DESIGN AND DEVELOPMENT OF ENERGY STORAGE UNIT FOR EMERGENCY USAGE USING RENEWABLE ENERGY SYSTEM

AHMAD NABIL BIN NAZAR
B092010036

BACHELOR OF MECHANICAL ENGINEERING TECHNOLOGY (AUTOMOTIVE TECHNOLOGY) WITH HONOURS

2024

Faculty of Mechanical Technology and Engineering

DESIGN AND DEVELOPMENT OF ENERGY STORAGE UNIT FOR EMERGENCY USAGE USING RENEWABLE ENERGY SYSTEM

AHMAD NABIL BIN NAZAR

Bachelor of Mechanical Engineering Technology (Automotive Technology) with Honours

2024

DESIGN AND DEVELOPMENT OF ENERGY STORAGE UNIT FOR EMERGENCY USAGE USING RENEWABLE ENERGY SYSTEM

AHMAD NABIL BIN NAZAR

A thesis submitted
in fulfillment of the requirements for the degree of
Bachelor of Mechanical Engineering Technology (Automotive Technology) with Honours

Faculty of Mechanical Technology And Engineering

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2024

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

TAJUK: **DESIGN AND DEVELOPMENT OF ENERGY STORAGE UNIT FOR EMERGENCY USAGE USING RENEWABLE ENERGY SYSTEM**

SESI PENGAJIAN: **2023-2024 Semester 1**

Saya **AHMAD NABIL BIN NAZAR**

mengaku membenarkan tesis ini disimpan di Perpustakaan Universiti Teknikal Malaysia Melaka (UTeM) dengan syarat-syarat kegunaan seperti berikut:

1. Tesis adalah hak milik Universiti Teknikal Malaysia Melaka dan penulis.
2. Perpustakaan Universiti Teknikal Malaysia Melaka dibenarkan membuat salinan untuk tujuan pengajian sahaja dengan izin penulis.
3. Perpustakaan dibenarkan membuat salinan tesis ini sebagai bahan pertukaran antara institusi pengajian tinggi.
4. **Sila tandakan (✓)

☐ TERHAD (Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysia sebagaimana yang termaktub dalam AKTA RAHSIA RASMI 1972)

☐ SULIT (Mengandungi maklumat TERHAD yang telah ditentukan oleh organisasi/badan di mana penyelidikan dijalankan)

☑ √ TIDAK TERHAD

Disahkan oleh:

Alamat Tetap:

313-4 BATU 4 KAMPUNG
PERMATANG KLEBANG
BESAR 75200 MELAKA

Cop Rasmi: LUQMAN HAKIM BIN HAMZAH
Jurutera Pengajar
Fakulti Teknologi Dan Kejuruteraan Mekanikal
Universiti Teknikal Malaysia Melaka (UTeM)

Tarikh: 11 January 2024

Tarikh: 9/2/2024

DECLARATION

I declare that this Choose an item. entitled “ Design and Development Of Energy storage Unit For Emergency Usage Using Renewable Energy System ” is the result of my own research except as cited in the references. The Choose an item. has not been accepted f or any degree and is not concurrently submitted in candidature of any other degree.

Signature :

Name : AHMAD NABIL BIN NAZAR

Date : 9/2/2024

APPROVAL

I hereby declare that I have checked this thesis and in my opinion, this thesis is adequate in terms of scope and quality for the award of the Bachelor of Mechanical Engineering Technology (Automotive Technology) with Honours.

Signature :

LUQMAN HAKIM BIN HAMZAH
Jurutera Pengajar
Fakulti Teknologi Dan Kejuruteraan Mekanikal
Universiti Teknikal Malaysia Melaka (UTeM)

Supervisor Name : TS LUQMAN HAKIM BIN HAMZAH

Date : 9/2/2024

DEDICATION

I dedicate this final year effort to the people whose constant support, understanding, and encouragement have been my guiding lights throughout this journey, with the utmost gratitude and admiration. First and foremost, I would want to express my gratitude to my wonderful supervisor TS Luqman Hakim Bin Hamzah, whose guidance, knowledge, and support have been priceless. This project and my academic endeavors have been shaped by their mentorship and steadfast faith in my talents. My strength has always come from my family, my dear mother, father, brother, and sister. Your steadfast love, boundless patience, and unceasing encouragement. Your selflessness and steadfast encouragement have strengthened my resolve to strive for greatness and reach this goal. To all of my friends,Nurul Nur'Ain, Arif Lukman, Hanif Asyraf, Afiq Zakwan and Uwais Nadzmi your support, understanding, and company have made the difficult times happier and more inspiring. Your confidence in my ability to succeed has always inspired me. I will conclude by dedicating myself to everyone whose affection, guidance, or encouragement has helped to light the way towards this project's successful completion. This accomplishment has been made possible by your support to follow my aspirations and your belief in my vision. This commitment is proof of the encouragement and support I've received from everyone, which has helped me advance. I will always be appreciative of your contributions because they have had a lasting influence on this journey, no matter how tiny.

ABSTRACT

The problem of battery damage often happens to all individuals regardless of the age of the vehicle. This problem has many adverse effects on the individual in terms of safety and also car life span. Problem that occur include weak state of battery to start your car and there is no electricity supply that can be used to charge mobile phones in case of emergency or energy source for light supply. For this problem that occur this energy storage unit will be the answer for it. This portable device is light enough to be carry and keep inside your car without taking much space while taking advantage for the movement of renewable energy this device will also be mainly charge using solar power. This device will be leave inside your car while charging using solar panel that fit under your rear mirror.To make this device name power storage box requires a battery that is easy to maintain. Therefore the selection for the type of lead acid battery is the best. This energy storage box serves as a lifeline for the car battery. It can be used as a tool to start the car. In addition, as a source of electricity for emergency needs. The manufacture of this energy box uses a combination of existing tools. For this project to be done I will use the design and development method. Pugh Matrix Table will be used for the selection of parts. The selection of goods is done by evaluating the factors that have been stated. After that making a circuit that can save the use of wires. In this report, it is clearly stated the findings that can be obtained based on the research carried out including the types of batteries and renewable energy sources that will be used, namely solar energy. Finally , as a result this project will be able to help cranking the engine more than 2 times without needing to charge it in between and the time taken to charge this energy storage unit is 7.43 hours using solar panel. This device will help to solve the problem of low car battery and save energy and time by only to be charge inside your car without needing to take it out.

ABSTRAK

Masalah kerosakan bateri sering berlaku kepada semua individu tanpa mengira usia kenderaan. Masalah ini banyak memberi kesan buruk kepada individu dari segi keselamatan dan juga jangka hayat kereta. Masalah yang berlaku termasuk keadaan bateri lemah untuk menghidupkan kereta anda dan tiada bekalan elektrik yang boleh digunakan untuk mengecas telefon bimbit sekiranya berlaku kecemasan atau sumber tenaga untuk bekalan cahaya. Untuk masalah yang berlaku ini unit simpanan tenaga ini akan menjadi jawapan untuknya. Peranti mudah alih ini cukup ringan untuk dibawa dan disimpan di dalam kereta anda tanpa mengambil banyak ruang sambil mengambil kesempatan untuk pergerakan tenaga boleh diperbaharui peranti ini juga akan dicas terutamanya menggunakan kuasa solar. Peranti ini akan dibiarkan di dalam kereta anda semasa mengecas menggunakan panel solar yang muat di bawah cermin belakang anda. Untuk membuat kotak simpanan kuasa nama peranti ini memerlukan bateri yang mudah diselenggara. Oleh itu pemilihan untuk jenis bateri asid plumbum adalah yang terbaik. Kotak simpanan tenaga ini berfungsi sebagai talian hayat untuk bateri kereta. Ia boleh digunakan sebagai alat untuk menghidupkan kereta. Selain itu, sebagai sumber tenaga elektrik untuk keperluan kecemasan. Pembuatan kotak tenaga ini menggunakan gabungan alatan sedia ada. Untuk projek ini dilakukan saya akan menggunakan kaedah reka bentuk dan pembangunan. Jadual Matriks Pugh akan digunakan untuk pemilihan bahagian. Pemilihan barangan dilakukan dengan menilai faktor-faktor yang telah dinyatakan. Selepas itu membuat litar yang boleh menjimatkan penggunaan wayar. Dalam laporan ini dinyatakan dengan jelas dapatan yang boleh diperolehi berdasarkan kajian yang dijalankan termasuk jenis bateri dan sumber tenaga boleh diperbaharui yang akan digunakan iaitu tenaga suria. Akhir sekali, projek ini akan dapat membantu menghidupkan enjin lebih daripada 2 kali tanpa perlu mengecasnya di antara penggunaan dan masa yang diambil untuk mengecas unit simpanan tenaga ini ialah 7.43 jam menggunakan panel solar. Peranti ini akan membantu menyelesaikan masalah bateri kereta lemah dan menjimatkan tenaga dan masa dengan hanya mengecas di dalam kereta anda tanpa perlu mengeluarkannya.

ACKNOWLEDGEMENTS

In the Name of Allah, the Most Gracious, the Most Merciful

I begin by acknowledging and thanking Allah the Almighty, the source of all blessings and guidance, for giving me the gift of life and the opportunities that have formed my journey, with the deepest reverence and appreciation. His steadfast assistance and heavenly direction have been the bedrock of my efforts, guiding me to this significant accomplishment.I would like to express my sincere gratitude to Universiti Teknologi Malaysia Melaka (UTeM) for offering such a great research platform that encouraged learning, creativity, and academic inquiry. Their dedication to academic achievement has been crucial in guiding my educational goals and ensuring the success of this endeavor.

I owe a debt of gratitude to the Malaysian Ministry of Higher Education (MOHE) for their priceless financial support, which has made pursuing an education less difficult. Their assistance has made it possible for me to concentrate on my academics and research, which has made it easier for me to achieve my academic goals. I am incredibly grateful for all of the help and direction I have received along the way; this journey is a tribute to that. Every organization and person listed has contributed something unique to my academic achievement, and I am grateful for their unwavering support and contributions.

TABLE OF CONTENTS

		PAGE
DECLARATION		
APPROVAL		
DEDICATION		
ABSTRACT		**i**
ABSTRAK		**ii**
ACKNOWLEDGEMENTS		**iii**
TABLE OF CONTENTS		**iv**
LIST OF TABLES		**vii**
LIST OF FIGURES		**viii**
LIST OF SYMBOLS AND ABBREVIATIONS		**xi**
LIST OF APPENDICES		**xii**
CHAPTER 1	**INTRODUCTION**	**1**
1.1	Background	1
1.2	Problem Statement	2
1.3	Research Objective	3
1.4	Scope of Research	3
CHAPTER 2	**LITERATURE REVIEW**	**4**
2.1	Introduction	4
2.2	Emergency Situation	6
2.3	Car Battery Failure	6
	2.3.1 Electrolyte level	8
	2.3.2 Corrosion	8
	2.3.3 Overcharging	8
	2.3.4 Cycling	9
	2.3.5 Temperature	9
	2.3.6 Undercharging	9
	2.3.7 Vibration	9
2.4	Battery Characteristics	10
	2.4.1 Charging And Discharging Voltage	10
	2.4.2 Battery Amp	11
	2.4.3 CCA 12	
2.5	Everyday Electronic Device	14
2.6	Portable Power Station	14

2.7 Battery Type 16
2.7.1 Lead Acid 18
2.7.2 Lithium Ion 18
2.7.3 Sodium Sulphur 19
2.7.4 Nickel Cadmium 20
2.7.5 Nickel Metal Hydride 20
2.8 Car Battery 21
2.9 Renewable Energy 23
2.9.1 Solar Energy 23
2.10 Photovoltaic 24
2.11 Inverters 25
2.12 Summary 26

CHAPTER 3 METHODOLOGY 27
3.1 Introduction 27
3.2 Overall Process 28
3.3 Methodology Flowchart 29
3.4 Gantt Chart 31
3.5 Identifying The Problem 32
3.5.1 Discussion on the Survey 32
3.6 Product Specification 35
3.6.1 Function 36
3.6.2 Product Estimated Cost 36
3.7 Conceptual Design 36
3.8 Part Selection 37
3.8.1 Solar Charger Controller 37
3.8.2 Solar Panel 39
3.8.3 Battery40
3.8.4 Power Inverter 42
3.8.5 Wire Cable 43
3.8.6 Fuse 44
3.8.7 Car Cigarette Power Socket 44
3.8.8 Car Jumper Starter Cable 45
3.9 Tools And Equipment used to fabricate the Product. 46
3.10 Equipment used for data reading. 48
3.11 Circuit Diagram 49
3.12 Bill of Materials 50
3.13 Product Assembly 50
3.14 Summary 55

CHAPTER 4 RESULTS AND DISCUSSION 56
4.1 Introduction 56
4.2 Finalizing the varieties of Part selection 56
4.2.1 Solar Charger Controller 57
4.2.2 Solar Panel 57
4.2.3 Battery57
4.2.4 Power Inverter 58
4.3 Data Analysis and Discussions 58

4.3.1 Solar Charging Analysis 58
4.3.2 Jumper Session Analysis and Discussions 63
4.3.3 Current Output Analysis and Discussions 66
4.3.4 Maximum Current Output Analysis and Discussions 69
4.4 Product Overview 75
4.5 Summary 76

CHAPTER 5 CONCLUSION AND RECOMMENDATIONS 77
5.1 Conclusion 77
5.2 Problem Facing During Project 78
5.3 Future Work Improvements 79
5.4 Project Potential 80

REFERENCES 81

APPENDICES 83

LIST OF TABLES

TABLE	TITLE	PAGE
Table 3.1: Solar charger Controller Pugh Matrix Rubric		**38**
Table 3.2: Solar panel Pugh Matrix Rubric		**40**
Table 3.3: Battery Pugh Matrix Rubric		**42**
Table 3.4: Power inverter Pugh Matrix Rubric		**43**
Table 3.5: Bill of materials		**50**
Table 4.1: Time taken to charge the device		**59**
Table 4.2: Car battery Condition		**63**
Table 4.3: Different current and time taken to drain the battery		**67**
Table 4.4: Lead acid battery specification		**70**

LIST OF FIGURES

FIGURE	TITLE	PAGE
Figure 2.1: Battery warning light indicator on dashboard		8
Figure 2.2: Baghdad battery		16
Figure 2.3: Principle of lead acid battery		18
Figure 2.4: Lithium ion battery part		19
Figure 2.5: Sodium sulphur battery part		20
Figure 2.6: Photovoltaic cell		25
Figure 3.1: Survey question 1		32
Figure 3.2: Survey question 2		33
Figure 3.3: Survey question 3		33
Figure 3.4: Review question 4		34
Figure 3.5: Survey question 5		34
Figure 3.6: Survey question 6		35
Figure 3.7: Conceptual design for the energy storage box		37
Figure 3.8: Solar charger controller 1		38
Figure 3.9: Solar charger controller 2		38
Figure 3.10: Foldable solar panel		39
Figure 3.11: Portable solar panel		39
Figure 3.12: Stationary solar panel		40
Figure 3.13: Battery 1		41
Figure 3.14: Battery 2		41
Figure 3.15: Battery 3		41

Figure 3.16: Power inverter 1 **42**

Figure 3.17: Power inverter 2 **43**

Figure 3.18: Wire cable **44**

Figure 3.19: Fuse with holder **44**

Figure 3.20: Car cigarette power socket **45**

Figure 3.21: Car jumper cable **45**

Figure 3.22: Test pen **46**

Figure 3.23: Wire cutter **46**

Figure 3.24: Wire connecter **47**

Figure 3.25: Screwdriver **47**

Figure 3.26: Electric porting machine **47**

Figure 3.27: Multimeter **48**

Figure 3.28: Bosch analyzer **48**

Figure 3.29: Battery capacity monitor **48**

Figure 3.30: Circuit diagram **49**

Figure 3.31: Selected toolbox as main body of the product. **50**

Figure 3.32: Measuring the length of the battery **51**

Figure 3.33: The size of the battery that been mark inside the toolbox tray **51**

Figure 3.34: Unnecessary parts that been removed **51**

Figure 3.35: Parts placement in the toolbox **52**

Figure 3.36: Measuring the length of wire **52**

Figure 3.37: Wire stripper removing the wire insulation **53**

Figure 3.38: Applied heat shrinks on wire connections **53**

Figure 3.39: Wire connecting to all the parts **53**

Figure 3.40: Securing wire position 54

Figure 4.1: Graph of battery percentage against time and optimum line 60

Figure 4.2: Solar panel information 61

Figure 4.3: Device during charging session 62

Figure 4.4: Device at 0% capacity 62

Figure 4.5: Device at 100% capacity 62

Figure 4.6: Car battery condition 64

Figure 4.7: Car battery normal voltage 64

Figure 4.8: Condition when data analysis 65

Figure 4.9: Car battery lowest voltage tested 65

Figure 4.10: Device battery capacity after being test 65

Figure 4.11: Device jumper setting condition 66

Figure 4.12:Time taken to fully drain the battery against Current 67

Figure 4.13: Graph of amphere,A against time,ms 71

Figure 4.14: Bosch analyzer used to measure current 73

Figure 4.15; Low battery car and the device 73

Figure 4.16: Jumper position during data analysis 74

Figure 4.17: Bosch analyzer amp clamp position during data analysis 74

Figure 4.18: Top view 75

Figure 4.19: Front view 75

Figure 4.20: Side view 75

LIST OF SYMBOLS AND ABBREVIATIONS

Ah	-	Ampere Hour
min	-	Minute
A	-	Ampere
V	-	Voltage
ms	-	Milisecond
	-	
	-	
	-	

LIST OF APPENDICES

APPENDIX	TITLE	PAGE
Appendix 1: Gantt Chart		**83**

CHAPTER 1

INTRODUCTION

1.1 Background

In Malaysia, bad batteries are the primary cause of auto breakdowns. Battery problems accounted for seven out of ten vehicle breakdowns, followed by engine, and wiring problems at 20 and 5%, respectively. This is supported by a recent survey of 350 Malaysian drivers, aged 18 to 55, that was carried out by Bosch, a well-known provider of automotive aftermarket parts. The poll, which attempts to shed light on Malaysian drivers' practises regarding car batteries, also showed that about 75% of Malaysian drivers use maintenance-free batteries, with the other 25% using standard lead-acid battery.(CARSIFU, 2017)

All the electronic parts of your car, including the car computer, might be impacted by a bad battery. A battery that isn't performing properly can have problems giving a computer the power it needs. The modern car's computer, known as the Powertrain Control Module (PCM), oversees controlling vital components such the engine, gearbox, and powertrain. Based on the information it receives from the numerous sensors inside your car, it regulates these systems. Lower voltages of power may be sent when a battery empties, which may or may not harm your PCM. But because your PCM isn't receiving adequate voltage, it may undoubtedly result in some issues.(Rahmi, 2022)

When a car breaks down, the driver is left stranded and unable to move, which might put them in danger if the automobile breaks down in the middle of traffic. Accidents and traffic congestion may result if the car breaks down in the middle of the road. This is especially dangerous if it happens at night when the driver has no access to adequate lights for warning or troubleshooting the vehicle and where seeking help may be difficult. Additionally, the driver might not be able to call for assistance if their cell phone battery expires. Battery deterioration can result in a variety of auto faults as well as more serious safety concerns for the driver.

1.2 Problem Statement

Not having an emergency battery unit can make things worse. When there is an emergency, we easily feel panic and want to get help. That's where this emergency battery unit comes in handy. Among the importance of this emergency battery unit is to help provide electricity to a weak or damaged battery to restart the car. In addition, as a mobile phone charger when the battery has run out, it is intended to call for help. Then as a source of energy to turn on the emergency lights so that the driver is not in the dark if a breakdown occurs at night and can easily find the cause of the breakdown. This tool has many benefits for drivers who are in an emergency.

Apart from supplying electricity, in a world full of non-renewable energy, this emergency battery unit can be recharged using energy from the sun by using solar panels. This emergency battery unit must always be checked for energy levels and charged periodically to optimize its performance. Most users often forget to charge all these tools and with solar panels they can always be charged especially when we park the car in the sun.

1.3 Research Objective

The main aim of this research is as follows:

a) To design and fabricate an emergency device or backup power source that can store electrical power supply

b) To develop an emergency battery unit that can be charge using renewable energy(solar energy)

c) An emergency battery unit that can be used for jump starting a car, phone charging and source of electric supply.

1.4 Scope of Research

The scope of this research are as follows:

- The use of emergency battery units is intended to be limited to vehicle use only.
- Can be used to jump start the car minimum to 2 times only before needing to be recharged.

- Only use maintenance-free lead acid batteries to store electricity.
- Solar power as the main source of energy supply during charging.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

The issue of insufficient power supply prevents the vehicle from starting up, which is a common occurrence in cars that have surpassed the 10-year mark. While some developed countries have prohibited the use of vehicles over a decade old, the Malaysian Government has opted to permit their use without any age limitations; however, they must comply with the regulations established by the Road Transport Department (JPJ) to ease the financial burden on the citizens who cannot purchase a new vehicle.

Being faced with challenges because of a dead car battery is a big deal, especially when the old automobile makes matters worse because it has other problems that make the battery die more quickly. This difficulty intensifies when the car's condition deteriorates, and the battery drains repeatedly. The intricacy increases, particularly when it comes to cars with automatic transmissions, for which simple fixes like pushing the car to jumpstart it are no longer practical. This forces the search for more workable and alternative solutions.

The installation of an emergency battery unit appears to be a workable and efficient way to handle this problem. Apart from its typical use as a vehicle jump starter, this device has several uses, such as three USB ports and three socket outlets, which allow it to charge various electronic items within its power output range. This versatile functionality greatly expands the device's usefulness by meeting the needs of both cars and other electronic devices, therefore increasing the device's total utility.

An integrated foldable solar panel offers a novel charging method, further enhancing the ease of this energy storage solution. Using solar energy when the automobile is parked, this solar panel makes it easy for owners to top off the unit's power reserves. This feature maximizes the device's usability and ensures its preparedness for future emergency circumstances without sacrificing user convenience by eliminating the need to bring the unit indoors for recharging.

The goal of this study is to address two major issues: the scarcity of power outlets in this setting and the problem of electrical interference that arises when driving. Although the idea is portable, it concentrates on a particular problem: interference disruptions that arise when driving and the lack of convenient power sources in cars. The suggested remedy focuses on creating a little gadget that can function as a dependable emergency power source and efficiently handle electrical interference.

This study emphasizes how ironic it is that this tool is portable while addressing a particular issue that is common in car environments. Because of its small size, the device is very portable and convenient to transport. Its main advantage, though, is that it serves as a dependable emergency power source in addition to mitigating electrical interference while driving. This functionality is especially helpful in scenarios where larger power sources cannot be accommodated due to spatial constraints within vehicles; it offers a practical and ideal way to ensure a continuous power supply during emergencies without taking up too much space inside the vehicle.

2.2 Emergency Situation

Cars that have been in operation for more than ten years frequently suffer battery recharging issues due to a lack of user awareness to complete inspections. Only the engine and suspension parts are frequently tested. Car batteries must also be changed after a few years of use, which most consumers are unaware of or may overlook. When the next breakdown occurs, the automobile cannot be started owing to a shortage of energy. This will be more concerning if we are alone in a quiet or dark spot. Furthermore, it poses complications when we need to utilize a vehicle, but the car is not available. Smartphones have also become a part of our life, so when they run out of power, they can cause work to be disrupted even more in a circumstance that demands us to contact someone or seek assistance.

2.3 Car Battery Failure

Your car's battery is an essential component. It supplies the energy necessary to turn on your car's engine and maintain your electrical systems. Cars that have been in operation for more than ten years frequently suffer battery recharging issues due to a lack of user awareness to complete inspections. Only the engine and suspension parts are frequently tested.

Car batteries might malfunction for several reasons. Here are a few of the most typical reasons why a car battery fails. The battery age comes first. Normally, a car battery lasts three to five years. They then begin to lose the ability to maintain a charge. Most people are either unaware of or may disregard the need to replace a car battery after a few years of use. The battery discharging because of being unused for an extended period comes in second. This may occur if you park your car outside during the winter or if you use another vehicle's jumper cables to start your car with a dead battery. Third, rust on the battery terminals that might accumulate and cause a power loss. Numerous things, such as exposure to dampness, grime, and road salt, might contribute to this. Fourth, overcharging a car battery can limit its lifespan and cause harm. This may occur if you plug the battery charger for your automobile in for an extended period of time. The final condition is deep discharge, which can happen if the battery discharges too quickly. This may occur if your car's headlights are left on or if you attempt to start it with a dead battery. Deep discharges can harm batteries and reduce their lifespan.(Continental Battery, 2023)

A few actions can be taken to check the batteries' condition. You might start by determining the battery's voltage. At least 12.6 volts should be present in a good battery. The battery can be weak or dead if the voltage is less than 12.6 volts. The water level in the battery can also be checked. The appropriate amount of charge should be in the battery. The water level can be raised by adding distilled water. You should have the battery evaluated by a professional if you have examined the battery's voltage and water level and you still believe the battery is failing. A battery tester can be used by a mechanic to assess whether the battery is weak or dead. Your automobile battery needs to be replaced if it is damaged beyond repair. The majority of auto parts stores sell fresh batteries. Make sure you adhere to the manufacturer's recommendations when changing the battery. (Continental Battery, 2023)

When the next breakdown occurs, the automobile cannot be started owing to a shortage of energy. This will be more concerning if we are alone in a quiet or dark spot. Furthermore, it poses complications when we need to utilize a vehicle, but the car is not available.

Figure 2.1: Battery warning light indicator on dashboard

2.3.1 Electrolyte level

Active material is exposed when the electrolyte level is low, and any sulphate solidifies and resists chemical reaction. A broken case, negligent maintenance such as failing to add water when necessary, or severe overcharging that results in high internal heat and extensive gases can all lead to electrolyte loss. Electrolyte overload is equally harmful. The electrolyte is diluted by overfilling, and spills could degrade battery contacts. (Toyota, 2017)

2.3.2 Corrosion

Corrosion of terminals, connectors, and metal hold downs and carriers may be brought on by spilled electrolyte and condensation from gases. Such corrosion raises electrical resistance, which lowers the voltage that is available and the efficiency of charging. It might also produce a channel for current leakage to enable self-discharge.

2.3.3 Overcharging

An excessive amount of gas and internal heat result from overcharging a battery using the vehicle's charging system or a separate battery charger. Too much gas can waste a lot of water and wash the active ingredients off the plates. The positive plate material may oxidize at excessive heat, warping the plates.

2.3.4 Cycling

Battery cycling is an essential part of a battery's functioning, which involves repeatedly charging and discharging the battery. On the other hand, repeated cycling can eventually lead to battery degradation. A battery experiences physical and chemical alterations with each cycle that impacts its general condition. Even though these modifications are necessary for battery operation, frequent or vigorous cycling can cause deterioration.

2.3.5 Temperature

Battery life may be shortened by high temperatures brought on either overcharging or engine heat. Weak electrolytes may freeze in low temperatures. A fully charged battery produces less than half of its typical power at 0°F (-17.8°C). In addition, a cold engine requires twice as much cranking power to start as one that is at room temperature. While the electrolyte in a fully depleted battery will freeze at +18°F, the electrolyte in a fully charged battery won't until -60°F or lower.(Toyota, 2017)

2.3.6 Undercharging

A malfunctioning charging system won't keep the battery charged to capacity. Sulphate on the plates can grow hard and impossible to remove by regular charging because of severe undercharging. The weakened electrolyte freezes more quickly. The engine might not start if the battery is undercharged.

2.3.7 Vibration

Unnoticed but powerful, vibration is a hidden danger to the longevity and health of batteries. Even though batteries are strong, they can be harmed by excessive vibration, particularly in applications involving vehicles or mobile devices. When a battery experiences vibration, its internal components are put under mechanical stress, which might have negative consequences. Extended periods of exposure to vibrations, like those seen in equipment or cars, can damage internal plates, loosen connections, or upset the electrolyte, all of which can weaken the structural integrity of the battery.

2.4 Battery Characteristics

Crucial elements that determine the operation, capacity, and performance of electrochemical storage devices are battery properties. These characteristics encompass a variety of critical elements that impact a battery's performance, longevity, and appropriateness for uses. Comprehending these attributes is essential for assessing, choosing, and refining battery systems in a variety of sectors, ranging from portable devices to automobile and renewable energy retention.

2.4.1 Charging And Discharging Voltage

The basic cycles that control a 12V battery's operation as an energy storage device are charging and discharging. These procedures, which are necessary for several applications, show how energy is stored and released from this widely utilized power source. Refilling a 12V battery's energy reserves is the process of charging it. To start the charging process, an external power source—such as an alternator or charger—applies a voltage greater than the battery's normal value, which is between 14 and 14.5 volts. The battery's chemical reactions reverse because of the greater voltage, turning lead sulfate compounds that were created during discharge back into lead dioxide and lead. The battery is effectively recharged for usage thanks to this chemical reversal, which also restores its ability to transmit electrical energy.(Kim et al., 2018)

On the other hand, discharging is the process of using the battery's stored energy. The battery powers the linked applications by supplying electrical current when it is connected to a load, such as an electrical system in a car or electronic equipment. Until the voltage falls below a predetermined level, which indicates that the battery needs to be recharged, electricity is produced by the chemical reactions occurring within the battery as it discharges.(Kim et al., 2018)

To maximize a 12V battery's efficiency and lifespan, it is essential to comprehend these fundamental procedures. Efficient use of this vital energy storage device is made possible by proper charging and discharging management, which guarantees a consistent power supply for automotive applications, backup power sources, and other electrical devices.(Kim et al., 2018)

2.4.2 Battery Amp

An essential factor in determining a battery's ability to provide electrical charge is its amp measurement, often known as current or amperage. It is a key factor in assessing a battery's capacity and performance in different applications since it indicates the rate at which the electric charge is flowing through it. The battery amp, which is measured in Amperes (A), represents the speed at which electricity leaves the battery when it is connected to a load or circuit. In essence, it counts the amount of charge that flows through a circuit point in each amount of time. For example, in the same period, a battery with a greater amp rating can supply more electrical current than a battery with a lower amp rating.

The amp rating of a battery must be understood to choose the right power source for a given application. Because higher amp batteries can generate more current, they are appropriate for high demand uses like electric vehicles, heavy machinery, and systems that need a significant amount of power output. On the other hand, devices with moderate power requirements, like small electronics or some household appliances, can get by with lower amp batteries. Furthermore, a battery's capacity to discharge is also influenced by its amp rating. Larger currents can be discharged from higher amp batteries without causing undue strain or overheating. This feature is essential for situations where a rapid spike in power demand is anticipated, as it guarantees the battery can sustainably supply the load requirements.

It's crucial to remember that, although a high amp rating indicates that the battery can handle higher currents, it doesn't necessarily indicate the battery's total capacity or amount of energy stored. When evaluating a battery's overall capacity, the amp-hour (Ah) rating which indicates the total charge the battery can produce over a certain length of time is just as significant. To sum up, battery amp, which measures the rate of current flow, is an important consideration when evaluating a battery's performance and applicability for different uses. Comprehending the amp rating of a battery facilitates the process of choosing the right power source in accordance with power requirements, guaranteeing dependable and effective functioning in a variety of industries and electrical systems.(Kim et al., 2018)

2.4.3 CCA

An important metric to gauge a battery's capacity to start an engine in inclement weather, especially in cold climates, is called Cold Cranking Amps (CCA). For a 12-volt battery at 0°F (-18°C), it is the maximum current that the battery can provide for 30 seconds while keeping a voltage of at least 7.2 volts. In essence, CCA measures how much electricity a battery may temporarily drain to start the engine and move the car. This parameter is essential, particularly in colder regions where lower temperatures can drastically impair battery efficiency by slowing down internal chemical reactions and reducing the battery's capacity to generate electrical energy. A greater CCA rating, therefore, denotes a battery's improved capacity to deliver power.

The CCA rating helps consumers and automotive experts choose batteries that are appropriate for their vehicles by providing a uniform metric that is applicable to different battery manufacturers and types. It's important to match a battery's CCA rating to the engine specifications of the car; otherwise, the battery may have insufficient CCA, which might cause slow starts or sometimes not starting at all in very cold weather. The electrolyte composition, plate surface area, and internal architecture of the battery are factors that affect CCA. Furthermore, developments in battery technology have made it possible to create batteries that are more versatile and perform better for a wider variety of vehicles, all while keeping small sizes and higher CCA ratings.

Knowing CCA enables technicians and vehicle owners to choose batteries with confidence, assuring peak performance and dependability, especially in areas with colder weather. On battery labelling, manufacturers frequently place a major emphasis on CCA to facilitate simple comparison and selection. To maintain CCA levels and extend a battery's lifespan, regular battery maintenance—which includes making sure it is properly charged and avoiding over discharge—is essential. This helps maintain vehicle performance in adverse weather.

2.5 Everyday Electronic Device

Smartphones are an example of electronic devices that become a part of our life. The battery life of a smartphone was stated in mAh, or milliamperes per hour. Your smartphone's battery receives energy when it is being charged. The battery capacity essentially tells you how much energy the battery can hold. The battery can hold more energy than the higher number. You may think of it as a form of energy storage. A smartphone's battery typically has a 4500mAh capacity. The battery life of your smartphone is significantly influenced by both the characteristics of the device and how you use it. For instance, using your smartphone continuously will cause the battery to deplete more quickly. Background-running applications consume energy continuously as well. The battery life is also impacted by your settings. A screen that is set to its greatest brightness quickly depletes the battery. When they run out of power, they can cause work to be disrupted even more in a circumstance that demands us to contact someone or seek assistance.(Jesper, 2023)

2.6 Portable Power Station

A portable power station is a gadget that has a rechargeable battery that saves energy and releases it through different outlets like AC outlets, USB ports, and DC carports. Outdoor activities, camping, and use as a backup power source during a power outage all frequently involve the use of portable power stations. You can select the ideal portable power station for your needs from a range of sizes and capacities. While some portable power units are little enough to carry in a backpack, others can supply power to a whole house. It's critical to take size, weight, capacity, output ports, charging time, and cost into account when selecting a portable power source.(ECOFLOW, 2022)

The difference between the two is that a power bank is a portable battery that may be used to recharge electronic devices like computers, tablets, and smartphones. With a USB interface that enables connection to devices, power banks are often composed of plastic or metal. They come in a range of sizes and capacities, allowing you to pick the one that best suits your requirements. Just insert your gadget into the USB port on the power bank to start using it. Your device will then start to charge on the power bank. The power bank's capacity and the battery life of your smartphone will determine how long it will take to charge.(Narayan R & Venkateswarlu M, 2018)

Chinese business Pisen invented the first portable power bank in 2001. Two AA batteries were used in the original design, which was a circuit! At the Las Vegas International Consumer Electronics Show, it made its public premiere. A portable charger was required by an Antarctic expedition team for use with their video cameras and other electronics. A power bank was necessary for the journey because the cold would shorten the battery life of their gadgets. It had a poor battery life and was clunky. There are many more advanced, small, and battery-efficient designs available today. The majority of contemporary power banks are small enough to fit in the palm of your hand and can recharge your smartphone multiple times before losing power.(Gianna Petan, 2023)

Compared to power banks, which typically just contain USB plugs, portable power stations have far greater capacity and outlets. For devices that would typically plug into a wall or automobile socket, portable power stations are available. This is due to the fact that they can output more electricity and have the juice to run equipment for hours. Although the battery is the primary component of a portable power station, there are other parts and technologies that help transmit stored energy to your appliances safely and effectively. They are equipped with technology that enables faster recharging, screens that display input and output, and even apps for remote energy management.

2.7 Battery Type

An apparatus that transforms chemical energy into electrical energy is a battery. It is made up of one or more electrochemical cells, which are electrolyte-separated assemblies of positive and negative electrodes. An electric current is produced when a battery is linked to an external circuit by the movement of electrons from the negative electrode to the positive electrode.

The "Baghdad Battery," a ceramic pot battery, was found in the ruins of Khu jut Rabu, a village on the outskirts of Baghdad, the capital of Iraq. It is the earliest known "ceramic pot battery" in the world. This battery is older than two thousand years. It was believed that rather than being a battery to produce energy, it was utilised for metallic plating. About 1.5 to 2 volts would have been the voltage. Although the actual composition of the electrolyte solution is unknown, we can speculate that they may have used wine or vinegar.(Eggert, 2020)

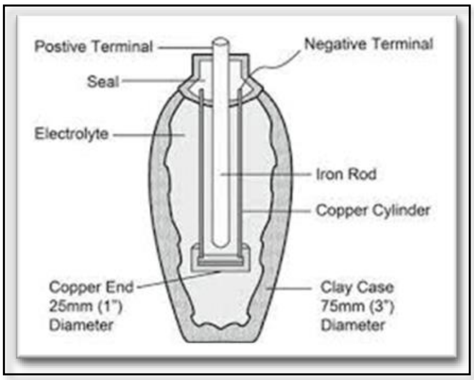


Figure 2.2: Baghdad battery

The copper atoms hardly change at all in an electrolyte solution, such as diluted sulfuric acid or saline solution, but the zinc atoms change, and electrons flow out. As a result, when the two are connected by a conductor, the copper transforms into a positive (+) pole and the zinc into a negative (-) pole, and electricity flows from the copper to the zinc. This is the Volta battery, on which all contemporary chemical batteries are based. Another Italian named Alessandro Volta, after whom the battery was named, made the discovery in 1800. Then, in 1868, Georges Leclanché, a Frenchman, created the "Leclanché cell." This was the precursor to dry batteries as we know them today, but it was potentially dangerous to use because the ammonium chloride solution would leak. A German inventor by the name of Carl Gassner created a battery in 1888 that eliminated the possibility of the solution spilling. Despite containing a liquid, Gassner's innovation was called a "dry cell" or "dry battery" since it would not leak. Nickel-cadmium batteries were created in 1899 by Swedish engineer Waldemar Jungner. This battery set the standard for storage batteries going forward .(Heth, 2019)

Batteries are typically divided into primary (non-rechargeable) and secondary (rechargeable) battery technologies. The most established technique of chemical energy storage is rechargeable batteries, which are preferred in power system applications. Numerous electrochemical cells are connected in series or parallel within a battery depending on the required voltage and capacity. Each cell has a positive electrode and a negative electrode that are separated by an electrolyte, which can be a paste, liquid, or solid. The conversion of electrical energy to chemical energy (during charge) and vice versa (during discharge) should be energy-efficient processes that cause little physical changes.(Datta, 2020)

2.7.1 Lead Acid

Lead-acid batteries have been the most advanced and widely used rechargeable battery technology in power systems since they first saw widespread use in 1860. Lead-acid batteries consist of a sponge lead negative electrode and a lead oxide positive electrode that are separated by a microporous material. Its 5- to 15-year life cycle restricts its use for large-scale storage notwithstanding its 70–90% efficiency. The most popular lead-acid battery types are valve-regulated (VRLA) and flooded batteries.(Datta, 2020)

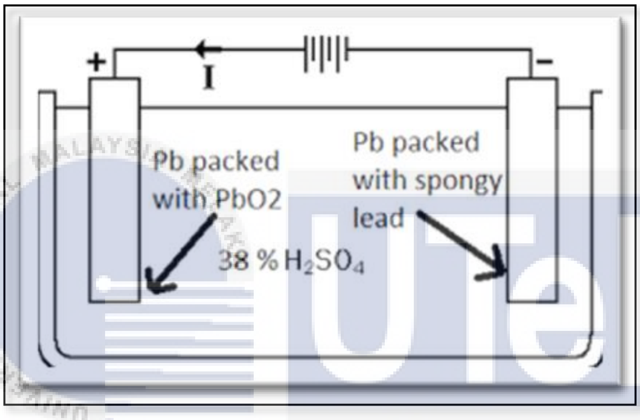


Figure 2.3: Principle of lead acid battery

2.7.2 Lithium Ion

Li-ion batteries have been used in power grid applications and hybrid electric or plug-in hybrid vehicles for about 50 years. Lithium-ion batteries have an anode made of lithiated graphite or lititanate and a cathode formed of either lithium metal oxide or lithium metal phosphate, which are separated by an electrolyte of lithium salts. This technology is profitable for 3Cs (computer, communication, and consumer) industry applications because of its efficiency of over 100%. The issue with Li-ion batteries, however, is their high capital cost ($)/kWh. Lithium iron phosphate (LiFePO4) produces an orthorhombic olivine-like structure with somewhat deformed O2 atoms. Despite having a lower energy density, it exhibits less heat generation. The most valuable material for use in electric vehicle (EV) applications is LiFePO4. Electrodes are isolated from one another in Li-ion polymer batteries by microporous polyolefin. Because of their increased power and energy density as well as their reduced memory effect, these batteries are growing in popularity for usage in EVs and renewable energy.(Datta, 2020)

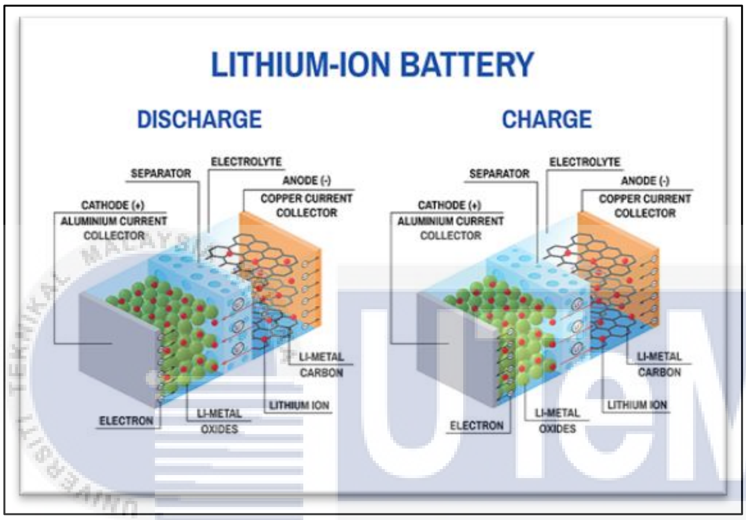


Figure 2.4: Lithium ion battery part

2.7.3 Sodium Sulphur

In comparison to lead-acid batteries, sodium sulphide has four times the power and energy density and almost the same energy efficiency. Molten sodium (negative) and molten sulphur (positive) are used as the electrodes, which are separated by sodium alumina, a powerful ceramic electrolyte. According to a study, pricey NaS is more cost-effective over the long run than inexpensive lead-acid.(Datta, 2020)

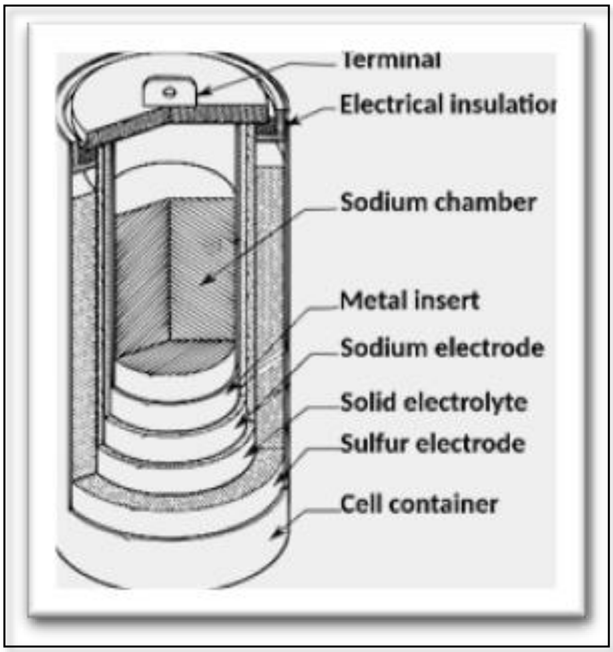


Figure 2.5: Sodium sulphur battery part

2.7.4 Nickel Cadmium

Batteries made of nickel cadmium have been around for more than a century. An alkaline electrolyte separates the cathode, which is nickel hydroxide, from the anode, which is metallic cadmium. With higher energy density (two times) and power density (six to seven times), NiCd batteries are still a reliable substitute for lead-acid batteries.(Datta, 2020)

2.7.5 Nickel Metal Hydride

With nearly 50 years of battery development, nickel-metal hydride is most frequently utilised in electric vehicles. They are more powerful and have a higher energy density than NiCd batteries, but at a cost per kWh that is almost 40% lower. They have taken the position of hazardous NiCd in numerous applications as a low-cost battery technology, primarily in the transportation sector. Nevertheless, their implementation in power systems has been constrained by their short service life and excessive self-discharge.(Datta, 2020)

2.8 Car Battery

The ignition system and starting motor are powered by the car battery when the engine is started. By providing current for the lights, radio, and other electrical accessories when the alternator is unable to handle the load, it also serves as a voltage stabiliser. A device that uses electrochemistry is the battery. In other words, it generates electricity using chemicals. It can only generate a certain amount of electricity. The battery discharges or runs out as the chemicals in it are depleted. It can be recharged using a battery charger to supply electric power, or a vehicle's alternator can also recharge it. The battery is subsequently recharged by restoring the original state of the used-up chemicals.

Lead oxide, solid sponge lead, and liquid sulfuric acid make up the battery's chemical composition. These three compounds are designed to interact chemically to create a current flow. Positive, negative, and negative plates are created by holding lead oxide and sponge lead in plate prides. The lead alloy plate grid is made up of bars that are both horizontal and vertical. By using lead oxide paste, the plate grids are transformed into plates. The plate's paste is secured by the horizontal and vertical bars. The battery is given a forming charge once the plates are put together. This converts the lead oxide paste into sponge lead in the negative or minus plate. It makes a good change to the lead oxide paste. (*The Automotive Battery Construction and Service*, 2011)

There are many non-maintenance batteries available. Other batteries have vent covers that can be removed, but they don't need any particular care other than the periodic check of the connections and the built-in charge indicator. The battery cells can then be seen from below to see if they require water. The battery charge can also be checked with a hydrometer. Typically, automotive batteries have a voltage of 12-volts. The 12-volt battery has six cells in total. Six cells are linked together in a series. When connected in series, the voltages increase. 24-volt batteries are used in some specialised applications; they have 12 cells. The standard practise is to use 2 volts even though a battery cell at 800 F will test on open circuit at roughly 2.1 volts when completely charged. In contrast to 12.6-volt batteries, six-cell batteries are therefore referred to as 12-volt batteries.(*The Automotive Battery Construction and Service*, 2011)

2.9 Renewable Energy

Renewable energy comes from natural sources that replace them more quickly than they are used up. Renewable energy is energy that is produced from renewable natural resources like sunshine, wind, water, and geothermal heat. Because they don't emit greenhouse gases or other pollutants, renewable energy sources are frequently regarded as being more environmentally friendly than non-renewable sources, such fossil fuels. Globally, the use of renewable energy is increasing. Renewable energy supplied 18% of the world's electricity in 2020. As nations make the shift to a more sustainable energy future, renewable energy is anticipated to increase even more in the years to come.(International Energy Agency, 2020)

2.9.1 Solar Energy

The most plentiful source of energy is solar energy, which may even be used under cloudy conditions. The rate at which the Earth absorbs solar energy is around 10,000 times higher than the rate at which people use energy. For a wide range of applications, solar systems can provide heat, cooling, natural lighting, power, and fuels. Solar technologies can use photovoltaic panels or solar radiation-concentrating mirrors to turn sunlight into electrical energy. Although not all nations have the same access to solar energy, direct solar energy can nevertheless make a major contribution to any nation's energy mix. Solar panels are now not only accessible, but frequently the cheapest source of electricity because of a sharp decline in the cost of solar panel production over the past ten years. Solar panels come in a variety of colors based on the type of material used in their manufacture and have an average lifespan of 30 years.(United Nations, 2023)

2.10 Photovoltaic

The most extensively used solar photovoltaics (PV) technology in use today is solar energy. Solar cells are powered by light, function at or near room temperature, have no moving components, and allow for generation of any scale: Theoretically, a 10-square-kilometer ($10km^2$) array is equally efficient per unit area as a 10-square-meter ($10m^2$) array. As opposed to other forms of energy production like thermal or wind turbines, which become less effective as scale is reduced.(Silvi, 2015)

A single photovoltaic cell is typically a tiny device, with an average power output of 1 to 2 watts. These cells are frequently thinner than four human hairs and constructed of various semiconductor materials. Cells are sandwiched between protective materials in a combination of glass and/or plastics to endure the outdoors for a long time. PV cells are chained together to create bigger units known as modules or panels, which increase their power output. You can use modules individually or link several of them to create arrays. The electrical grid is then linked to one or more arrays as part of a comprehensive PV system. This modular design allows PV systems to be developed to practically any electric power requirement. A PV system's modules and arrays are merely one component. In addition to the components that convert the direct-current (DC) electricity generated by modules into the alternating-current (AC) electricity used to power all of the appliances in your home, systems also contain mounting structures that direct panels towards the sun.(Silvi, 2015)

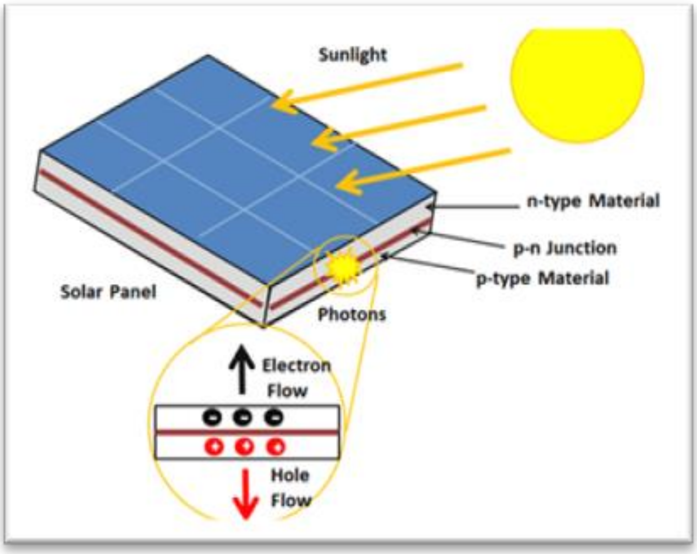


Figure 2.6: Photovoltaic cell

2.11 Inverters

An electrical device known as an inverter transforms direct current (DC) to alternating current (AC). The converted AC can be produced at any voltage and frequency by using the proper transformers, switching, and control circuits. Solid-state inverters are utilized in a variety of applications since they don't have any moving parts, from tiny switching power supply in computers to massive high voltage direct current power transmission systems used by electric utilities. Commonly, inverters are used to provide AC electricity from DC sources like solar panels or batteries.(Thumma & Sheri, 2015)

2.12 Summary

The research focus of this review of the literature is on designing and building an emergency device that can store electricity. It is intended to fulfil many functions, such as providing light, charging a phone while on the go, and providing automobile jump starts, to tackle the common problem of car battery failure. One of the many benefits of integrating this gadget into the automobile environment is that it provides a solution for persistent battery drainage problems.

Future developments will mostly focus on utilizing solar energy as the essential means of charging this gadget, so that's where things are headed. This forward-thinking strategy embodies the spirit of renewable energy sources, identifying solar energy as a sustainable and ecologically friendly way to power the gadget. Careful battery and solar panel selection is essential to guarantee the effectiveness and durability of this device. Carefully choosing these parts is essential to maximizing the device's performance and durability, ensuring that it will continue to function well for a long time.

CHAPTER 3

METHODOLOGY

3.1 Introduction

This chapter focuses on explaining and evaluating the approach used to accomplish the main goal of the project, which is to design and build an energy storage device suited for emergency situations by utilizing renewable energy sources more especially, portable solar generators. The blueprint that converts a method's progress into a methodical process intended to achieve a certain goal is known as methodology. In this chapter, a methodical, thorough methodology outlines the successive processes in the planning and building of an emergency-focused energy storage unit, methodically utilizing renewable energy sources to meet emergency needs.

As a fundamental reference, a thorough literature research was conducted before to the writing of this chapter. The purpose of this assessment was to increase understanding of the complex elements that go into planning and building an energy storage unit that is emergency-focused and dependent on renewable energy sources. The understanding gained from this review acts as a compass, helping us to complete this assignment by improving our comprehension of both strategic approaches and potential hazards.

3.2 Overall Process

First, the flow of research will begin with identified the difficulty that has been encountered during an emergency that called for electricity. Because the data may be easily accessed later, the data collection procedure will be facilitated by a survey that is distributed in Google form format.

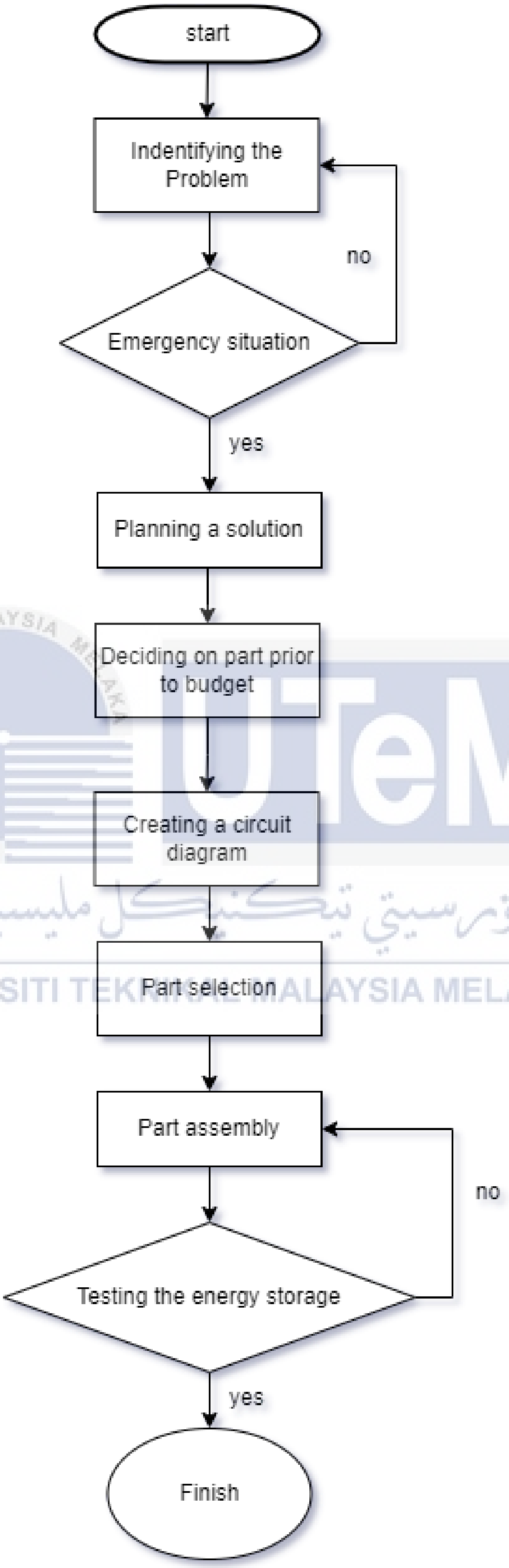
The selection of the Supervisor and title follows, and the process proceeds. After discussing the project's title with the supervisor, the following step is to draught the proposal and submit it for review by the supervisor to determine whether the content is correct or incorrect. The problem statement, objective, and task scope will all be included in the proposal. After the idea has been approved, the following stage is to come up with a plan for how to carry out the project.

Following a problem-solving brainstorming session, a renewable energy-powered energy storage device will be chosen for emergency use. The next step in data gathering is to acquire trustworthy information from a variety of sources, including reference books, journals, and the internet, to fully understand the issue. Reviewing the other portable solar generators or portable power plants is crucial to figuring out their function and any potential issues. Writing the literature review, which serves as a guide for completing this assignment, is the next step in the process. Every piece of information will be crucial while drafting the literature review.

Project methodology is the following procedure. This chapter will provide a detailed explanation of how the approach or process that will be used to complete this project was developed. The procedure of creating circuit diagrams is carried out in the ongoing project. After considering the appropriate design criteria, such as the battery type, weight, and size of the energy storage unit, the project is then constructed. To evaluate the success of the project, the final fabrication will undergo real testing with volunteer users. To ensure that the energy storage unit is genuinely secure enough for the respondents to utilise, safety measures must be taken. The report for this project will be completed, and it will be prepared for presentation and evaluation.

3.3 Methodology Flowchart

Planning the process order before the project begins is essential to guaranteeing a smooth project flow and preventing delays from ever occurring. To finish this project on time, the process order also serves as a guidance for what should be done first. The design process is as follows:


start
Indentifying the Problem
no
Emergency situation
yes
Planning a solution
Deciding on part prior to budget
Creating a circuit diagram
Part selection
Part assembly
no
Testing the energy storage
yes
Finish

3.4 Gantt Chart

A Gantt Chart became an essential tool for closely tracking the progress of project tasks after the deadline. This graphic, which is shown below, not only measures the project's changing dynamics but also acts as a careful roadmap to make sure that every procedure is completed on schedule. The Gantt chart provides stakeholders with a thorough perspective by outlining specific activities, their dependencies, and durations. This enables stakeholders to understand the project's trajectory. Its deliberate deployment serves as a preventative strategy, enabling prompt adjustments to minimize any delays or bottlenecks in addition to assisting with real-time progress tracking. Essentially, a Gantt chart is a dynamic road map that facilitates collaboration, streamlines project management, and ensures that activities are completed on schedule.

Appendix 1: Gantt Chart in page 83

3.5 Identifying The Problem

Survey forms are the most effective approach to gather information and opinions. A survey is a written questionnaire with project-related questions in it. To ensure that the project will be valuable to users, survey data will be used. There are issues with an emergency that needs electricity. The major remedy for this issue is this energy storage device. Most respondents have experience with this circumstance, according to the surveys. Another way is by doing brainstorming regarding the problem that happening in order come out with a solution.

3.5.1 Discussion on the Survey

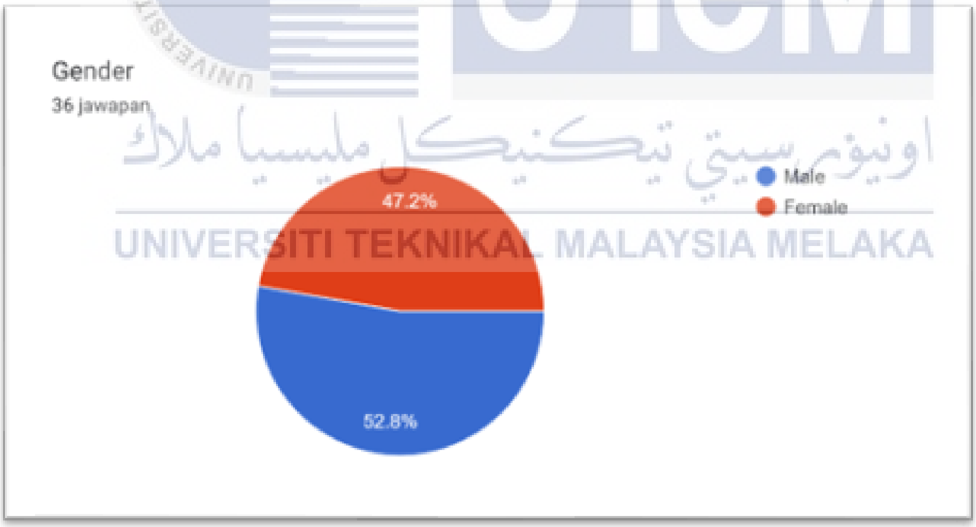


Figure 3.1: Survey question 1

Based on this survey question we can see 36 people participate in answering it. 52.8% which is 19 of it a male and balance are female.

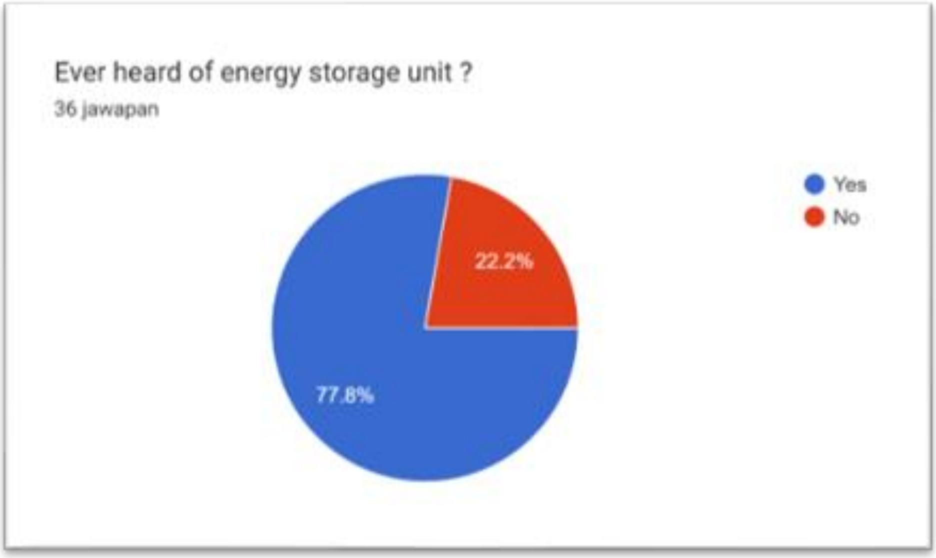


Figure 3.2: Survey question 2

77.8%, of which 28 people already heard and know about energy storage units and some feedback recognizes it as a big power bank. Although have been see the device but their never seen the one that uses renewable energy as charging source.

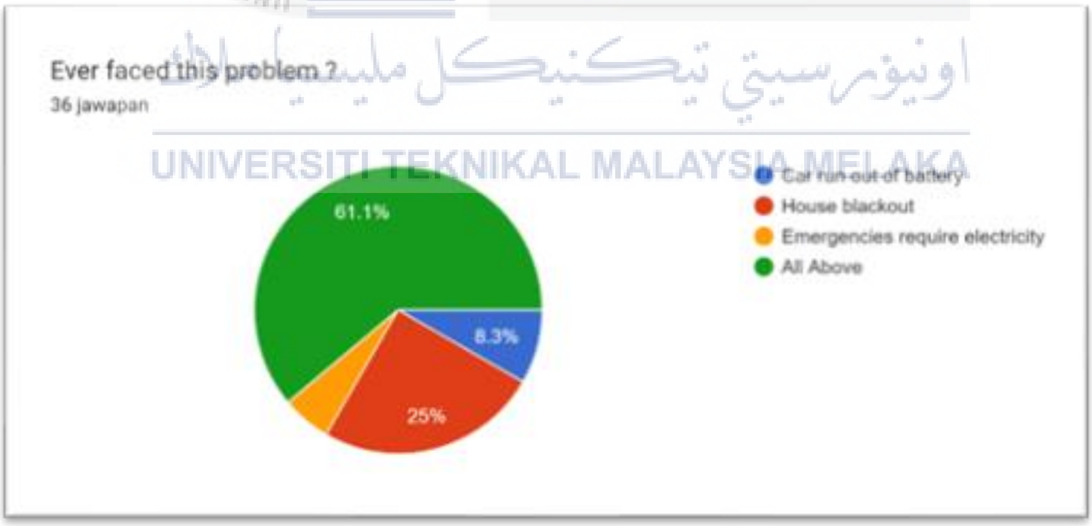


Figure 3.3: Survey question 3

Based on these answers 69.4% of the candidates have experience where their car runs out of battery. The total was achieved by adding the percentage from car battery failure and all the above data to get a total of 25 people. Emergencies that require electricity such as low phone battery are 24 people.

Figure 3.4: Review question 4

From the problems that have been stated, most of the surveyors agree that this kind of product will help them solve the problem they're facing.

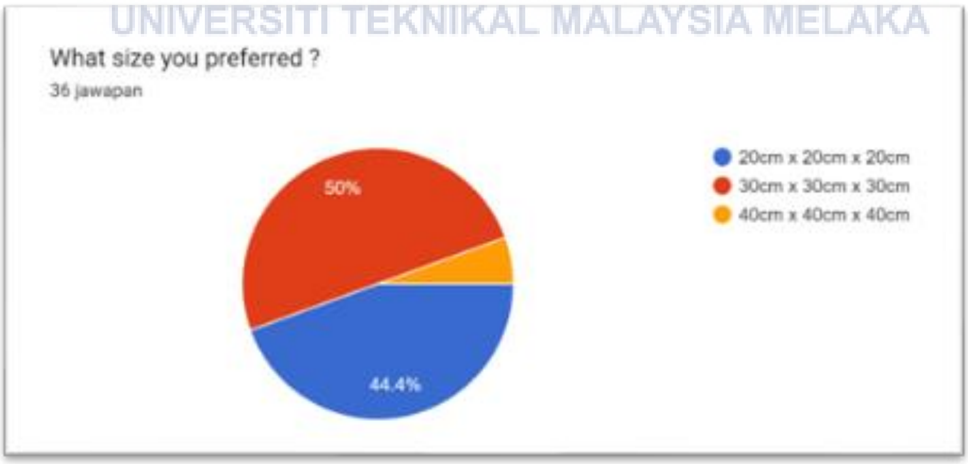


Figure 3.5: Survey question 5

For the size of the storage box that will be the storage for all the part. It also will be mounted with all the part considering the tidiness of the project assembly. From the survey it can be seen most of the surveyors agree to choose the medium size as the size for the storage box which is 30cm x 30cm x 30cm. The consideration of the box size also will be taken from the space required from all the part,

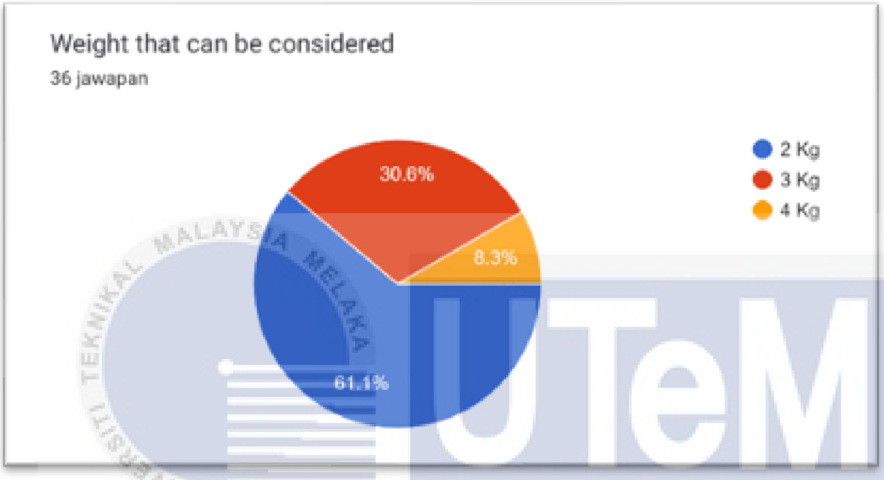


Figure 3.6: Survey question 6

For the last question from the survey is the weight that can be considered for the energy storage unit. From the answer we can see that majority of the surveyors want their energy storage unit to be light. The weight they consider is 2 kilograms. The final weight also will be considered from the total weight of all the part including the storage.

3.6 Product Specification

This product specification will contain the parameters, specifications, and essential requirements for the product that is being gathered. This is a prototype product detail. The requirements from the user served as the basis for this energy storage unit specification. This will guarantee that the finished result will match the planning.

3.6.1 Function

This function of energy storage unit is to be used when an emergency that required the use of electricity happen. The main emergency is when a car battery failure and everyday gadget run out of battery. This product will have a three-plug socket that can power >200V AC electrical equipment. This product has a car jumper that can help to start a car that has battery failure. Lastly it is equipped with a USB socket that can be used to charge or turn on your everyday gadget such as smartphone or tablet to call for help when your car breakdown. During breakdown you can use this device as a power source to turn the light to navigate the problem.

3.6.2 Product Estimated Cost

Cost is a very important factor in every project. It's crucial to monitor spending to ensure that they stay within the allocated budget. Better is a cost that is lower. Although a student may submit a claim for reimbursement from the institution, the funds must be appropriately used. Money will always be an issue for students, but after roughly estimating the costs, I realized that this project would require more funding than the institution could offer, so I voluntarily decided to use my own funds to finish it.

3.7 Conceptual Design

Designing the storage box that will be used as the based for all the electronic part. The box is designed to have a lid that is easy to open to facilitate inspection of tools or replacement of damaged tools. in addition, the box must be wide enough to place all the electrical equipment and able to support its weight. The box should also have a handle to facilitate the transport process.

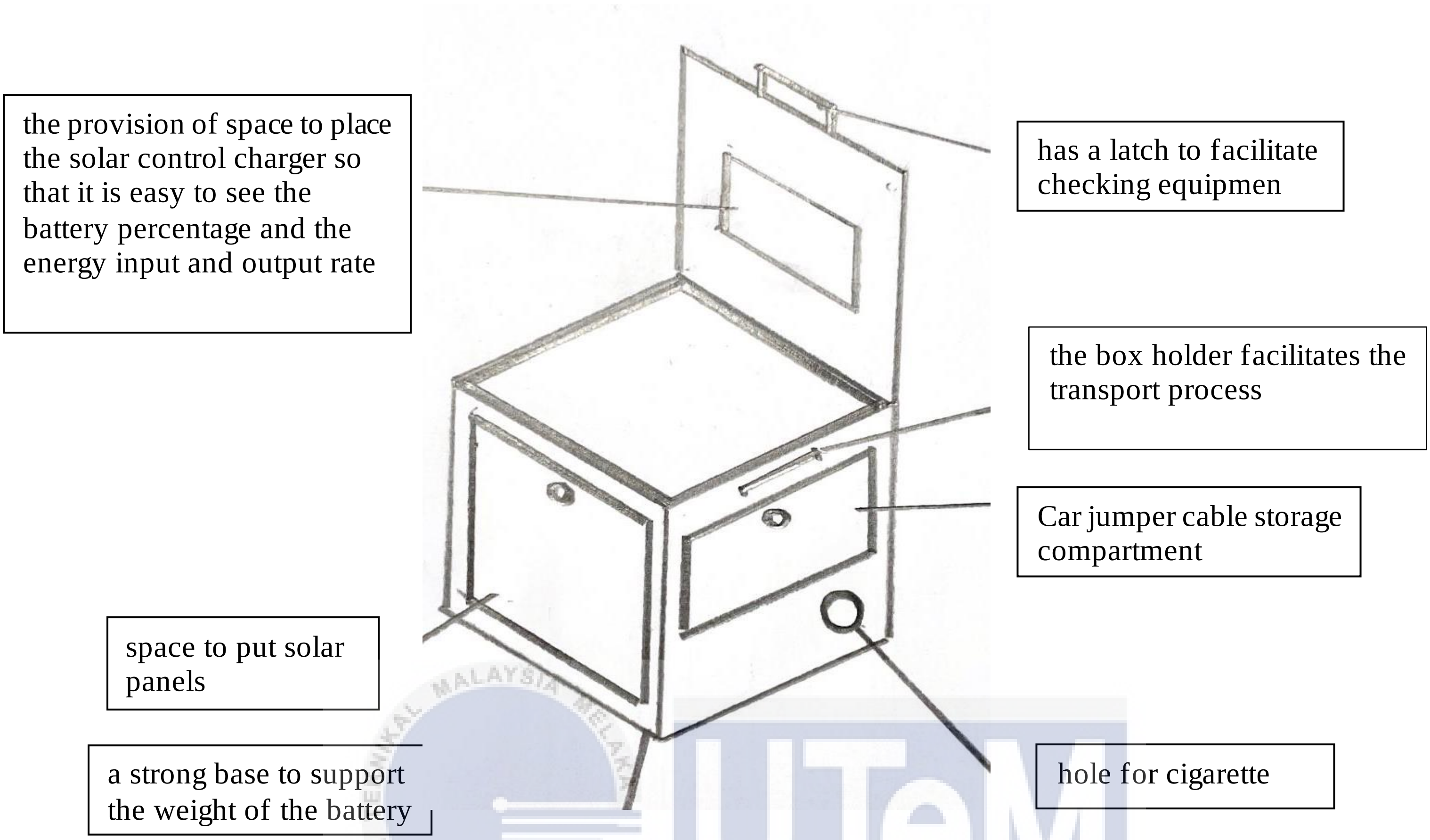


Figure 3.7: Conceptual design for the energy storage box

3.8 Part Selection

3.8.1 Solar Charger Controller

By controlling the voltage and current that travel from the solar panel to the battery, a solar charge controller prevents the battery from overcharging. It uses MPPT (maximum power point tracking) to speed solar charging of the battery by up to 30% per day and is programmed at 15-A/200-W unit. The controller for the solar charger will have a USB connector.

Figure 3.8: Solar charger controller 1

Figure 3.9: Solar charger controller 2

Table 3.1: Solar charger Controller Pugh Matrix Rubric

Criteria	Solar Charger Controller 1	Solar Charger Controller 2		Baseline	Weight
Safe				0	5
Durable				0	5
Additional Features				0	5
Easy to assemble				0	5
Cost				0	5
Net Score					
Rank					

s

3.8.2 Solar Panel

A solar panel, which is sometimes referred to as a PV panel or module, is a gadget that captures sunlight and transforms it into current.

Figure 3.10: Foldable solar panel

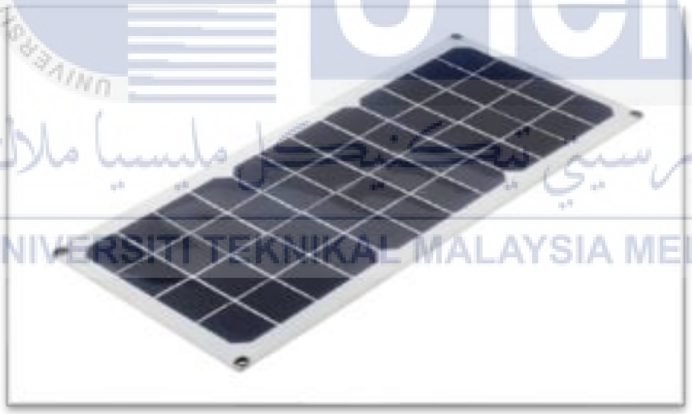


Figure 3.11: Portable solar panel

Figure 3.12: Stationary solar panel

Table 3.2: Solar panel Pugh Matrix Rubric

Criteria	Foldable Solar Panel	Portable Solar Panel	Stationary Solar Panel	Baseline	Weight
Safe				0	5
Durable				0	5
Portability				0	5
Easy to assemble				0	5
Cost				0	5
Max Power				0	5
Net Score					
Rank					

3.8.3 Battery

An apparatus that stores chemical energy and transforms it into electrical energy is a battery. Electrons move from one substance (electrode) to another through an external circuit during chemical reactions in batteries. An electric current can be created by the flow of electrons and employed to perform tasks. Two 12-volt batteries will be utilized in this product to store energy from the solar panel.

Figure 3.13: Battery 1

Figure 3.14: Battery 2

Figure 3.15: Battery 3

Table 3.3: Battery Pugh Matrix Rubric

Criteria	Battery 1	Battery 2	Battery 3	Baseline	Weight
Safe				0	5
Durable				0	5
Weight				0	5
Easy to assemble				0	5
Input				0	5
Cost				0	5
Capacity				0	5
Net Score					
Rank					

3.8.4 Power Inverter

A power electronic device or circuitry that converts direct current (DC) to alternating current (AC) is known as a power inverter, inverter, or invertor. The exact gadget used determines the produced AC frequency. Rectifiers, which were initially substantial electromechanical machines converting AC to DC, accomplish the opposite with inverters. A 3-Plug socket will be included with this kind of inverter.

Figure 3.16: Power inverter 1

Figure 3.17: Power inverter 2

Table 3.4: Power inverter Pugh Matrix Rubric

Criteria	Power Inverter 1	Power Inverter 2		Baseline	Weight
Safe				0	5
Durable				0	5
Weight				0	5
Easy to assemble				0	5
Additional Features				0	5
Cost				0	5
Power Outage				0	5
Net Score					
Rank					

3.8.5 Wire Cable

A conductor or collection of conductors for transporting electrical power or telecommunication signals from one location to another is referred to as a wire cable in electrical and electronic systems. The choice of wire cable must be in accordance with the current that will be channeled. To guarantee that the wire can withstand the current without overheating, bigger wires with lower gauge numbers are required for higher amperage.

Figure 3.18: Wire cable

3.8.6 Fuse

If an appliance malfunction results in excessive current flow, the fuse shuts off the circuit. If something goes wrong, this safeguard both the wiring and the appliance. A wire that melts easily is within the fuse. The wire heats up until it melts if the current flowing through the fuse is too high, breaking the circuit.

Figure 3.19: Fuse with holder

3.8.7 Car Cigarette Power Socket

There are two main uses for cigarette lighter sockets, which are common in cars and other vehicles. Some have a heating element that can be used as a cigarette lighter. As an alternative, they serve as an adapter and/or power socket to power portable gadgets.

Figure 3.20: Car cigarette power socket

3.8.8 Car Jumper Starter Cable

Jumper leads, which are also referred to as booster cables or jump leads, are a pair of insulated wires with enough capacity and alligator clips at each end to connect the disabled vehicle or equipment with an auxiliary source, such as another vehicle or piece of equipment with the same system voltage or to a different battery. In this product, jumper cables attached to male car cigarette plugs will be used.

Figure 3.21: Car jumper cable

3.9 Tools And Equipment used to fabricate the Product.

This projects primary process is the wire cutting and connection. The wire cutting process takes place before connecting the wire by following the diagram. Cutting the wire to expose the wire conductor. When connecting the wire, you will basically use a connector and test pen. Another part is to assemble all the part in the storage box to make it portable. Other equipment is used to measure the voltage is multimeter.

1.

Figure 3.22: Test pen

2.

Figure 3.23: Wire cutter

3.

Figure 3.24: Wire connecter

4.

Figure 3.25: Screwdriver

5.

Figure 3.26: Electric porting machine

3.10 Equipment used for data reading.

1.

Figure 3.27: Multimeter

2.

Figure 3.28: Bosch analyzer

3.

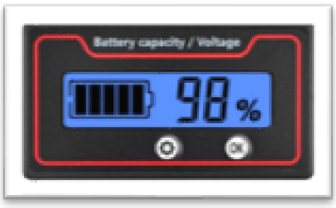


Figure 3.29: Battery capacity monitor

3.11 Circuit Diagram

Introducing a circuit diagram that shows the complex architecture that is necessary for the operation of this novel energy storage device. The dynamic system that powers the energy storage unit is visually represented by the diagram, which consists of components that are strategically coupled. It presents a clear picture of the electronic system in charge of generating and controlling energy through a succinct arrangement of connections and symbols, giving a brief but thorough explanation of the inner workings of the device.

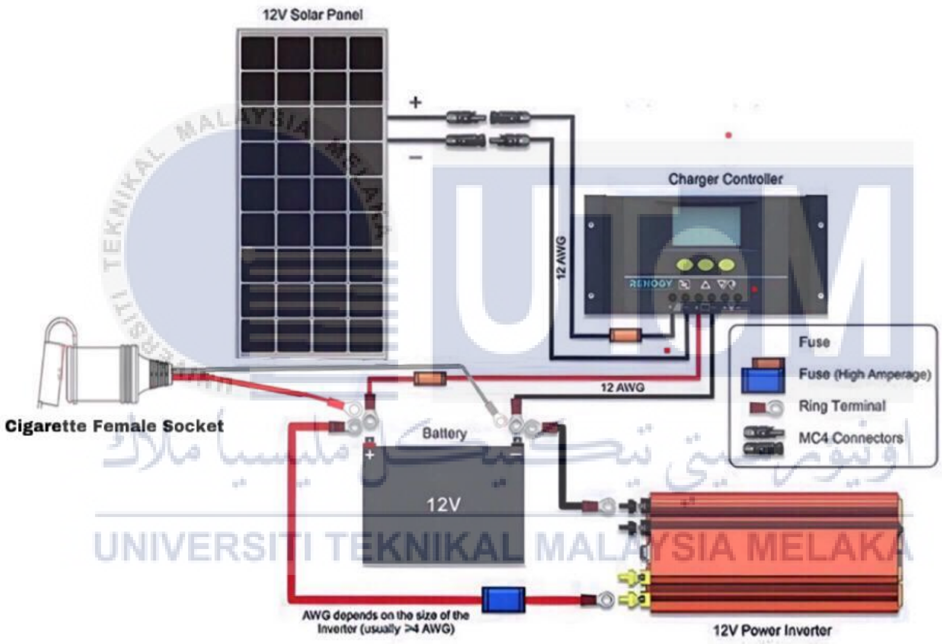


Figure 3.30: Circuit diagram

3.12 Bill of Materials

The material bill is important to this project's production of Energy Storage Unit for Emergency Usage Using Renewable Energy System. Based on the part surveyed in the previous topic, this is the list for selected part and including its cost. The table will show the price for the major component not including parts that already have by me or the faculty.

Table 3.5: Bill of materials

No	Item	Quantity	Cost (RM)	Total Price (RM)
1	12V Lead Acid Battery	2	36.00	72.00
2	Fuse Holder	4	2.90	11.60
3	Cigarette Lighter Power Socket	2	4.90	9.80
4	Solar Charger Controller	1	13.50	13.50
5	Car Battery Jumper Cable	1	19.00	19.00
6	Power Inverter	1	75.99	75.99
7	Battery Capacity Monitor	1	4.60	4.60
8	Wire Connector	1	3.90	3.90
		Total		210.39

3.13 Product Assembly

1. A toolbox of a size capable of holding all the selected parts has been considered. The toolbox was selected based on its ability to withstand the high temperature inside an exposed car under a direct sunlight and able to load all the parts that have been choose.

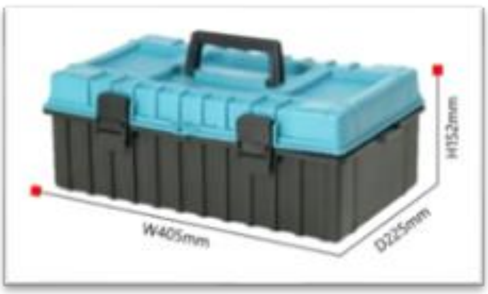


Figure 3.31: Selected toolbox as main body of the product.

2. Measuring all the parts. All the parts have been placed inside the toolbox to marks the space in needed to remove unnecessary parts inside the toolbox.

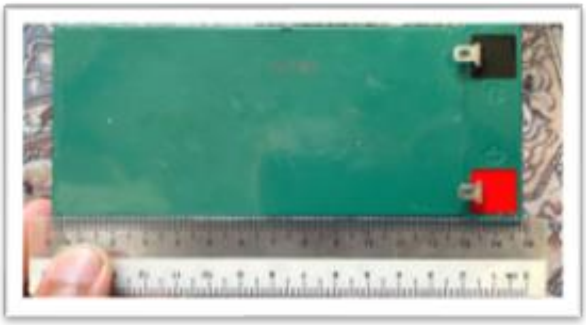


Figure 3.32: Measuring the length of the battery

Figure 3.33: The size of the battery that been mark inside the toolbox tray

3. Electric porting machine was used to remove the unnecessary parts.

Figure 3.34: Unnecessary parts that been removed

4. Placing all the parts in the toolbox for measuring the wire needed. All the parts were placed in their desired place inside and outside of the toolbox to measure the wire length needed based on the circuit diagram.

Figure 3.35: Parts placement in the toolbox

5. The length of the wire must be considered for its strip part, joined and the bending part inside the toolbox.

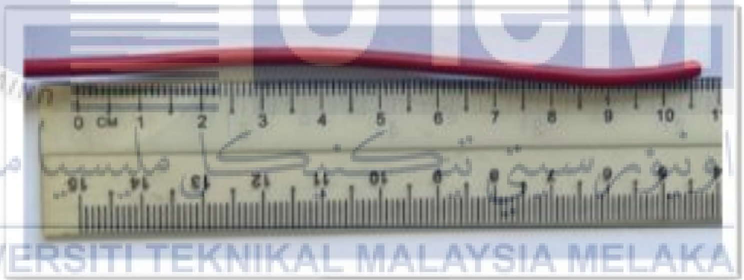


Figure 3.36: Measuring the length of wire

6. Wire cutters have been used to strip the wire for its connections and installation of wire connectors.

Figure 3.37: Wire stripper removing the wire insulation

7. Heat shrink was used to tidy up the connections.

Figure 3.38: Applied heat shrinks on wire connections

8. Wiring all the part based on wiring diagram. All the part was placed fix to it placed inside and outside of the toolbox. Wire connections to all parts are made following the circuit diagram.

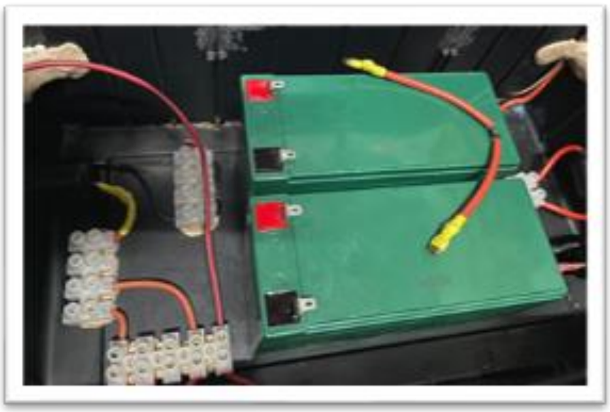


Figure 3.39: Wire connecting to all the parts

9. All the wire was secure to it position by using a mix putty and cable tie.

Figure 3.40: Securing wire position

10. Product testing to for the wiring connection.

3.14 Summary

This chapter outlines the suggested technique designed to clarify the methodical process used to create a new product. This approach emphasizes how important it is to understand the market before designing a product because it makes it easier to execute ideas that come later. It includes locating and choosing parts that are essential to the building of the product. This project's foundation is a mixed methods strategy that is in line with the research approach that was chosen. This methodology integrates multiple research approaches to attain a thorough comprehension. The framework for data analysis is based on experiments and observations, which provides a strong basis for drawing significant conclusions.

Additionally, this chapter provides a thorough overview of the necessary instruments and equipment needed for data collection and project completion. It clarifies the careful selection of tools and software that is essential to collecting and processing data. To wrap up this methodology, a thorough procedural blueprint outlines the product's step-by-step assembly process from the point of conception to the finished product. This thorough approach blueprint acts as a road map for the development process, guaranteeing methodical advancement in the direction of the intended outcome.

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Introduction

This chapter's main goal is to investigate and summarise the procedure for coming up with, developing, and implementing an idea. A current design is frequently modified using the redesign process to make it the most advantageous technique. Redesigning a product is making it conform to a new requirement. The product's functionality and quality needed to be improved. This chapter also will be focusing on the method of data collection and discussion on how the data analysis will be run. Complete the design development process, and make sure the development approach is used correctly. By adhering to the steps of the development process, work efficiency can be increased. To make sure the product design complies with safety requirements and is not overdesigned, optimise the chosen components and machinery. Both the cost of fabrication and waste will be reduced.

4.2 Finalizing the varieties of Part selection

For the selection of the part will be considered from the evaluation of the table of Pugh Matrix Rubric. It will show the score for all the parts that have multiple selections. It also shows the advantage of the part by differentiating all the scores and choosing the one with higher score.

4.2.1 Solar Charger Controller

Table 3.12. 1: Solar charger Controller Pugh Matrix Rubric Completed

Criteria	Solar Charger Controller 1	Solar Charger Controller 2		Baseline	Weight
Safe	4	3		0	5
Durable	4	4		0	5
Additional Features	5	3		0	5
Easy to assemble	5	4		0	5
Cost	5	4		0	5
Net Score	23	18			
Rank	1	2			

4.2.2 Solar Panel

Table 3.12. 2 Solar panel Pugh Matrix Rubric Complete

Criteria	Foldable Solar Panel	Portable Solar Panel	Stationary Solar Panel	Baseline	Weight
Safe	4	4	4	0	5
Durable	5	4	3	0	5
Portability	5	4	3	0	5
Easy to assemble	4	4	4	0	5
Cost	3	3	4	0	5
Max Power	3	4	5	0	5
Net Score	24	23	23		
Rank	1	2	2		

4.2.3 Battery

Table 3.12. 3: Battery Pugh Matrix Rubric Complete

Criteria	Battery 1	Battery 2	Battery 3	Baseline	Weight
Safe	4	4	4	0	5
Durable	4	4	4	0	5
Weight	4	4	5	0	5
Easy to assemble	5	5	5	0	5
Input	4	4	2	0	5
Cost	4	4	5	0	5
Capacity	4	5	2	0	5
Net Score	29	30	27		
Rank	2	1	3		

4.2.4 Power Inverter

Table 3.12. 4: Power inverter Pugh Matrix Rubric

Criteria	Power Inverter 1	Power Inverter 2		Baseline	Weight
Safe	4	4		0	5
Durable	3	3		0	5
Weight	4	3		0	5
Easy to assemble	4	4		0	5
Additional Features	5	3		0	5
Cost	4	4		0	5
Power Outage	5	3		0	5
Net Score	29	24			
Rank	1	2			

4.3 Data Analysis and Discussions

In this subtopic, theoretical and physical data collection methods will be discussed. The method shown includes preparing the formula to be used and preparing the table for the purpose of data collection.

4.3.1 Solar Charging Analysis

This data collection is done in a place that receives direct sunlight using available solar panels. The electrical connection directly from the solar is connected to the solar charge controller. Data is taken based on the time required to charge this product from battery energy that is at 0 percent based on the battery capacity monitor. In theory it can be calculated using the formula that has been prepared and the information written on the solar panel to know the time required to fully charge this product.

4.3.1.1 Theoritical Data

As the connection of the 2 battery in the product is in parallel.

$$Voltage, V = V1 = V2$$

Voltage = 12V

$$Battery\ Amphour, Ah = Ah1 + Ah2$$

Battery Amphour = 7.2 +7.2
= 14.4 Ah

Solar Charge Controller max charge current, A = 30A
Solar Panel max curent output, A = 1.16A

$$time\ taken, t = \frac{Battery\ Amphour, Ah}{Charging\ current, A}$$

Time taken, t = 14.4 / 1.16 A

= 12.41 hours

Theoritically the time needed to charge the battery in the product is 12.41 hours.

4.3.1.2 Experimental Data

Table 4.1: Time taken to charge the device

Time taken,min	Battery percentage ,%	Battery voltage,V
246	0 - 50	9.3
38	50 - 87	10.2
55	87 - 89	12.1
47	89 - 91	12.7
60	91 - 100	13.5

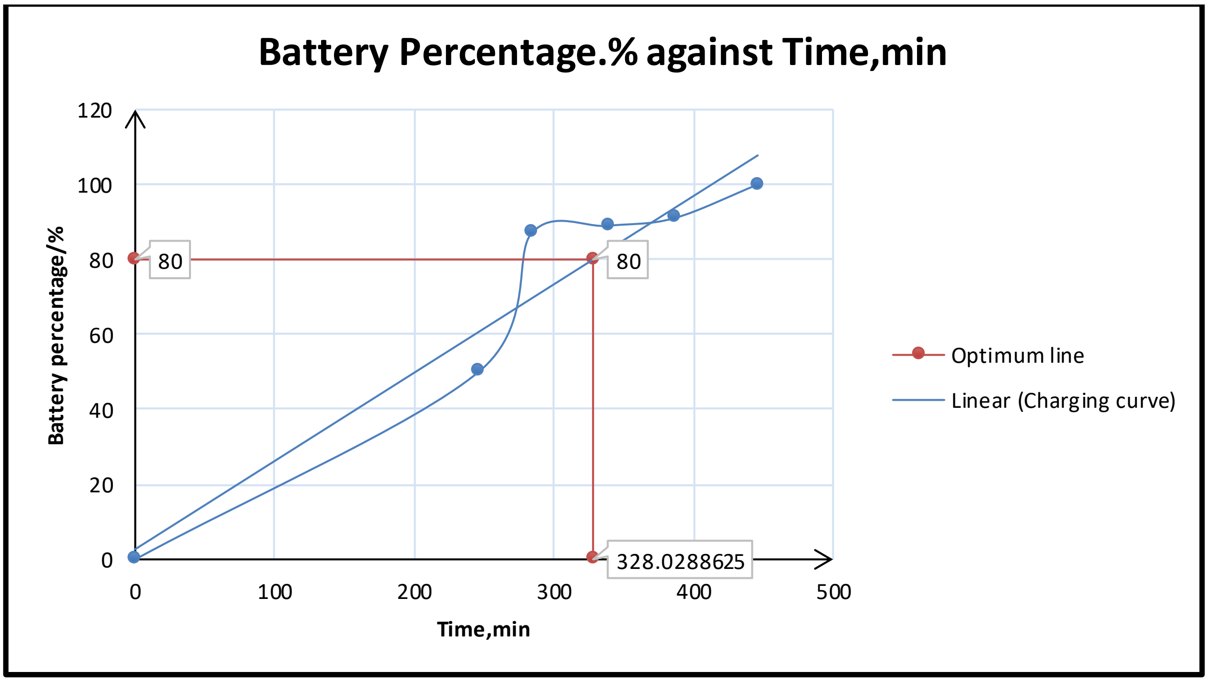


Figure 4.1: Graph of battery percentage against time and optimum line

During the data taken, sunny weather conditions with a small percentage of clouds.

446/60 = 7.43hours

Time taken to charge the product using solar panel is 7.43 hours.

The differences of time taken to charge this device is different from the theorytical calculation can be cause by various factor. For a variety of real-world reasons, charging with solar panels may take less time than predicted by theory. While theoretical estimates usually take perfect conditions into account, solar panels may actually receive more constant or higher amounts of irradiance than anticipated. Faster charging times can also be attributed to technological developments in energy storage systems, charge controllers, and solar panel efficiency. The process of harvesting energy is further improved by advancements in Maximum Power Point Tracking (MPPT) algorithms and tracking systems that maximize the alignment of solar panels with the sun. A combination of these real-world conditions can lead to faster charging times than predicted by theoretical models.

4.3.1.3 Optimal battery condition

The best way to balance longevity and efficiency in a lead-acid battery is to fully charge it up to 80%. During the first stage of charging, also called the bulk charging stage, the battery takes on charge quickly up to 80% of its capacity. This is the point where the charging process slows down to minimize the risk of overheating and electrolyte loss, ensuring a more controlled and delicate approach. The battery's total lifespan is increased by using this thoughtful charging technique.

An effective charging technique is demonstrated by the graph that shows how a lead-acid battery may be charged to 80% capacity in 328 minutes, or roughly 5.47 hours. This **figure 4.1** highlights the significance of a regulated charging procedure, since the first stage quickly fills to 80% of its capacity. The subsequent methodical approach guarantees a more cautious and delicate charging, reducing the dangers of electrolyte loss and overheating. This observed charging profile emphasizes the need of striking a balance between charging speed and battery health preservation, and it is consistent with best practices for lead-acid batteries. As a practical guideline, the 80% charging point maximizes the battery's overall longevity while permitting a significant charge.

4.3.1.4 Figure from an experiment sessions

1.

Figure 4.2: Solar panel information

2.

Figure 4.3: Device during charging session

3.

Figure 4.4: Device at 0% capacity

4.

Figure 4.5: Device at 100% capacity

4.3.2 Jumper Session Analysis and Discussions

The main goal of data collection during a car jumper session is to comprehend the electrical properties and functionality of the batteries used.

4.3.2.1 Voltage Analysis

Voltage readings are obtained from the receiver (low) battery and the donor (product) battery prior to jump starting. This creates a starting point for evaluating the batteries' initial state. The data that will be taken based on this study is the normal voltage for a vehicle to crank the engine and the minimum voltage that can be used to crank the engine.

Car battery voltage on normal conditions = 12.78V

Table 4.2: Car battery Condition

Car Battery Voltage, V	Ability to crank the engine (Yes/No)
12.50	Yes
12.40	Yes
12.30	Yes
12.15	Yes
12.05	No
11.50	No

From the observations made, when the battery has a low voltage, it cannot crank the engine but by using this product it can help to crank the engine. The engine can be cranked at the two low voltages specified in the table above.

Understanding the electrical needs of the vehicle's starting system is necessary for analysing the minimum car battery voltage required to start an automobile. The minimum voltage required is usually greater than the battery's rated voltage since the ignition system and starter motor need a strong enough power source to crank the vehicle effectively. A completely charged and in good condition car battery should read approximately 12.6 volts, but because of the high current consumption when starting, there is a voltage drop. To guarantee dependable engine ignition, a car battery should maintain a minimum voltage of 9.6 to 10 volts during cranking. The battery's condition can be determined by regularly checking the voltage, particularly when attempting to ignite the battery.

4.3.2.2 Figures During Voltage Analysis

1.

Figure 4.6: Car battery condition

2.

Figure 4.7: Car battery normal voltage

3.

Figure 4.8: Condition when data analysis

4.

Figure 4.9: Car battery lowest voltage tested

5.

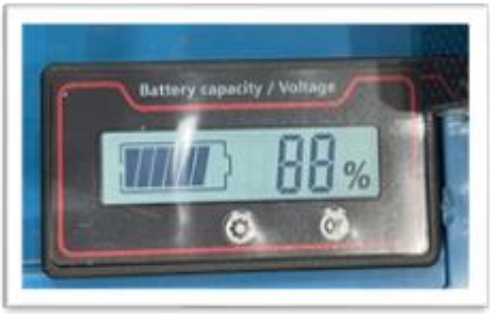


Figure 4.10: Device battery capacity after being test

6.

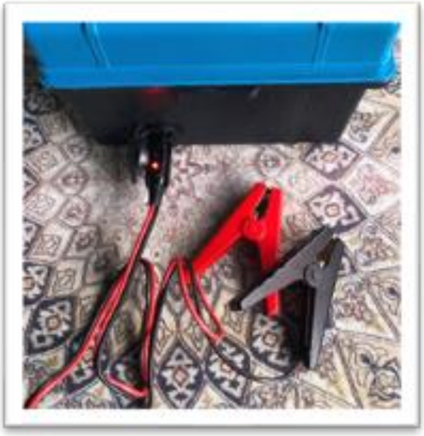


Figure 4.11: Device jumper setting condition

4.3.3 Current Output Analysis and Discussions

Analyzing current output and concentrating on the amount of time needed to completely empty a battery to 0% can reveal important details about the discharge properties and functionality of energy storage devices. This test provides a thorough grasp of how a battery reacts to different current loads, illuminating the discharge efficiency and the amount of time needed to completely drain the energy reserve. Through a close examination of the time-dependent discharge curves and corresponding current levels, one may evaluate the battery's endurance and make well-informed choices about the use and consumption of energy. This research is essential for managing energy resources as efficiently as possible, ensuring that energy storage devices are used to their fullest potential.

In the analysis, a multimeter is connected in series from the battery to the switch, and a table fan is connected to an inverter. Different current readings can be obtained by pressing the three fan speed settings. Next, the amount of time needed to completely drain the battery is noted for examination.

Table 4.3: Different current and time taken to drain the battery

Currents, A	Time taken to drain the battery, min
2.39	173
2.50	157
2.62	121

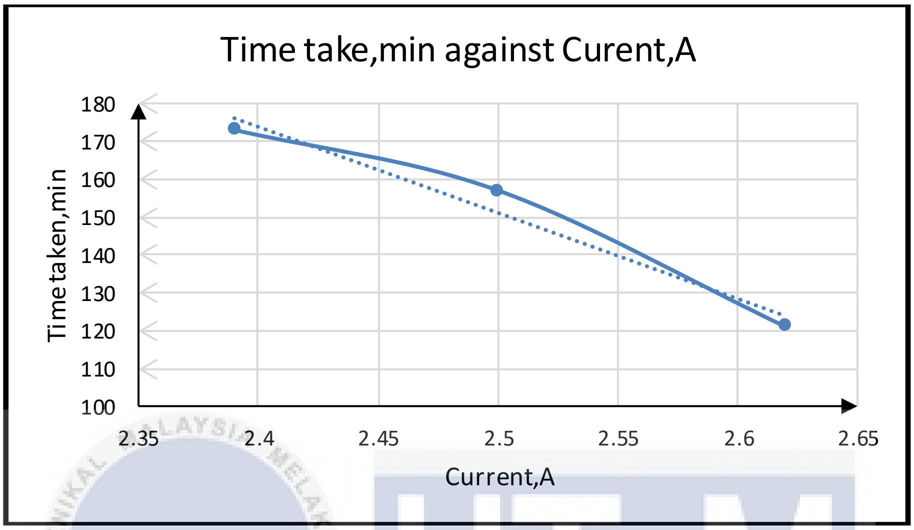


Figure 4.12:Time taken to fully drain the battery against Current

The battery discharge dynamics graph, which shows the duration required to empty the battery under varying current configurations, is essentially non-linear because of the intricate interactions between many components. The Peukert effect is an important aspect that relates to how the actual available capacity is affected by the rate of discharge. There exists a non-linear relationship between time and discharge current due to the battery's effective capacity decreasing as the discharge current increases. The non-linear behavior seen in the graph is further influenced by internal resistance, temperature changes, and voltage fluctuations. This illustrates the difficulties in precisely estimating discharge periods over a variety of current installations.

Furthermore, several real-world conditions might lead to variations between the claimed battery capacity and the actual amount discharged. Practically speaking, useful capacity may be less than what the manufacturer specifies because to internal losses during discharge, temperature variations, and the influence of charge cycles. Determining the actual capacity over time also depends on battery age and maintenance procedures. These intricacies highlight the necessity of a comprehensive comprehension of the various elements impacting discharge characteristics as well as the real useable capacity of batteries in real-world scenarios.

4.3.3.1 Figure During Current Output Analysis

1.

Figure 4.13: Current at 1st fan speed level

2.

Figure 4.14: Current at 2nd fan speed level

3.

Figure 4.15: Current at 3rd fan speed level

4.3.4 Maximum Current Output Analysis and Discussions

Battery current, often called "battery discharge current" or just "current," is the electric charge that flows through a circuit that is connected to a battery. Amperes (A) are used to measure it. A battery allows a device or circuit to function by allowing current to flow from the battery's positive terminal to the battery's negative terminal through the circuit. The electrical characteristics of the device or load linked to a battery determine how much current is extracted from it.

4.3.4.1 Battery Current Analysis (Theoretical)

The voltage, capacity (measured in Ampere-hours, Ah), and internal resistance of the battery all affect how much current it can supply. greater currents are usually possible with batteries that have a lower internal resistance and a greater voltage. Different loads or devices may have different current requirements. For example, a motor in its running state may require less surge current than when it is first started.

Table 4.4: Lead acid battery specification

Ampere-hours	7.2Ah
Voltage	12V
Maximum discharge current (5seconds)	40A

2 Battery connected in Parallel:

$$Current, Amax = Amax1 + Amax2$$

Current,Amax = 40A + 40A

=80A

Maximum discharge current in 5 second for this product is 80A.

4.3.4.2 Battery Current Analysis (Experimental)

The initial electrical current surge needed to start a car is far higher than the average current needed to keep the engine running. This high current demand is required to power the starter motor, which rotates the engine over until it starts operating on its own, and it happens throughout the ignition phase. Before the engine begins, there is typically a brief period of high current demand usually a few seconds. After then, the alternator takes over to power the car's electronics and recharge the battery when the electrical system switches to a lesser power requirement.

Data taken during car jumper session:

Figure 4.16: Graph of amphere,A against time,ms

Device maximum discharge current = 57.4A

From the graph above we can see the maximum value of current supply from this device during car jumping session is 57.4 A. As a theory the maximum current output for this device is 80A, the differences value of max current this device can discharge in short period of time can be cause by several factors. First, the surroundings, particularly changes in temperature, are important. Abrupt changes in temperature can influence the internal chemical reactions of battery cells, hence reducing their overall capacity. Variations in the battery's maximum state of charge are also influenced by the battery's age and usage habits. Over time, wear, and tear from repeated cycles of charging and discharging results in a progressive loss of capacity. Furthermore, because various chemistries and technologies react differently to charging and discharging situations, the battery chemistry, the presence of additives, and the design of the battery management system all affect the behaviour of the battery. The observed variations in the maximum current state on a battery in practical situations can be attributed to a combination of these factors.

Practically speaking, the C-rate the rate at which a battery is charged or discharged also holds significant importance. High C-rates during fast charging or discharging might cause the battery to become overheated and stressed, which will reduce its capacity and efficiency. Additionally, voltage cut-off limitations might affect the perceived maximum state of charge but are essential for battery safety as they guard against deep draining or overcharging. Additional elements that can introduce changes in reported state of charge and impact the dependability of battery indicators are calibration and measurement accuracy in battery management systems. Thus, in real-world applications, a battery's maximum state of charge is dynamic due to a combination of factors including usage patterns, battery chemistry, charging rates, measurement accuracy, and ambient variables.

4.3.4.3 Figure Of Amp Analysis

1.

Figure 4.17: Bosch analyzer used to measure current

2.

Figure 4.18; Low battery car and the device

3.

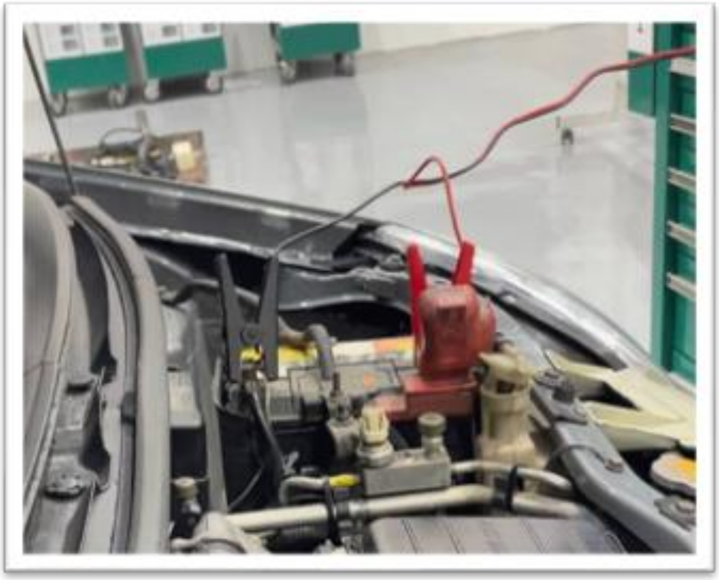


Figure 4.19: Jumper position during data analysis

4.

Figure 4.20: Bosch analyzer amp clamp position during data analysis

4.4 Product Overview

1.

Figure 4.21: Top view

2.

Figure 4.22: Front view

3.

Figure 4.23: Side view

4.5 Summary

The research utilized a methodical strategy in the data analysis chapter to collect and assess data using the Pugh matrix rubric table. With the help of this strategy, different criteria and possibilities may be evaluated in an organized manner, giving a thorough perspective of the data collection process. A decision-making tool called the Pugh matrix made it easier to compare options based on predetermined standards, allowing for both a quantitative and qualitative evaluation of each choice. The chapter explores the nuances of applying this methodology, highlighting how well it works to methodically arrange and analyse data, guaranteeing a thorough and impartial assessment of the research variables.

The data analysis chapter moves from applying the Pugh matrix rubric table to a thorough discussion of the results. It examines the ramifications and conclusions obtained from the assessed criteria, illuminating the advantages and disadvantages of each choice. By establishing links between the gathered data and the main goals of the study, the discussion helps to place the data into a larger research framework. This way of synthesizing the data gives the chapter a strong conclusion that supports the broader conclusions and recommendations of the research while also reflecting the scientific rigor of the data collection process.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

Based on the process flow, result and discussion, the conclusion of this case study shown below:

In conclusion, safety and the car's entire lifespan are severely impacted by the widespread problem of battery corrosion, which affects people irrespective of the age of their vehicle. The issues that have been found such as a poor battery and a lack of electricity in an emergency highlight the necessity of a workable fix. The Energy Storage Unit, a portable energy storage device that has been suggested, appears to provide a complete solution to these problems. Utilizing the advantages of renewable energy, especially solar power, the gadget is made to be lightweight, small, and simple to store within a car.

This device is an essential lifesaver for automotive batteries, using a lead acid battery for longevity and low maintenance. It can jump start the engine several times without requiring a temporary charge. Reducing reliance on external power sources, the integrated solar panel under the rearview mirror enables convenient and continuous charging. By using tools such as the Pugh Matrix Table for part selection and circuit optimization, this project's rigorous design and development approach will hopefully result in an effective, long-lasting, and user-friendly solution to the problems related to automobile battery problems. In the end, this cutting-edge energy storage device can greatly improve vehicle safety, offer backup electricity, and simplify energy management for a more dependable and environmentally friendly driving experience.

5.2 Problem Facing During Project

Throughout the project, a number of difficulties surfaced, mainly related to part arrangement and selection. It was challenging to choose the energy storage unit's component parts because compatibility, performance, and affordability had to be balanced. It was difficult to ensure that every component worked in unison to build a coherent and effective system, requiring close attention to interdependencies and technical requirements. Part layout also presented difficulties due to physical space limitations. To maximize energy storage while keeping the gadget small and portable, the best arrangement and positioning of the components became essential. To overcome these obstacles and arrive at an ideal configuration that satisfied both functional and design requirements, iterative testing and modifications were required.

Another set of difficulties was found in locating pertinent academic publications and articles for the literature review segment. A thorough investigation of academic databases and libraries was necessary to guarantee the inclusion of current and relevant research findings. The breadth and accuracy of the literature review were directly impacted by the availability of thorough and current literature. Furthermore, because battery technology, solar energy, and portable energy storage units are dynamic domains, it was difficult to find journals that particularly covered these topics.

In the end, a thorough evaluation necessitated careful curation and judgment in choosing articles that significantly added to the project's background and goals. Data collecting and processing also presented difficulties, especially with regard to standardizing data collection techniques and guaranteeing accuracy. It became imperative to follow a methodical approach and improve data collection procedures in order to reduce errors and guarantee the accuracy of the results. Despite being difficult, these obstacles helped to continuously solve problems and improve methods, which ultimately led to a more solid and knowledgeable project conclusion.

5.3 Future Work Improvements

The efficiency and usefulness of the suggested energy storage unit project can be improved in a number of ways. First of all, when it comes to battery type, although lead acid batteries are preferred due to their ease of maintenance, it may be beneficial to investigate new developments in battery technology, such as lithium-ion versions. The Power Storage Box may operate better overall and last longer if lithium-ion batteries are used since they have a longer cycle life, are lighter, and have a higher energy density. Additionally, integrating intelligent battery management systems helps streamline the operations of charging and discharging, guaranteeing the battery's longevity and improving user safety.

Further streamlining the device in terms of solar panel utilization can be achieved by investigating more compact and efficient solar technologies. Investing in high-efficiency solar panels with enhanced power conversion capabilities can shorten charging periods and increase the effectiveness of the device, particularly in scenarios where there is little exposure to sunshine. Energy harvesting could also be maximized by incorporating movable solar panels that can be positioned for the best possible exposure to sunlight throughout the day. Without sacrificing its ability to store energy, the storage box's size might be reduced to improve portability and convenience.

The Power Storage Unit can be more compact and simpler to store inside a car by utilizing lightweight materials and space-saving design concepts. Lastly, a more user-friendly experience may be achieved by optimizing wire selection by incorporating sturdy and tangle-free wiring materials, which also ensure hassle-free handling and reduce wear and tear over time. The energy storage unit project's overall performance, sustainability, and user experience can all be improved by these enhancements taken together.

5.4 Project Potential

The solar-powered portable energy storage device, which is also intended for use in auto crises, has enormous potential to improve vehicle resilience and safety. By offering a dependable and portable power supply, this novel solution tackles the prevalent problem of unplanned vehicle failures. The device's compatibility with sustainable energy practices is enhanced by the addition of a solar charging option. In order to ensure an environmentally sustainable and independent energy source, users can utilize solar power to recharge the device. Beyond its uses for jump-starting cars and powering necessary devices in an emergency, this portable energy storage unit meets the growing demand for eco-friendly and robust roadside assistance solutions by promoting a more resilient approach.

REFERENCES

- CARSIFU., 2017. Battery malfunction is top cause of vehicle breakdown in Malaysia. [Online]
  Available at:
  https://www.carsifu.my/news/battery-malfunction-is-top-cause-of-vehicle-breakdown-in-malaysia
  [Accessed on 19 June 2023]

- Rahmi Dogucan E., 2022. Can a Bad Car Battery Cause Electrical Problems?.[Online]
  Available at:
  https://pedalcommander.com/blogs/garage/bad-battery-problems
  [Accessed on 19 June 2023]

- Continental Battery., 2023. How Long Do Car Batteries Last?. [online]
  Available at:
  https://www.continentalbattery.com/blog/how-long-do-car-batteries-last
  [Accessed on 11 June 2023]

- Jesper., 2023. What's the battery life of a smartphone?. [online]
  Available at:
  https://www.coolblue.nl/en/advice/what-is-the-battery-life-of-a-smartphone.html
  [Accessed on 11 June 2023]

- ECOFLOW., 2022. What is a Portable Power Station?. [online]
  Available at:
  https://blog.ecoflow.com/us/what-is-a-portable-power-station/
  [Accessed on 11 June 2023]

- Gianna Petan., 2023. What Is a Power Bank? Everything You Need To Know About Charging On The-Go. [online]
  Available at:
  https://www.qualitylogoproducts.com/blog/what-is-a-power-bank/
  [Accessed on 11 June 2023]

- United Nations., 2023. What is renewable energy?. [online]
  Available at:
  https://www.un.org/en/climatechange/what-is-renewable-energy?gclid=CjwKCAjw4ZWkBhA4EiwAVJXwqQ8PCCVGhBe3EISd0CGzPQ-7XH0lnbWJKxPn4Ntr3w6OZyG5GWqOKRoC7K4QAvD_BwE
  [Accessed on 11 June 2023]

-

Datta, U. (2020). *Battery Energy Storage System for Renewable Energy Integrated Power System Stability Enhancement*. http://vuir.vu.edu.au/41874/

Eggert, G. (2020). *The Enigmatic ' Battery of Baghdad ' What ' s That I Smell ? The*

Claims of Aroma Fun and Fallacies with Numbers I by Marilyn vos Savant. *May 1996*.

Heth, C. L. (2019). Energy on demand: A brief history of the development of the battery. *An International Journal of the History of Chemistry*, *3*(2), 73–82. https://doi.org/10.13128/Substantia-280

International Energy Agency. (2020). Global Energy Review 2019. *Global Energy Review 2019*. https://doi.org/10.1787/90c8c125-en

Kim, D. K., Yoneoka, S., Banatwala, A. Z., Kim, Y.-T., & Nam, K.-Y. (2018). Handbook on Battery Energy Storage System. In *Asian Development Bank* (Issue December). https://www.adb.org/publications/battery-energy-storage-system-handbook

Narayan R, & Venkateswarlu M. (2018). Studies on portable power banks for recharging electronic gadgets. *International Research Journal of Engineering and Technology*, *5*(3), 1549–1553. www.irjet.net

Silvi, C. (2015). The Future of Solar Energy. *Leonardo*, *28*(4), 325. https://doi.org/10.2307/1576198

The Automotive Battery Construction and Service. (2011). 1–16.

Thumma, T., & Sheri, S. R. (2015). Unsteady MHD Free Convection Flow past a Vertical Porous Plate Considering Radiation and Volume Fraction Effects in a Nanofluid. *International Advanced Research Journal in Science, Engineering and Technology*, *2*(2), 197–205. https://doi.org/10.17148/IARJSET

Toyota, M. (2017). Battery Types. *Construction*, 1–19.

APPENDICES

Appendix 1: Gantt Chart

Plan	
Actual	

NO	Project Activities	Plan vs Actual Plan	October		November				December					January			February	
		Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	PSM BRIEFING	Plan																
		Actual																
2	Chapter 1: Introduction	Plan																
		Actual																
3	Chapter 2: Literature Review	Plan																
		Actual																
4	Chapter 3: Methodology	Plan																
		Actual																
5	Chapter 4: Result & Discussion	Plan																
		Actual																
6	Chapter 5: Conclusion	Plan								MID-TERM BREAK								
		Actual																
7	Formatting and Grammar Improvement	Plan																
		Actual																
8	Slide Presentation	Plan																
		Actual																
9	Final Improvement	Plan																
		Actual																
10	Final Presentation	Plan																
		Actual																
11	Report Submission	Plan																
		Actual																