unique perspective and due to its level of validity can be used to compare and contrast from different perspectives as well as to identify common themes and constructs (Dal Corso et al., 2013). RGT has widely been used in a range of fields like education, marketing, management, and design. It is particularly useful for understanding complex and subjective topics. It was also able to provide valuable information in making decisions and improving products, services, and processes.

1.7.4 Electroencephalogram

An electroencephalogram (EEG) is a test that measures the electrical activity of the brain. It is a non-invasive and painless test that uses electrodes placed on

the scalp to record the electrical signals generated by the brain in response to visual stimuli, such as Concept Car Design (CCD). The resulting electrical signals are then displayed as brainwaves on a screen. Brainwaves can be split into 4 different types of waves, which are alpha, beta, delta, and theta waves respectively which represent different levels of brain activity. Taking an example, alpha waves are associated with a relaxed state of consciousness, mental activity, and arousal (Frey et al., 2016).

EEG is proposed to be one of the methods in this study due to it can measure the brain's electrical activity and provide insight into a person's emotional response to a CCD. In the evaluation, EEG potential to assess a person's reaction to the look and feel of a car (Frey et al., 2014). The result of these brainwaves can be used to identify patterns and changes in brain activity that are indicative of emotions such as Pleasure, Cool, Stress, and Disgust. This valuable information about the emotional response to CCD can be used to guide design decisions and improve the overall aesthetics of the car. By measuring changes in brain activity in response to different design elements, automotive designers can better understand what aspects of design are most appealing and what elements may need to be refined to enhance the emotional appeal of the car which will trigger better acceptance of the end user.

1.7.5 Virtual Reality

Virtual Reality (VR) is a computer-generated simulation of a three-dimensional environment that can be interacted with in a seemingly real or physical way by a user using specialized equipment, such as a VR Headset (VRH) (Clerk, 2019). The person can experience the environment as if they were there and able to interact with objects and other elements in the virtual world using handheld controllers or other forms of input (Hertweck, p. 2019). VR is often used for gaming, education, and training, but it is also in pursuit of finding applications in a variety of other fields, including healthcare, architecture, and psychology.

In Concept Car Design (CCD) evaluation, VR can potentially be used as a tool for designers to engage in a virtual space that stimulates the immersive experience of being closer to the car they need to design. This can provide valuable insights into how a person tends to perceive the design and functionality of the car and later could assist in identifying related areas that require improvement during CCD. However, in this study, the definition of VR refers to the usage of video projection using VRH. The videos presented in VRH are used to make sure the participants could enhance concentration towards the shown videos in comparison to watching solely on video projection on the screen.

1.8 Significance of the Study

This research will find out the relationship between Emotional Intelligence (EI) in CCD towards Sustainable Transportation Design (STD). The outcomes possibly

answer all hypotheses and research questions and indirectly achieve all the objectives of this research. One of the expected outcomes is to highlight design practitioners' preferences in CCD and lead to the theory of design practitioners' preference towards STD. Other expected outcomes will have a new perspective on EI, especially the implementation of CCD. The outcome of the implementation of EI via CCD is expected beneficial to the design practitioners and the transportation industry.

1.9 Limitations of the Study

This research meant to open the door to understanding how we could tackle road accidents by using the CCD approach towards National Policies. However, there are still several limitations that the researcher has to take into consideration. Upon conducting this research, one of the things that mainly becomes a major concern is the enormous amount of cost. This research will find out the relationship of EI in CCD towards sustainable transportation design.

1.10 Thesis Structure

The outline of the thesis structures shown in Figure 1.2 is organized into six chapters;

-*Chapter One* is an overview of the large context in the research background that highlights the root of Malaysia's focus on the issues related to the investigation topic.

-*Chapter Two* will review five main sections from the literature on the current status of the concern of Emotional Intelligence (EI) measures.

-*Chapter Three* on research methodology and the related procedures that are involved in Phases.

-*Chapter Four* will elaborate on all the results and research findings from the data collection sessions

-*Chapter Five* discusses the research findings and linkage to answering the hypotheses

-*Chapter six* is a conclusion and recommendations as the last chapter.

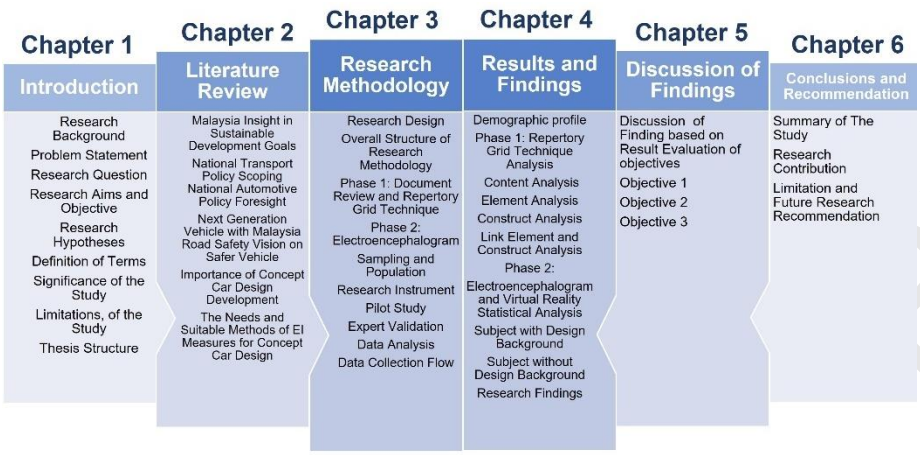

Figure 1.2 : Thesis Structure

1.11 Summary

The chapter presented an overview of the whole perspective on the purpose of this research on the relationship of Emotional Intelligence (EI) with Concept Car Design (CCD). These studies are expected to contribute to the theory and practice of EI studies on CCD to the academic purpose and the automotive industry as a future bridge for the next design direction. This study also fills the gap in connecting multidisciplinary studies of design, behavior, and psychology to the feast of the convergence of technology with more research efforts to contribute. It consisted of the background, problem statement, objective, expected contributions, operational definition, and the whole structure of this research plan. The following chapter will cover the literature review that highlights the related theories for the study.

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