Implementation of Solar Photovoltaic Technology in The Construction Industry : Case Study In Perak State

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A project submitted in partial fulfilment of the
requirements for the award of
Master of Sustainable Construction Management

Faculty of Engineering and Green Technology
Universiti Tunku Abdul Rahman

APRIL 2023

DECLARATION

I hereby declare that this project report is based on my original work except for citations and quotations which have been duly acknowledged. I also declare that it has not been previously and concurrently submitted for any other degree or award at UTAR or other institutions.

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APPROVAL FOR SUBMISSION

I certify that this project report entitled **"**IMPLEMENTATION OF SOLAR PHOTOVOLTAIC TECHNOLOGY IN THE CONSTRUCTION INDUSTRY : CASE STUDY IN PERAK STATE**"** was prepared by CHONG POH KIEN has met the required standard for submission in partial fulfilment of the requirements for the award of Master of Sustainable Construction Management 21AGM02242 at Universiti Tunku Abdul Rahman.

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Date : 19/04/2023

ACKNOWLEDGEMENTS

I wish to express my sincere appreciation to my supervisor, Dr Shalini A/P Sanmargaraja, for her dedicated guidance and support during the entire project duration. Her advice and support have been valuable and constructive for my completion of this Project paper.

Additionally, I wish to thank the great replies from the survey respondents, for their time and effort in helping me to complete and provide their valuable feedback for the requested surveys.

Lastly, I am happy and touched by the steady support provided by my family and friends. I would say that my project completion would not have happened without their love and encouragement.

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ABSTRACT

Solar Photovoltaic (PV) Technology is one type of renewable energy which could help to combat the climate change. The sunlight is free of charge, and many countries can enjoy this valuable resources. Solar panels could be installed on buildings' rooftop to generate free electricity from sunlight. The electricity generated by the solar PV Technology can be used to supply electricity to support the daily usage of various building's functions.

The implementation of solar PV technology in the construction industry in Perak State, Malaysia, provided an opportunity for sustainable development and able to reduce Carbon Dioxide (CO^2) emission. The Net Energy Metering (NEM) policy in encouraging solar PV technology in the construction industry undoubtedly help to limit the dependence on crude fuels and subsequently supported the use of renewable energy.

Nonetheless, the implementation of Solar Photovoltaic (PV) technology encountered various challenges, amongst the most significant are ; the difficulty in getting financing and bank loan, limited export capacity imposed by Net Energy Metering (NEM) policy as well as availability of cheaper alternative energy source etc.

In aggravating the situation, while implementing projects, clients would usually prioritize project cost, quality and health & safety , in contrast with Solar Photovoltaic (PV) technology.

Nevertheless, there are measures which could increase the application of Solar PV technology in Perak. These measures include providing loans and reducing taxes, financial support from government as well as implementing several policies to improve the Solar PV technology adoption.

In a nutshell, the application of solar PV technology in the construction industry in Perak State do encounter some challenges, yet it provides an encouraging opportunity for sustainable development and this can serve as good measure to fight the climate change. By understanding the market demand and making some accommodative measures, Perak State can have the application of solar PV be improved , thus contributing to a cleaner and more sustainable society in the future.

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CHAPTER 1

RESEARCH PROPOSAL

1.1 Introduction

In this Chapter, we will discuss the topic of Background of Study, Problem Statement, Research Question , Research Objectives, Research Scopes, Outline of the Research and Summary.

1.2 Background Of Study

Climate change is an increasingly pressing issue for local and global . The world demand and reliance on electricity is increasing but it needs to consider the reduction of greenhouse gas emissions at the same time. Solar Photovoltaic (PV) Technology is one of the renewable technologies which potentially shape a clean, dependable, and cheap electricity system for the future. It's main function is to convert sunlight into electricity .

Malaysia is a country which is blessed with abundance of sunlights. Refer Figure 1.1 for Solar irradiance in Malaysia (SEDA Malaysia,2021).

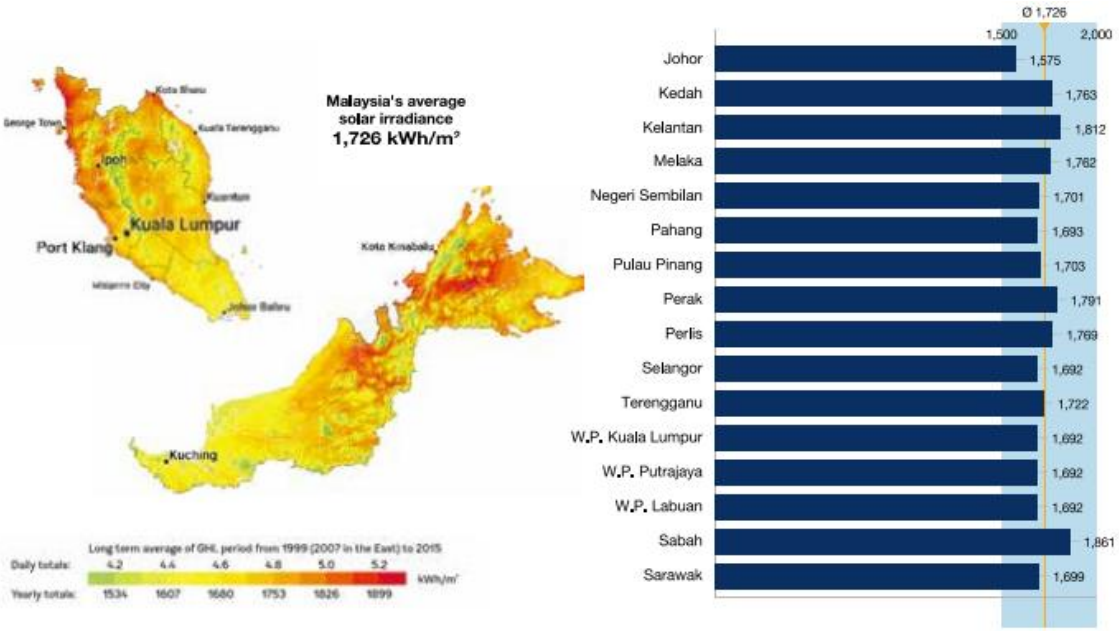


Figure 1.1 Solar irradiance in Malaysia (SEDA Malaysia, 2021)

Due to the vast landbank availability in Malaysia, hence there is huge potential for various types of Renewable Energy (RE) resources. Figure 1.2 show the Summary of RE resource potential in Malaysia.

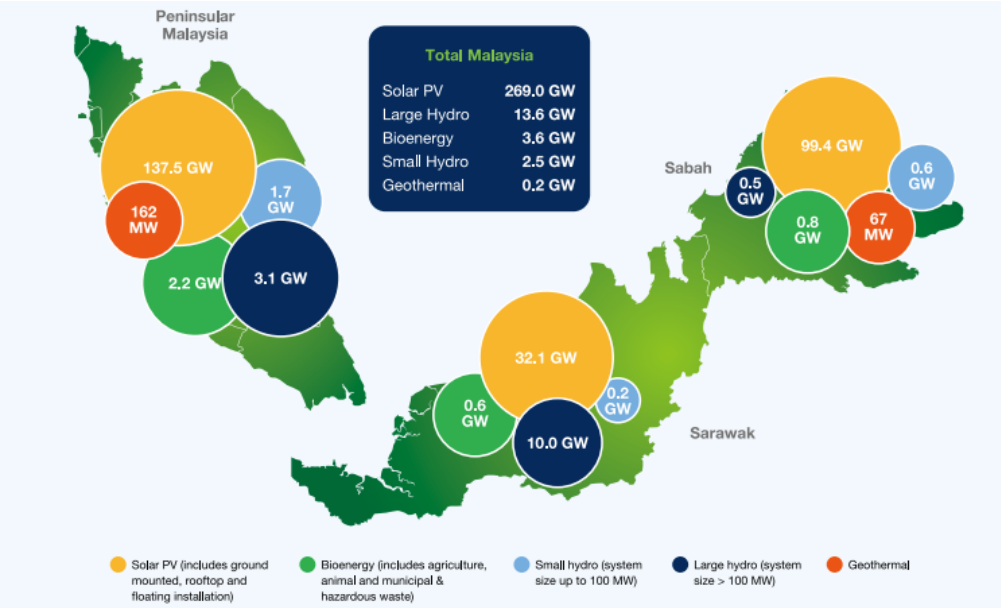


Figure 1.2 Summary of RE resource potential in Malaysia (SEDA Malaysia,2021)

The construction industry in Malaysia use mainly the power from national utility provider, namely Tenaga Nasional Malaysia (TNB) . Considering the strategic location of our country and the suitable climate condition as well as numerous new and old buildings scattered around our country, therefore a huge opportunity can be explored in the construction industry. Figure 1.3 show the Summary of buildings assessed for rooftop Solar PV.

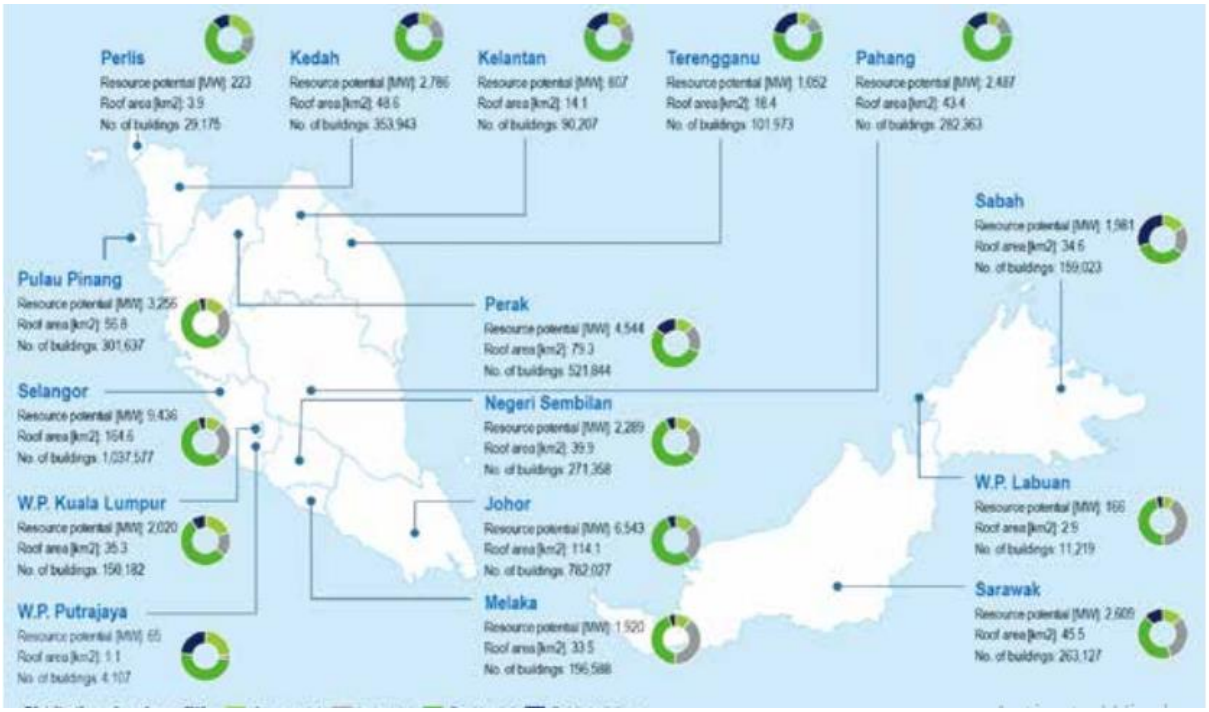


Figure 1.3 : Summary of buildings assessed for rooftop solar PV (SEDA Malaysia, 2021)

1.3 Problem Statement

Regardless of the opportunities and favourable condition for Solar PV installation, its electricity generated and used by construction industry in Malaysia is considerable low and discouraging. The Malaysian energy supply is mainly reliant on non-renewable sources such as fossil fuels and natural gas .

In general, the supply of energy from Renewable Energy especially solar PV is still not encouraging from the public community mainly because availability of lower priced alternative energy.

Additionally, solar PV technology needs extensive investment, yet the maintenance cost could be unexpectedly high. As an example, for conventional building , any roof leakage can be easily attended, as the building rooftop is usually not occupied and make it easier for maintenance. However, for building which installed with Solar PV, if there is solar panel already installed and at the same time there is roof leakage or maintenance issue, then the solar panel may need to be removed before the maintenance for leakage can be carried out. This will definitely incur additional cost for maintenance as compared to conventional building.

Kardooni et al. (2016) studied the popularity of renewable energy technology in Peninsular Malaysia. Lacking in motivation to install solar PV technologies is one main factor. It was found out the cost of renewable energy indirectly impacted public's attitude on the adoption of renewable energy . According to Mekhilef (2012) , Solar PV technology is not common in Small Renewable Energy Programme (SREP) mostly due to the high cost of PV cells and lower electricity bill (21 cents/kWh)

Limited awareness of general public to appreciate the clean solar energy resource posed another problem, The clients usually have limited knowledge and information on solar PV technology. In this scenario, it continues to hinder Malaysian construction industry to adopt solar PV.

In Malaysia, solar PV projects usually encounter difficulty to get finance support and loan approval because of the high risk exposed , in addition to lacking of technical knowledge on the side of financiers. Therefore, the construction industry player viewed this as another challenge and they must be financially good to implement solar PV projects

According to Cheam (2021), public usually prefer to use solar PV technology when they are impacted by environmental concerns. Lack of environmentalism and knowledge may hinder public solar PV adoption . Community who values the environment usually spend more on green products because they believe it helps to improve health and meets community and social's expectations.

Technical difficulty during the construction is another barrier. Solar PV technology needs advance techniques and extra ordinary construction Standard Operating Procedure (SOP). If complications not countered well, then it impacts the project's performance. For sure the design is more difficult than that of a conventional construction.

Lack of incentives is another barrier problem. Without a good incentive as attraction, the public will not have a good reason to include solar PV technologies in their projects.

1.4 Research Question

1) What are the challenges faced by clients to integrate solar power into their new projects
2) What are the client's priority while implementing new projects
3) How to integrate solar panel into all the new projects

1.5 Research Objectives

1) To determine the challenges faced by clients to integrate solar power into their new projects
2) To analyse the client's priority while implementing new projects
3) To propose recommendations to integrate solar panel into all the new projects

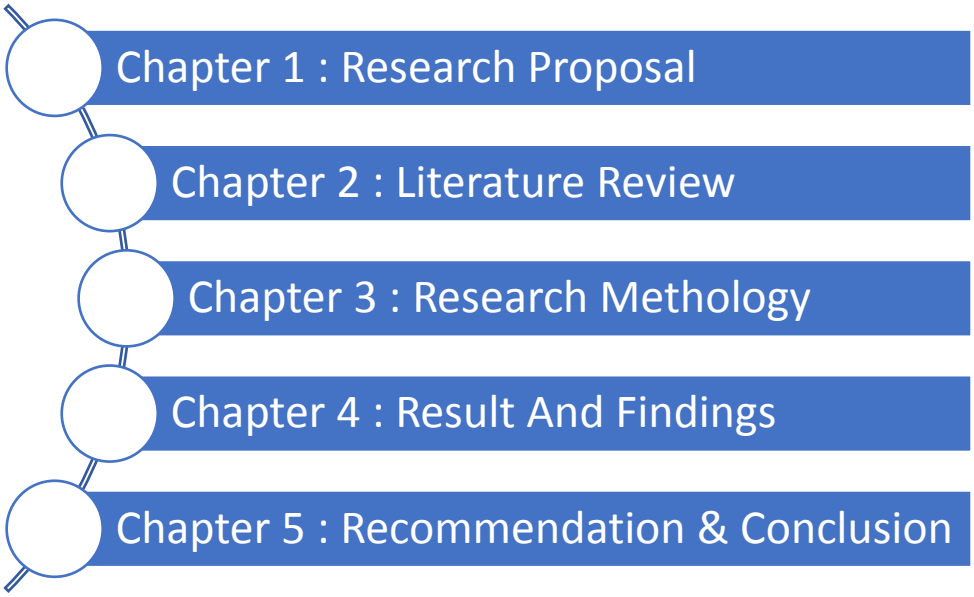
1.6 Research Scope

This project is mainly to focus in Perak State, on finding out the challenges faced by clients to integrate solar power into their new projects, as well as analysing the client's priority while implementing new projects. Based on these findings, analyse the clients' recommendation which can help to encourage the integration of solar panel into all the new projects. Figure 1.4 below shown the location of Perak State

Figure 1.4 Location Of Perak State (wikipedia.org)

As part of this research, I will collect data for this study through a survey questionnaire. The distribution of questionnaires will take place in Perak, Malaysia. Perak was chosen due to the low adoption of Solar Photovoltaic Technology in the construction industry.

1.7 Outlines of the Research



1.8 Summary

In this Chapter, it was mainly discussed about the background of solar photovoltaic (PV) technology in Malaysia, and briefly explain the problem statement that it encountered. Based on this discussion, 3 research objectives were established together with the intended research scope. Lastly, it was presented the outlines of the entire research.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This Chapter will discuss about the definition of Solar Photovoltaic. It will includes types of solar PV installation and the different schemes for supporting Renewable Energy (RE) . Additionally, we will explore the challenges faced by clients to integrate solar power into their new projects, to analyse the client's priority while implementing new projects and to propose recommendations to integrate solar panel into all the new projects.

2.2 The Definition of Solar Photovoltaic

2.2.1 Solar Photovoltaic

Solar photovoltaics (PV) is one of the most favourite resources for power generation. According to Jordehi (2016), the main component of PV systems is PV cells. The physical structure of PV cell is depicted in Figure 2.1 whereas the diagram of a typical PV system is depicted in Figure. 2.2.

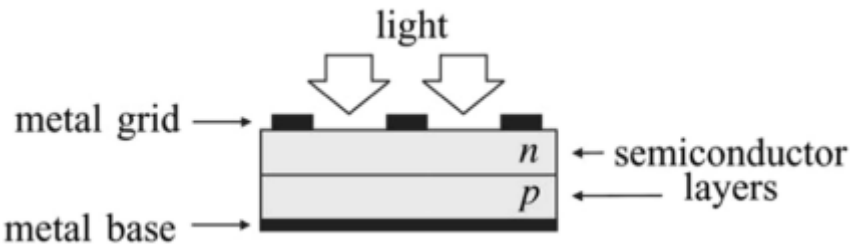


Figure 2.1. Physical structure of PV cell (Jordehi, 2016)

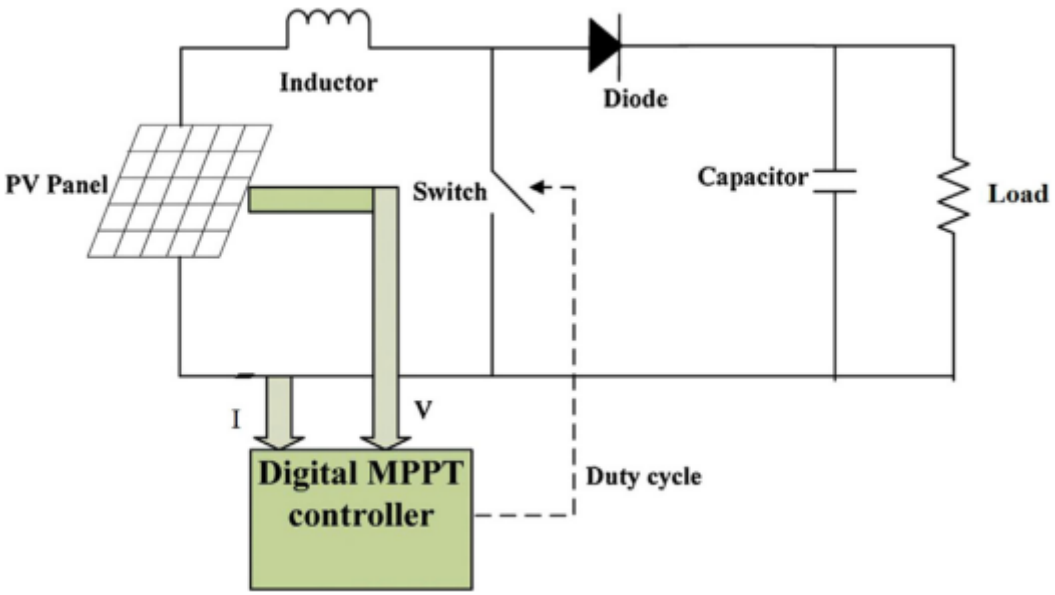


Figure 2.2 . Schematic of a general PV system (Jordehi, 2016)

2.3 Types of Solar PV Installation

There are three (3) types of Solar PV Installation, namely Ground Mounted, Floating and Rooftop

2.3.1 Ground-mounted solar PV

According to Sustainable Energy Development Authority , SEDA (2021), this type of solar PV involves installation on ground. This type of solar panel installation has the highest solar potential in Malaysia at 210 GW, contributed by the availability of unused suitable land.

2.3.2 Floating solar PV

According to SEDA (2021), Floating Solar PV is to install PV modules on water surfaces. Nowadays, only hydroelectric plant and reservoir can cater for this type of demand, and they have the highest possibility to connect a floating Solar PV system to a electrical substation**.**

2.3.3 Rooftop solar

Rooftop solar utilize roof space to generate clean and cheap electricity. According to SEDA (2021), PV Rooftop solar is about installation of solar PV systems on buildings' roofs.

2.4 Different schemes for supporting renewable energy RE

There are two schemes, namely Feed in tariff (FiT) and Net Energy Metering (NEM), both initiated and managed by Sustainable Energy Development Authority (SEDA) of Malaysia .

2.4.1 Feed in Tariff (FiT)

According to Husain et al. (2020), Feed in tariff (FiT) is a payment system which pay for community who produce energy at their houses. It provides Distribution Licensees (DLs) to buy from FiT users in which electricity generated from renewable resources and fix the FiT rate. FiT was introduced in 2011 in Malaysia and attracted serious attention considering its high profit return.

2.4.2 Net energy metering (NEM)

According to Husain et al. (2020), NEM is a policy which allows consumers to offset some or all of the energy created by their own solar system against their unit's electricity bill. A photovoltaic system consist of a panel of solar modules, solar inverter, and regularly a battery with interconnection wiring. Additionally, clients have to install the bidirectional meter. The element of NEM in solar system as depicted in Figure 3 below.

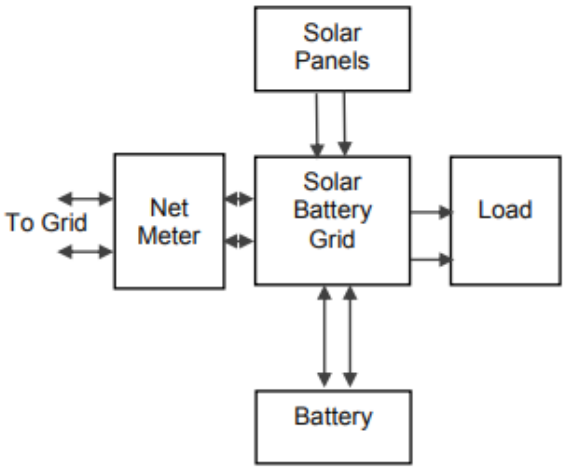


Figure 2.3 Diagram of Net Metering Using Solar (Husain et al. ,2020)

2.5 Challenges Faced By Clients To Integrate Solar Power Into Their New Projects

There are numerous challenges faced by clients to integrate the solar photovoltaic in new projects. The details of it will be discussed in the following points:

2.5.1 Difficult To Obtain Financing For Solar PV Rooftop Project

According to SEDA (2021), the financing price for individual Solar PV system, together with lacking of affordable debt financing and public awareness, discouraged the subscription of rooftop PV among community. There isn't any Renewable Energy's specific loan programmes and clients are usually opt for conventional lending products which usually imposed higher interest rates.

2.5.2 Capacity Limits Restricted Utilization Of Resource Potential For Rooftop Solar

According to SEDA (2021), under the NEM scheme, there is limit on solar PV capacity , ie, for residential 3 phase -10kW and residential single phase -4kW are imposed respectively.

2.5.3 Limitation Of NEM To Assets On Customers' Own Premises

According to SEDA (2021), in the existing programme, NEM is only available to generate power using assets on the client's own property. This will deter public to participate in the NEM program:

2.5.4 Lacking In Regulatory Frameworks To Support Customer Preference

According to Ahmad et al. (2011), Solar Photovoltaic Technology is prevented by the lack of resources such as investment and labour, because of lacking interest from commercial investors due to unavailability of security provided by any act and policy.

2.5.5 Availability Of Cheaper Alternative Energy

According to Ahmad et al. (2011), one of the most challenge is the fuel subsidy , as in Malaysia public do receive a competitive electric price from the national grid due to subsidy

According to Almaktar et al. (2015), the current electricity tariff discourage the PV development . The energy such as from solar PV is not attractive to the community because of the availability of cheaper alternative energy.

2.5.6 Limited Solar Energy Awareness

Limited Solar PV awareness among the community to appreciate the clean solar energy resource is also another barrier, which required to solve. Government bodies like SEDA is

responsible to solve, and GreenTech Malaysia is to diffuse the use of Green Technology (GT) by strengthening community education.

2.5.7 Requires High Capital Investment And Maintenance Cost

It requires huge capital to install Solar PV on the residential house and usually ordinary people would consider this as additional cost, in addition to the residential unit. Besides, there is maintenance cost required during the service life of the Solar PV.

2.5.8 Lack Of Motivation and Incentives For Installation Of Solar PV Technologies

There is a lack of motivation and incentives to attract the clients to install Solar PV panels on their units . They often asks why they need to do so, since the existing TNB tariff is acceptable and low enough for their usage.

2.5.9 Sustainability measure was not required by the clients

Clients do not need to consider Solar PV panel installation , as they don't have obligation to commit to sustainability.

2.5.10 Lack of political will, legislation and enforcement

According to Shari et al. (2012), usually politicians and regulatory stakeholders possess quite limited knowledge of sustainable development. Hence, these people became un-effective to promote and raise awareness amongst the public. Policy, legislation and implementation are all important elements which support the sustainable developments.

2.5.11 Project team members lacked technical understanding

According to Shari et al. (2012) , the study found that 14% of the barriers are due to challenges with the project team. They are lacking in technical understanding and knowledge for sustainable practices implantation such as Solar PV technology.

2.6 Client's Priority While Implementing New Projects

There were a number of priorities considered by clients while implementing new projects, and here below we will discuss some of them.

2.6.1 Initial cost to be more important than the long-term operational cost

According to Shari et al. (2014), the study found that most respondents considered the project upfront cost is more important than the operational cost. Developers usually more interested in saving money of project and to maximise profit margin.

2.6.2 Implementation of Green environment or Space

According to Yam (2013) ,the preparation of parks and tree are usually on the main interest of most property developers , as part of contribution to promote sustainable environment..

2.6.3 Human Resource

According to Yam (2013), many developers recognized the importance of human resources to help them to succeed. They emphasized on human development, as well as technical or soft skills trainings.

2.6.4 Corporate Social Responsibility (CSR) Practises

According to Yam (2013), Corporate Social Responsibility **(**CSR) is considerably new in Malaysia, hence, most established property developers are quite active in social and environmental activities to fulfil their obligations, to be seen as a responsible entity.

2.6.5 Construction Time

One of the focuses of developer when implementing new projects is about how soon the project can be completed, the sooner the better as it can initiate the handover to clients. The practise of using TNB power supply as it is easier and cheaper to adopt., as compared to installation of Solar PV technology. Connection to TNB gird is usually faster as there is already technical personnel and process to implement it. However, for Solar PV technology, it needs the expertise and special material for installation, and if not carefully planned, it could prolong the construction period and delay the handover to clients.

2.6.6 Quality of product

By connecting the new project to TNB system, it can be done usually without much quality issue which needed to be rectified. However, for Solar PV, it could be complicated, as poor quality of installation can lead to various issues during the construction as well as after

handover to client. Additionally, for rooftop solar installation, one of the barriers is leakages, and if it happens, then the solar panel installed may impact the leakage repair work and cause difficult rework.

2.6.7 Workplace Initiative And Safety

According to Yam (2013), work place safety is top priority in the developers' agenda, as without safety there will not have any productivity on site. Hence, nowadays most developers committed to provide a healthy and safe work place for their labour and employee. Equality in work place is another practise, as this is one of the principles to respect human rights.

Solar PV panels are bulky to handle, as it needs to be lifted to rooftop for installation. During the transfer of these panels and accessories, it could invite unnecessary risk to the property or personnel. As compared to TNB connection, it just needed to be installed with cables without much bulky handling, and therefore is considered a much more safer installation.

2.7 Recommendations To Integrate Solar Panel Into All The New Projects

In this section, I will discuss about the recommendations which could encourage the integration of solar panel into new projects.

2.7.1 Policy implications

According to Cheam et al. (2021), it is important to adopt some policies to improve solar PV adoption. In Malaysia, environmental awareness still considerably low. Enhancing the legislation is way to encourage community to be environmentally aware.

2.7.2 Enhance Clients' Knowledge

According to Cheam et al. (2021), knowledge do linked to solar PV installation. Clients with a higher level of knowledge will trust Solar PV to benefit them and likely they will install it. If clients think that solar PV requires much effort, this meant that they are lacking of knowledge and experience with solar PV.

2.7.3 Financial support to encourage small and medium scale industries to use renewable energy

According to Vaka et al. (2021), the Malaysian Government shall encourage schemes and subsidies to support small and medium scale industries to develop Renewable Energy, which is still at initial stage.

2.7.4 Sustainable Energy Development Authority Act of 2011

According to Vaka et al. (2021), Sustainable Energy Development Authority (SEDA) is a Malaysian government agency empower to promote and implement sustainable energy. The main intention of this Act is to comply with the current requirements without compromising the needs of future generation, which includes renewable energy as well.

2.7.5 Attractive loans to support small and large scale to use and supply green technology

According to Vaka et al. (2021) ,Malaysian Government introduced the Green Technology Financing Scheme (GTFS) to encourage the adoption of green technology. This scheme was under the jurisdiction of Ministry of Energy and Green Technology and Water, Malaysia . Availability of loan will make solar power more affordable, as well as reducing taxes and customs duties related to solar PV technology;

2.7.6 Cooperation between government and non-governmental organizations (NGOs)

Cooperation between government and non-governmental organizations (NGOs) to raise awareness for the adoption of solar PV technology is another important aspect to diffuse the application of solar energy.

2.7.7 Review Fossil-fuel subsidy

The Fossil-fuel subsidy to be reduced or reviewed, for the fund to be channelled for development of Solar PV technology , which also providing attractive pricing for users and suppliers.

2.7.8 Improving Client’s knowledge and acceptance

According to Abidin (2010) , our countries' developers consisted mainly of small and medium size developers, and it will definitely making huge impact in sustainable construction practise if we improve their knowledge and acceptance level. By organizing more conferences, trainings, seminars and workshops for these groups, the sustainable target is possible to achieve.

2.7.9 Influence Prospective Buyers

According to Abidin (2010), developers will usually act based on market's direction and sentiment. Hence, if prospective property buyers aim for sustainable houses such as the one provided with Solar PV technology, it will encourage developers to improve the criteria of their building which includes Solar PV installation .

2.8 Summary

In this chapter, it was mainly discussed about Solar PV definitions, types of Solar PV Installation and the different schemes for supporting renewable energy (RE), Additionally, there were also the discussion about factors which contributed to the low usage of solar photovoltaic project , priority of clients while implementing new projects as well as recommendations which could encouraged the integration of solar panel into new projects

CHAPTER 3

RESEARCH METHODOLOGY

3.1 Introduction

In this Chapter, I will discuss about the quantitative research, research questionnaires, method to reach targeted respondents and sampling methodology for the current study.

3.2 Quantitative Research

Quantitative research is a systematic investigation of phenomena by gathering quantifiable data and carrying out statistical, mathematical, and computational techniques. Quantitative research gather information using sampling methods , such as sending out online surveys etc.

3.2.1 Quantitative Research Characteristics

Some distinctive characteristics of quantitative research are:

- **Structured tools**
- **Sample size**
- **Close-ended questions**
- **Prior studies**
- **Quantitative data**
- **Generalization of results**

3.3 Questionnaire

A questionnaire or survey is to gather the response from survey participants. According to Zhang (2022) , questionnaire is a written list of questions, the answers for them are recorded by survey participants. Participants will read the questions, understand what is expected and then register the answers.

3.3.1 Questionnaire Design

According to Roopa et al. (2012), to collect useful and relevant information, it is important to carefully consider and pay attention to the design of questionnaire. There are several stages to develop questionnaires (Figure 3.1):

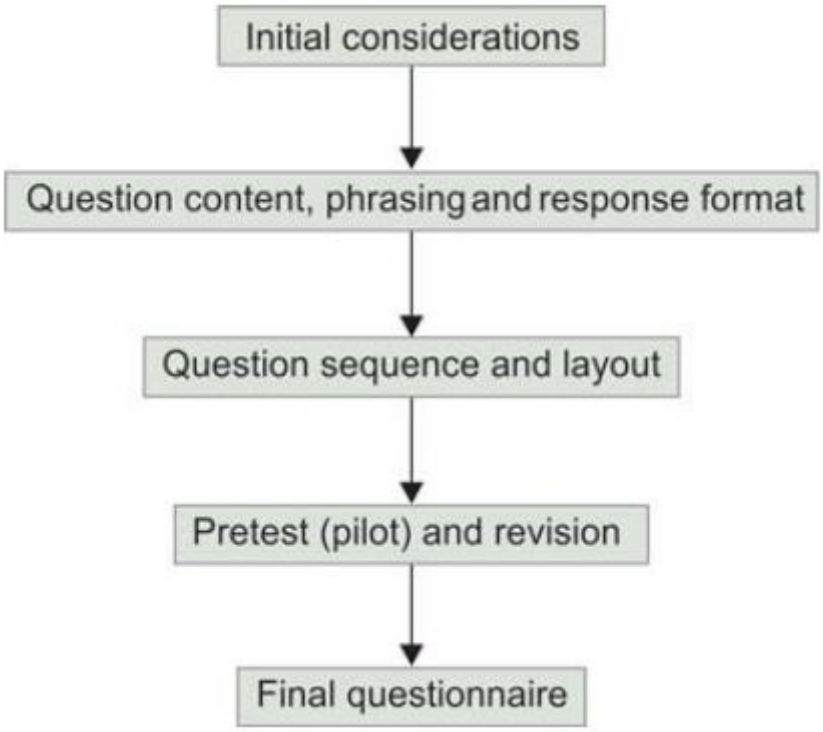


Figure 3.1 Stages of planning a questionnaire (Roopa et al.,2012)

3.4 Google Form Survey

A Google Forms survey can be created easily via online platform.

With Google Forms, we can create and analyse surveys anytime and anywhere, by using our own mobile or web browser. The results came in instantly. Thereafter, we can summarize survey results easily with charts and graphs.

3.5 Sampling Method

The developers, property owners, contractors, project manager and site team at Perak, Malaysia will be the targeted respondents for quantitative survey. Considering that the respondent's workload is usually substantial, the questionnaires will be designed to be completed at the respondents' comfort in the soonest time possible.

The questionnaire consisted of 4 sections – General information of the respondent, challenges faced by clients to integrate solar power into their new projects, client's priority while implementing new projects and recommendations to integrate solar panel into all the new projects, as structures below:

Section A : General information of the respondent

Section B : Challenges faced by clients to integrate solar power into their new projects

Section C: Client's priority while implementing new projects

Section D : Recommendations to integrate solar panel into all the new projects

The questionnaire simply indicates the respondents' level of agreement, which range from 1 to 5 on the ordinances' scale - (1) Strongly Agree (2) Agree (3) Neutral (4) Disagree (5) Strongly Disagree

The distribution of questionnaires will take place in Perak, Malaysia. The reason for selecting Perak is considering it as one of the developed state, but with low level of implementation of Solar Photovoltaic in projects. With the study result, I hope to have better understanding of the interest and wishes of clients and community in Perak , and the data can be a reference to enhance the Solar PV implementation for Perak state moving forward .

3.6 Summary

In this Chapter, it was concluded to use the Google Form's questionnaires as Quantitative Method to make the study investigation. Area focus is identified in Perak with developers, owners as well as project team are the targeted respondents. To make it easier for respondents, the level of agreement from respondents will be on 5 ordinances' scale ranging from "Strongly Agree" to "Strongly Disagree".

CHAPTER 4

RESULTS AND FINDINGS

4.1 Introduction

This chapter shows the results of collected data and describes conclusions. We researched the data collected through an online survey to determine challenges, priority and recommendation for rooftop solar installation. All data for targeted respondents such as clients, consultants, developers, contractors, sub-contractors etc. are collected through online surveys. Subsequently, the data were analysed using SPSS statistics and Excel spreadsheet.

4.2 Question Structure

The survey sample can be found in Appendix. In general, questionnaires are divided into four sections, as described in Chapter 3:

Section A : General information of the respondent

Section B : Challenges faced by clients to integrate solar power into their new projects

Section C: Client's priority while implementing new projects

Section D : Recommendations to integrate solar panel into all the new projects

4.3 Distribution and Return of Questionnaire

This study addresses Implementation of Solar Photovoltaic Technology in The Construction Industry, in Perak State of Malaysia. Surveys were conducted through an online survey. Online survey were sent to prospective respondents and the responses were received beetween 14 Feb 2023 till 02 March 2023. Only 50 sets of completed questionnaires were received.

Table 4.1: Summary of data collected

Survey Questionnaire	**Duration of Survey received**	**Number of Survey Received**
Survey done using Google form	Between 14 Feb till 02 Mar	50 copies

4.3.1 Respondent's Background

There was a total of 50 people that filled out the online survey form. They all came from various backgrounds in terms of age, profession, academic qualification, and job experiences.

4.3.1.1 Age

From the total respondents, there were 14% between age 20 -30, 30% of respondents between age 30-40, 50% between age 40-50 and lastly 6% above 50 years old. Hence, majority of the respondents are between 40 – 50 years old. Detail breakdown as per Figure 4.1.

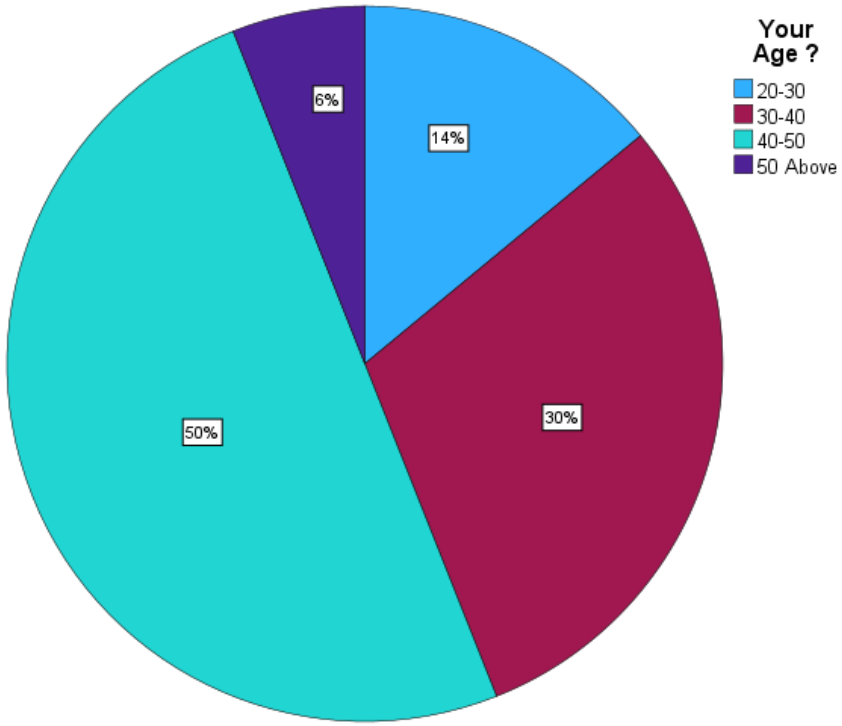


Figure 4.1 Age

4.3.1.2 Profession

From the total respondents, 22% were client or property Owner,2% developer and 28% were engineers. The rest of respondents from various background, with the detail breakdown as per Figure 4.2 below.

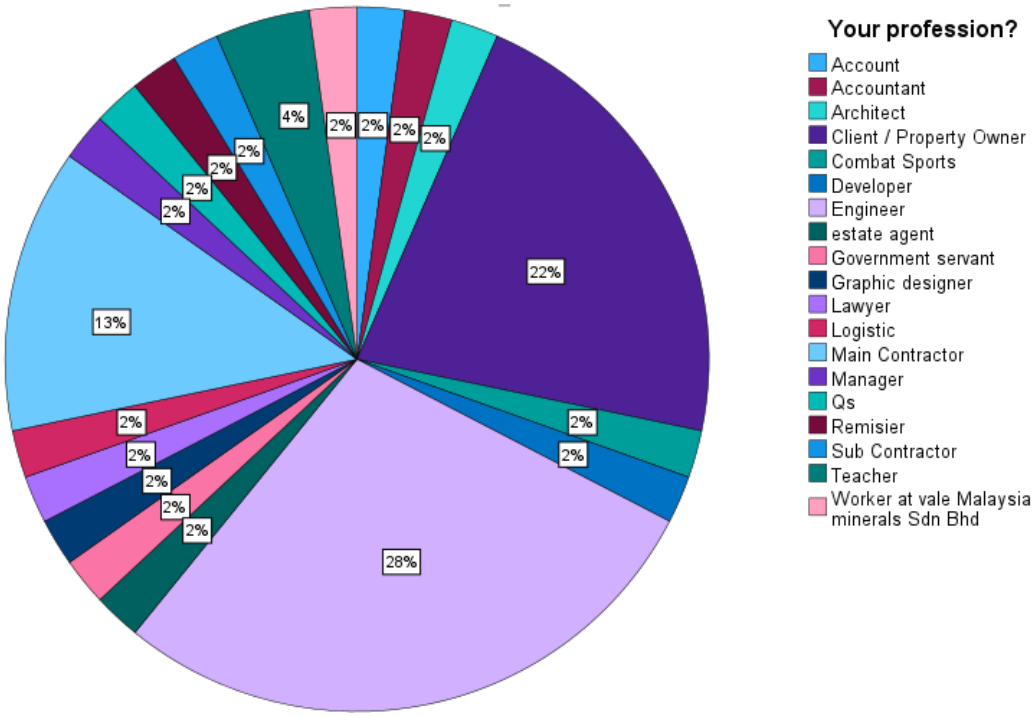


Figure 4.2 Profession

4.3.1.3 Highest academic qualification

From the total respondents, 49% were degree holders, 16% were Foundation/Diploma and Master holders respectively. The rest of respondents are from various education background , with the detail breakdown as per Figure 4.3 below.

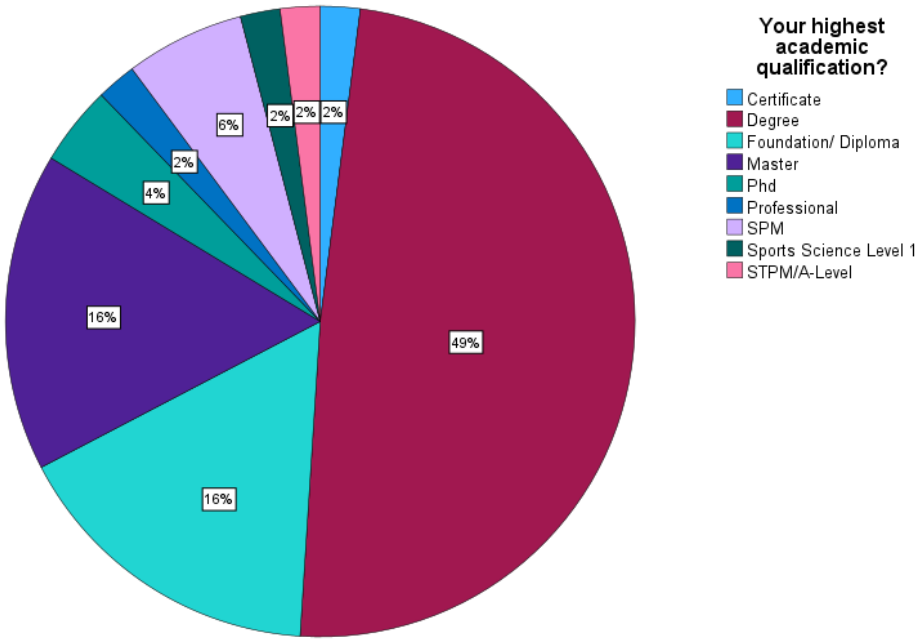


Figure 4.3. Highest academic qualifications

4.3.1.4 Working experiences

From the total respondents, the working experiences were 14% between 11-15 years, 6% between 1-5 years, 22% between 16 – 20 years, 38% more than 21 years, 16% between 6 – 10 years, and 4% below one year. The detail breakdown as per Figure 4.4 below.

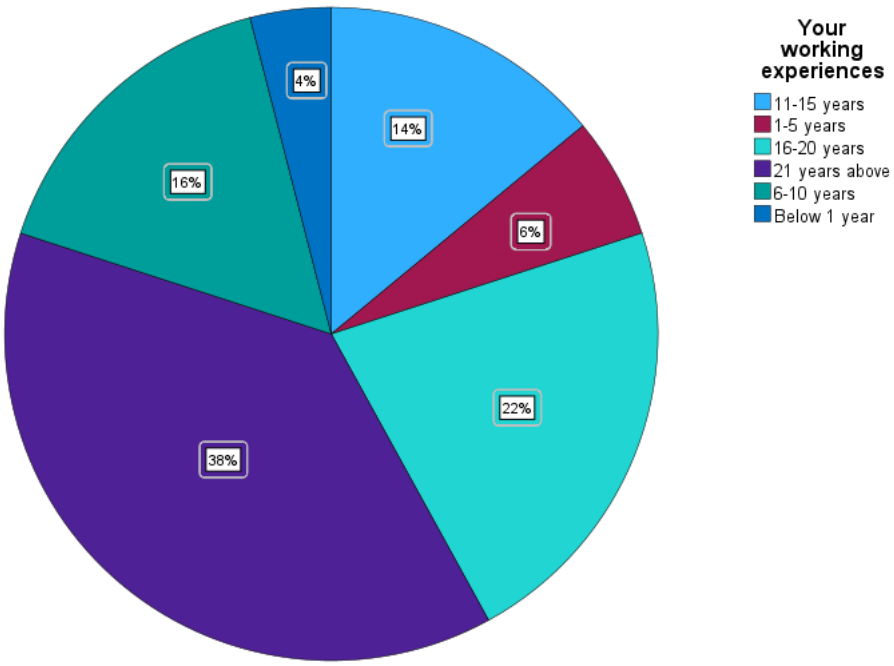


Figure 4.4 working experiences

4.3.1.5 Know that solar energy is a sustainable energy

From the total respondents, 88% know that solar energy is a sustainable energy, 10% maybe and lastly 2% don't know. The detail breakdown as per Figure 4.5 below.

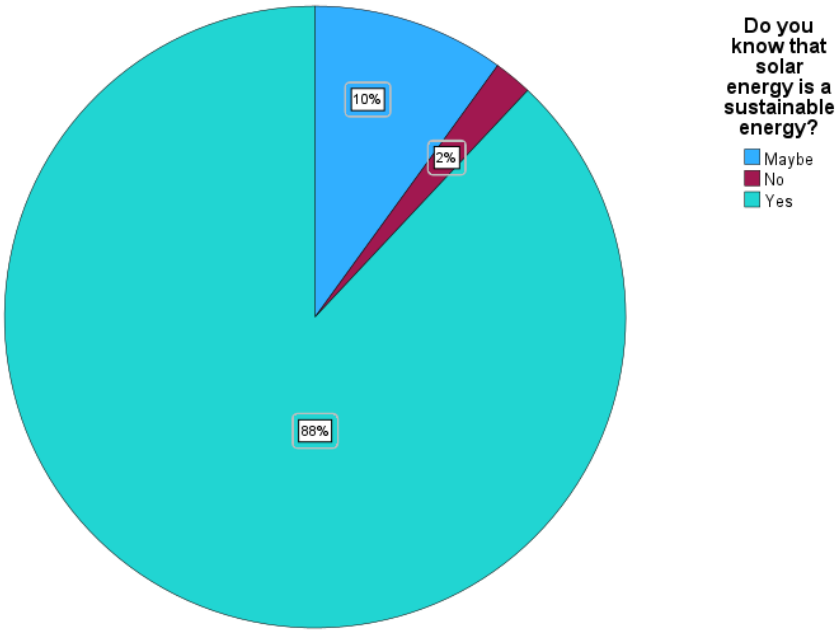


Figure 4.5 Know solar energy is a sustainable energy

4.3.1.6 Heard about rooftop solar power

From the total respondents, 96% heard about rooftop solar power, and 4% maybe. The detail breakdown as per Figure 4.6 below.

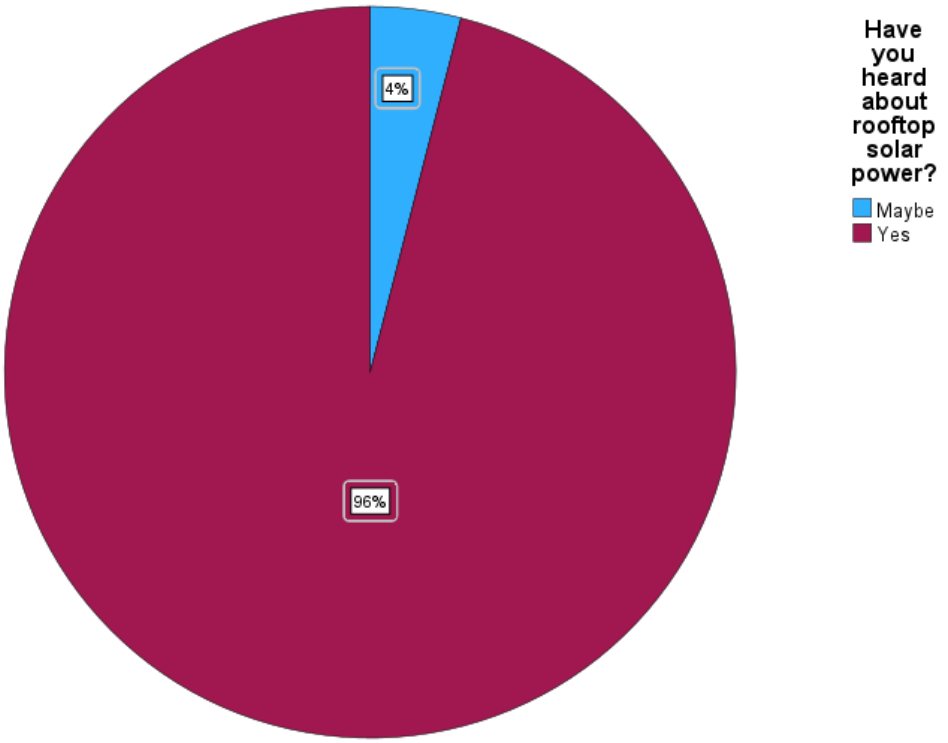


Figure 4.6 Heard about rooftop solar power

4.3.2 Analysis Of Descriptive, Reliability And Validity

In this section, I will be using SPSS software for analysis of descriptive , reliability and validity of the survey results.

4.3.2.1 Descriptive Statistics

In the survey form, the Likert scale of measurement was being used as Strongly Agree =1, Agree =2, Neutral = 3, Disagree = 4, Strongly Disagree =5.

In Descriptive Statistic of SPSS, we obtained the information of “Mean” and “Standard Deviation”. The lowest “Mean” value is interpreted as the most agreed condition.

4.3.2.2 Reliability

A characteristic of measurement concerned with accuracy, precision and consistency. Using SPSS software to find Realibility Statistics - Cronbach’s Alpha.

If Cronbach’s Alpha > 0.6 , the instrument is reliable .

If Cronbach’s Alpha < 0.6 , not reliable

4.3.2.3 Validity

This is to measure if the survey result and questions are valid. We can use SPSS software to do the correlation analysis - Pearson Correlation. Then refer the significance value (Sig.) as follow:

• If Sig. < 0,05 it is valid

• If Sig. > 0,05 it is not valid

4.3.3 Challenges faced by clients to integrate solar power into their new projects

In this section, we will analyse the feedback from the respondents , on their perception about the challenges faced by clients to integrate solar power into their new projects. Based on the analysis done with SPSS software, the following were tested:

4.3.3.1 Descriptive Statistics

Table 4.2: Descriptive Statistics for "Challenges faced by clients to integrate solar power into their new projects"

	N	Minimum	Maximum	Mean	Std. Deviation
Lack of motivation and incentives to attract the clients to install rooftop solar PV panels on their properties	50	1.00	4.00	1.7800	.78999
Installation rooftop solar PV on the residential houses usually requires huge capital investment and maintenance cost	49	1.00	4.00	1.9796	.85366
Under the Net Energy Metering (NEM) policy, limit on solar PV export capacity hinder full utilization of resource potential for rooftop solar	50	1.00	4.00	2.0400	.75485

Limited awareness of the public towards the appreciation of the clean solar energy resource such as solar photovoltaic technology	49	1.00	4.00	2.1224	.78083
Clients do not need to consider Solar PV panel installation in their projects , as they don't have obligation to commit to sustainability	50	1.00	4.00	2.2000	.83299
Difficulty in getting financing and bank loan approval to install rooftop solar system in their units	50	1.00	4.00	2.3400	.91718
Project team members including consultants, project managers, facility managers and building operators, are lacking technical understanding and knowledge to implement solar PV in the projects	50	1.00	4.00	2.4400	.90711
Availability of cheaper alternative energy, in which Malaysia provides enormous subsidy that result in a cheap electric price from the national grid, hence making solar PV unattractive to the public	50	1.00	4.00	2.6000	.90351
Valid N (listwise)	48				

4.3.3.2 Reliability

Table 4.3: Reliability Statistics for "Challenges faced by clients to integrate solar power into their new projects"

Cronbach's Alpha	N of Items
.730	8

Table 4.4: Item – Total Statistics for "Challenges faced by clients to integrate solar power into their new projects"

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Difficulty in getting financing and bank loan approval to install rooftop solar system in their units	15.0208	12.021	.468	.693
Under the Net Energy Metering (NEM) policy, limit on solar PV export capacity hinder full utilization of resource potential for rooftop solar	15.3125	12.773	.469	.695
Availability of cheaper alternative energy, in which Malaysia provides enormous subsidy that result in a cheap electric price from the national grid, hence making solar PV unattractive to the public	14.7708	13.159	.295	.729

Limited awareness of the public towards the appreciation of the clean solar energy resource such as solar photovoltaic technology	15.2083	12.509	.494	.689
Installation rooftop solar PV on the residential houses usually requires huge capital investment and maintenance cost	15.3750	12.495	.445	.698
Lack of motivation and incentives to attract the clients to install rooftop solar PV panels on their properties	15.5833	12.461	.506	.687
Clients do not need to consider Solar PV panel installation in their projects , as they don't have obligation to commit to sustainability	15.1667	13.163	.335	.720
Project team members including consultants, project managers, facility managers and building operators, are lacking technical understanding and knowledge to implement solar PV in the projects	14.8958	12.478	.394	.709

4.3.3.3 Validity

Table 4.5: Correlations for "Challenges faced by clients to integrate solar power into their new projects"

Correlations

		Difficulty in getting financing and bank loan approval to install rooftop solar system in their units	Under the Net Energy Metering (NEM) policy, limit on solar PV export capacity hinder full utilization of resource potential for rooftop solar	Availability of cheaper alternative energy, in which Malaysia provides enormous subsidy that result in a cheap electric price from the national grid, hence making solar PV unattractive to the public	Limited awareness of the public towards the appreciation of the clean solar energy resource such as solar photovoltaic technology	Installation rooftop solar PV on the residential houses usually requires huge capital investment and maintenance cost	Lack of motivation and incentives to attract the clients to install rooftop solar PV panels on their properties	Clients do not need to consider Solar PV panel installation in their projects , as they don't have obligation to commit to sustainability	Project team members including consultants, project managers, facility managers and building operators, are lacking technical understanding and knowledge to implement solar PV in the projects	Total_1
Difficulty in getting financing and bank loan approval to install rooftop solar system in their units	Pearson Correlation	1	.452**	.217	.320*	.406**	.303*	.256	.111	.643**
	Sig. (2-tailed)		<.001	.131	.025	.004	.033	.072	.443	<.001
	N	50	50	50	49	49	50	50	50	50
Under the Net Energy Metering (NEM) policy, limit on solar PV export capacity hinder full utilization of resource potential for rooftop solar	Pearson Correlation	.452**	1	.323*	.102	.257	.289*	.344*	.242	.619**
	Sig. (2-tailed)	<.001		.022	.484	.074	.042	.014	.090	<.001
	N	50	50	50	49	49	50	50	50	50
Availability of cheaper alternative energy, in which Malaysia provides enormous subsidy that result in a cheap electric price from the national grid, hence making solar PV unattractive to the public	Pearson Correlation	.217	.323*	1	.306*	.016	.103	.054	.319*	.490**
	Sig. (2-tailed)	.131	.022		.032	.915	.477	.708	.024	<.001
	N	50	50	50	49	49	50	50	50	50
Limited awareness of the public towards the appreciation of the clean solar energy resource such as solar photovoltaic technology	Pearson Correlation	.320*	.102	.306*	1	.389**	.325*	.125	.422**	.635**
	Sig. (2-tailed)	.025	.484	.032		.006	.023	.393	.003	<.001
	N	49	49	49	49	48	49	49	49	49
Installation rooftop solar PV on the residential houses usually requires huge capital investment and maintenance cost	Pearson Correlation	.406**	.257	.016	.389**	1	.605**	.210	.119	.616**
	Sig. (2-tailed)	.004	.074	.915	.006		<.001	.147	.416	<.001
	N	49	49	49	48	49	49	49	49	49
Lack of motivation and incentives to attract the clients to install rooftop solar PV panels on their properties	Pearson Correlation	.303*	.289*	.103	.325*	.605**	1	.347*	.252	.653**
	Sig. (2-tailed)	.033	.042	.477	.023	<.001		.013	.078	<.001
	N	50	50	50	49	49	50	50	50	50
Clients do not need to consider Solar PV panel installation in their projects , as they don't have obligation to commit to sustainability	Pearson Correlation	.256	.344*	.054	.125	.210	.347*	1	.232	.521**
	Sig. (2-tailed)	.072	.014	.708	.393	.147	.013		.105	<.001
	N	50	50	50	49	49	50	50	50	50
Project team members including consultants, project managers, facility managers and building operators, are lacking technical understanding and knowledge to implement solar PV in the projects	Pearson Correlation	.111	.242	.319*	.422**	.119	.252	.232	1	.581**
	Sig. (2-tailed)	.443	.090	.024	.003	.416	.078	.105		<.001
	N	50	50	50	49	49	50	50	50	50
Total_1	Pearson Correlation	.643**	.619**	.490**	.635**	.616**	.653**	.521**	.581**	1
	Sig. (2-tailed)	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	
	N	50	50	50	49	49	50	50	50	50

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

4.3.3.4 Summary for Section B-“ Challenges faced by clients to integrate solar power into their new projects”

From the descriptive analysis, I pick the top three with the lowest mean as the “most agreed” challenges faced by clients, as follow:

(i) Lack of motivation and incentives to attract the clients to install rooftop solar PV panels on their properties

(ii) Installation rooftop solar PV on the residential houses usually requires huge capital investment and maintenance cost

(iii) Under the Net Energy Metering (NEM) policy, limit on solar PV export capacity hinder full utilization of resource potential for rooftop solar

For Reliability test, the Cronbach's Alpha is 0.73, which is more than 0.6. This meant that the responses are reliable.

For validity test, the Sig (2 tailed) value is less than 0.05, meant that the responses are valid.

4.3.4 Client’s priority while implementing new projects

In this section, we will analyse the feedback of the respondents , on their perception with regards to the Client’s priority while implementing new projects

Based on the analysis done with SPSS software, the following were tested:

4.3.4.1 Descriptive

Table 4.6 Descriptive Statistics For “Client’s priority while implementing new projects”

	N	Minimum	Maximum	Mean	Std. Deviation
The project cost is to be priotized, as compared with the long-term operational cost resulted from rooftop solar system	50	1.00	4.00	1.8800	.65900
Quality of construction project is to be prioritized as compared with the implementation of rooftop solar system	50	1.00	4.00	2.0000	.80812

Health and safe working environment for the employees to be prioritized as compared with the implementation of rooftop solar system	50	1.00	4.00	2.0600	.81841
Priorities are for implementation of green environment or space such as lush greenery , beautifully landscaped lakes or parks complete with leisure amenities, as compared with the implementation of rooftop solar system.	50	1.00	4.00	2.1000	.78895
Human resource development such as continuing education, training and development are to be prioritized as compared with the implementation of rooftop solar system	50	1.00	4.00	2.1800	.80026
Corporate Social Responsibility (CSR) Practise is to be prioritized as compared with the implementation of rooftop solar system"	50	1.00	4.00	2.2400	.84660
Project completion time is more important as compared with the implementation of rooftop solar system, which usually consume more construction time as compared with conventional way	50	1.00	4.00	2.3200	.86756
Valid N (listwise)	50				

4.3.4.2 Reliability

Table 4.7 Reliability Statistics For “Client’s priority while implementing new projects”

Cronbach's Alpha	N of Items
.864	7

Table 4.8 Item - Total Statistics For “Client’s priority while implementing new projects”

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
The project cost is to be priotized, as compared with the long-term operational cost resulted from rooftop solar system	12.9000	14.010	.582	.853
Priorities are for implementation of green environment or space such as lush greenery , beautifully landscaped lakes or parks complete with leisure amenities, as compared with the implementation of rooftop solar system.	12.6800	13.324	.585	.852
Human resource development such as continuing education, training and development are to be prioritized as compared with the implementation of rooftop solar system	12.6000	13.224	.593	.851
Corporate Social Responsibility (CSR) Practise is to be prioritized as compared with the implementation of rooftop solar system"	12.5400	12.376	.709	.834

Project completion time is more important as compared with the implementation of rooftop solar system, which usually consume more construction time as compared with conventional way	12.4600	12.213	.718	.833
Quality of construction project is to be prioritized as compared with the implementation of rooftop solar system	12.7800	12.991	.631	.846
Health and safe working environment for the employees to be prioritized as compared with the implementation of rooftop solar system	12.7200	12.940	.630	.846

4.3.4.3 Validity

Table 4.9 Correlations For "Client's priority while implementing new projects"

Correlations

		The project cost is to be priotized, as compared with the long-term operational cost resulted from rooftop solar system	Priorities are for implementation of green environment or space such as lush greenery , beautifully landscaped lakes or parks complete with leisure amenities, as compared with the implementation of rooftop solar system.	Human resource development such as continuing education, training and development are to be prioritized as compared with the implementation of rooftop solar system	Corporate Social Responsibility (CSR) Practise is to be prioritized as compared with the implementation of rooftop solar system"	Project completion time is more important as compared with the implementation of rooftop solar system, which usually consume more construction time as compared with conventional way	Quality of construction project is to be prioritized as compared with the implementation of rooftop solar system	Health and safe working environment for the employees to be prioritized as compared with the implementation of rooftop solar system	Total_2
The project cost is to be priotized, as compared with the long-term operational cost resulted from rooftop solar system	Pearson Correlation	1	.534**	.313*	.345*	.461**	.575**	.430**	.682**
	Sig. (2-tailed)		<.001	.027	.014	<.001	<.001	.002	<.001
	N	50	50	50	50	50	50	50	50
Priorities are for implementation of green environment or space such as lush greenery , beautifully landscaped lakes or parks complete with leisure amenities, as compared with the implementation of rooftop solar system.	Pearson Correlation	.534**	1	.391**	.483**	.698**	.256	.307*	.703**
	Sig. (2-tailed)	<.001		.005	<.001	<.001	.073	.030	<.001
	N	50	50	50	50	50	50	50	50
Human resource development such as continuing education, training and development are to be prioritized as compared with the implementation of rooftop solar system	Pearson Correlation	.313*	.391**	1	.507**	.562**	.410**	.482**	.711**
	Sig. (2-tailed)	.027	.005		<.001	<.001	.003	<.001	<.001
	N	50	50	50	50	50	50	50	50
Corporate Social Responsibility (CSR) Practise is to be prioritized as compared with the implementation of rooftop solar system"	Pearson Correlation	.345*	.483**	.507**	1	.588**	.597**	.597**	.803**
	Sig. (2-tailed)	.014	<.001	<.001		<.001	<.001	<.001	<.001
	N	50	50	50	50	50	50	50	50
Project completion time is more important as compared with the implementation of rooftop solar system, which usually consume more construction time as compared with conventional way	Pearson Correlation	.461**	.698**	.562**	.588**	1	.437**	.432**	.811**
	Sig. (2-tailed)	<.001	<.001	<.001	<.001		.002	.002	<.001
	N	50	50	50	50	50	50	50	50
Quality of construction project is to be prioritized as compared with the implementation of rooftop solar system	Pearson Correlation	.575**	.256	.410**	.597**	.437**	1	.586**	.740**
	Sig. (2-tailed)	<.001	.073	.003	<.001	.002		<.001	<.001
	N	50	50	50	50	50	50	50	50
Health and safe working environment for the employees to be prioritized as compared with the implementation of rooftop solar system	Pearson Correlation	.430**	.307*	.482**	.597**	.432**	.586**	1	.741**
	Sig. (2-tailed)	.002	.030	<.001	<.001	.002	<.001		<.001
	N	50	50	50	50	50	50	50	50
Total_2	Pearson Correlation	.682**	.703**	.711**	.803**	.811**	.740**	.741**	1
	Sig. (2-tailed)	<.001	<.001	<.001	<.001	<.001	<.001	<.001	
	N	50	50	50	50	50	50	50	50

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

4.3.4.4 Summary for Section C – "Client's priority while implementing new projects"

From the descriptive analysis, I pick the top three with the lowest mean as the "most agreed" priority focused by clients, as follow:

i) The project cost is to be prioritized, as compared with the long-term operational cost resulted from rooftop solar system

ii) Quality of construction project is to be prioritized as compared with the implementation of rooftop solar system

iii) Health and safe working environment for the employees to be prioritized as compared with the implementation of rooftop solar system

For Reliability test, the Cronbach's Alpha is 0.864, which is more than 0.6. This meant that the responses are reliable.

For validity test, the Sig (2 tailed) value is less than 0.05, meant that the responses are valid.

4.3.5 : Recommendations to integrate rooftop solar panel into all the new projects

In this section, we will discuss the feedback of the respondents, with regards to the recommendations to integrate rooftop solar panel into all the new projects. Based on the analysis done with SPSS software, the following were tested:

4.3.5.1 Descriptive

Table 4.10 Description Statistics For "Recommendations to integrate rooftop solar panel into all the new projects"

	N	Minimum	Maximum	Mean	Std. Deviation
Attractive loans and reduced taxes and customs duties on equipment related to solar energy technology	50	1.00	3.00	1.7600	.71600
Financial support from government to encourage small and medium scale industries to use renewable energy such as solar PV	50	1.00	3.00	1.7800	.70826

Policymakers and solar PV practitioners could implement several policies to improve solar PV adoption	50	1.00	4.00	1.8400	.79179
Cooperation between government and non-governmental organizations (NGOs) to enhance present level of public awareness via dissemination of information on solar energy benefits,	50	1.00	3.00	1.9000	.70711
Enhance clients' knowledge in rooftop solar PV system could encourage solar PV adoption	50	1.00	4.00	1.9200	.63374
Improving developer's knowledge and acceptance of sustainable practice such as rooftop solar PV system"	50	1.00	4.00	1.9600	.69869
Influence prospective buyers to adopt for sustainable houses such as installation of rooftop solar PV system, will push the housing developers to install solar PV for their houses	50	1.00	4.00	2.0400	.69869
Reduce fossil-fuel subsidy benefits and transfer the savings for development of solar technology and solar energy markets, and provide attractive pricing for users and suppliers	50	1.00	4.00	2.1000	.86307

Sustainable Energy Development Authority Act to compel the installation of rooftop solar PV system for new construction projects	50	1.00	4.00	2.1800	.80026
Valid N (listwise)	50				

4.3.5.2 Reliability

Table 4.11 Reliability Statistics For "Recommendations to integrate rooftop solar panel into all the new projects"

Cronbach's Alpha	N of Items
.898	9

Table 4.12 Item-Total Statistics For "Recommendations to integrate rooftop solar panel into all the new projects"

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Policymakers and solar PV practitioners could implement several policies to improve solar PV adoption	15.6400	19.460	.608	.892
Enhance clients' knowledge in rooftop solar PV system could encourage solar PV adoption	15.5600	19.762	.741	.882
Financial support from government to encourage small and medium scale industries to use renewable energy such as solar PV	15.7000	19.969	.611	.891

Sustainable Energy Development Authority Act to compel the installation of rooftop solar PV system for new construction projects	15.3000	19.235	.636	.890
Attractive loans and reduced taxes and customs duties on equipment related to solar energy technology	15.7200	19.430	.696	.885
Cooperation between government and non-governmental organizations (NGOs) to enhance present level of public awareness via dissemination of information on solar energy benefits,	15.5800	19.187	.750	.881
Reduce fossil-fuel subsidy benefits and transfer the savings for development of solar technology and solar energy markets, and provide attractive pricing for users and suppliers	15.3800	18.975	.614	.892
Improving developer’s knowledge and acceptance of sustainable practice such as rooftop solar PV system"	15.5200	19.479	.708	.884
Influence prospective buyers to adopt for sustainable houses such as installation of rooftop solar PV system, will push the housing developers to install solar PV for their houses	15.4400	19.762	.658	.887

4.3.5.3 Validity

Table 4.13 Correlations For "Recommendations to integrate rooftop solar panel into all the new projects"

Correlations

		Policymakers and solar PV practitioners could implement several policies to improve solar PV adoption	Enhance clients' knowledge in rooftop solar PV system could encourage solar PV adoption	Financial support from government to encourage small and medium scale industries to use renewable energy such as solar PV	Sustainable Energy Development Authority Act to compel the installation of rooftop solar PV system for new construction projects	Attractive loans and reduced taxes and customs duties on equipment related to solar energy technology	Cooperation between government and non-governmental organizations (NGOs) to enhance present level of public awareness via dissemination of information on solar energy benefits,	Reduce fossil-fuel subsidy benefits and transfer the savings for development of solar technology and solar energy markets, and provide attractive pricing for users and suppliers	Improving developer's knowledge and acceptance of sustainable practice such as rooftop solar PV system"	Influence prospective buyers to adopt for sustainable houses such as installation of rooftop solar PV system, will push the housing developers to install solar PV for their houses	Total_3
Policymakers and solar PV practitioners could implement several policies to improve solar PV adoption	Pearson Correlation	1	.665**	.373**	.336*	.615**	.591**	.352*	.468**	.344*	.705**
	Sig. (2-tailed)		<.001	.008	.017	<.001	<.001	.012	<.001	.014	<.001
	N	50	50	50	50	50	50	50	50	50	50
Enhance clients' knowledge in rooftop solar PV system could encourage solar PV adoption	Pearson Correlation	.665**	1	.460**	.431**	.452**	.619**	.500**	.776**	.514**	.796**
	Sig. (2-tailed)	<.001		<.001	.002	<.001	<.001	<.001	<.001	<.001	<.001
	N	50	50	50	50	50	50	50	50	50	50
Financial support from government to encourage small and medium scale industries to use renewable energy such as solar PV	Pearson Correlation	.373**	.460**	1	.359*	.578**	.526**	.371**	.477**	.596**	.697**
	Sig. (2-tailed)	.008	<.001		.010	<.001	<.001	.008	<.001	<.001	<.001
	N	50	50	50	50	50	50	50	50	50	50
Sustainable Energy Development Authority Act to compel the installation of rooftop solar PV system for new construction projects	Pearson Correlation	.336*	.431**	.359*	1	.469**	.501**	.742**	.451**	.498**	.727**
	Sig. (2-tailed)	.017	.002	.010		<.001	<.001	<.001	.001	<.001	<.001
	N	50	50	50	50	50	50	50	50	50	50
Attractive loans and reduced taxes and customs duties on equipment related to solar energy technology	Pearson Correlation	.615**	.452**	.578**	.469**	1	.637**	.403**	.429**	.591**	.767**
	Sig. (2-tailed)	<.001	<.001	<.001	<.001		<.001	.004	.002	<.001	<.001
	N	50	50	50	50	50	50	50	50	50	50
Cooperation between government and non-governmental organizations (NGOs) to enhance present level of public awareness via dissemination of information on solar energy benefits,	Pearson Correlation	.591**	.619**	.526**	.501**	.637**	1	.451**	.611**	.545**	.810**
	Sig. (2-tailed)	<.001	<.001	<.001	<.001	<.001		<.001	<.001	<.001	<.001
	N	50	50	50	50	50	50	50	50	50	50
Reduce fossil-fuel subsidy benefits and transfer the savings for development of solar technology and solar energy markets, and provide attractive pricing for users and suppliers	Pearson Correlation	.352*	.500**	.371**	.742**	.403**	.451**	1	.514**	.366**	.717**
	Sig. (2-tailed)	.012	<.001	.008	<.001	.004	<.001		<.001	.009	<.001
	N	50	50	50	50	50	50	50	50	50	50
Improving developer's knowledge and acceptance of sustainable practice such as rooftop solar PV system"	Pearson Correlation	.468**	.776**	.477**	.451**	.429**	.611**	.514**	1	.547**	.775**
	Sig. (2-tailed)	<.001	<.001	<.001	.001	.002	<.001	<.001		<.001	<.001
	N	50	50	50	50	50	50	50	50	50	50
Influence prospective buyers to adopt for sustainable houses such as installation of rooftop solar PV system, will push the housing developers to install solar PV for their houses	Pearson Correlation	.344*	.514**	.596**	.498**	.591**	.545**	.366**	.547**	1	.734**
	Sig. (2-tailed)	.014	<.001	<.001	<.001	<.001	<.001	.009	<.001		<.001
	N	50	50	50	50	50	50	50	50	50	50
Total_3	Pearson Correlation	.705**	.796**	.697**	.727**	.767**	.810**	.717**	.775**	.734**	1
	Sig. (2-tailed)	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	
	N	50	50	50	50	50	50	50	50	50	50

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

4.3.5.4 Summary for Section D-“ Recommendations to integrate rooftop solar panel into all the new projects”

From the descriptive analysis, I pick the top three with the lowest mean as the “most agreed” recommendations by clients, as follow:

iv) Attractive loans and reduced taxes and customs duties

v) Financial support from government

vi) Develop policies to enhance solar PV adoption

For Reliability test, the Cronbach's Alpha is 0.898, which is more than 0.6. This meant that the responses are reliable.

For validity test, the Sig (2 tailed) value is less than 0.05, meant that the responses are valid.

CHAPTER 5

RECOMMENDATIONS AND CONCLUSION

5.1 Introduction

This chapter will bring the research to a conclusion. In addition, I also discuss the research limitation and future recommendations in this chapter.

5.2 Conclusion

The purpose of this survey is to find out about the challenges which caused the low implementation of rooftop solar in Perak, client's priority while implementing new project and recommendation to integrate rooftop solar into new projects.

Base on the survey feedback, the top three most agreed challenges facing the implementation of rooftop solar are the lacking of motivation and incentives to attract the clients to install rooftop solar PV panels on their properties. Secondly, the installation rooftop solar PV on the residential houses usually requires huge capital investment and maintenance cost is another major challenge. Additionally, under the Net Energy Metering (NEM) policy, limit on solar PV export capacity is another main challenge.

On the client's priority when implementing new projects, the most agreed priorities imposed by client are project cost , quality of construction project as well as healthy and safe working environment.

To integrate rooftop solar panel into all the new projects, the top three most agreed recommendations are attractive loans and reduced taxes and customs duties, financial support from government as well as to develop policies to enhance solar PV adoption.

5.3 Limitation

Similar as per other on line surveys, the responds from the google form survey was not encouraging. The online surveys were share mainly via Whatsapp to various background of people and responses received betwen the duration of 14 Feb 2023 till 02 Mar 2023, in which the responds were slow and low participation.

Additionally, the online survey were also shared with some developers and construction companies in Perak, but the responses were not encouraging.

Some attempts were tried in order to encourage the respondents to reply , such as approaching personally and repeated phone calling, and these actions seemed to increase the responses received.

5.3.1 To improve the respond for similar survey in future, here are some reflections and proposals:

1) Tax incentive for developer who demonstrated commitment to support academic research.
2) The children of respondents carried certain evaluation marks, when University evaluate their application for further education.
3) Provide Monetary incentives to increase responses, such as cash voucher for hypermarkets shopping use etc.
4) Provide free gift for certain respondents, as example, for every 10^{th}, 20^{th} respondents and so on , and there will be special gift for them
5) Provide lucky draw for respondents.

5.4 Recommendations

For future thesis work, here are 3 recommendations areas to be focused on :

i) Incentives

Discuss and find out the types of incentives which can attract clients to install rooftop solar on their properties. I believe the information obtained can be served

as reference for policy makers and government, for their consideration to boost the participation of general public to participate in this sustainable practise

ii) Awareness

Discuss and find out the numerous ways to increase awareness of public and developers , in order to adopt solar PV on their properties

iii) Enforcement

Discuss the policy, building codes or laws which could compel the property owner to adopt solar PV installation on their properties.

With the above, I strongly believe the adoption of solar PV technology will be increased substantially, and our country is on the right track to achieve net zero carbon in combating the issues of climate change and bring carbon neutrality.

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APPENDIX

FACULTY OF ENGINEERING & GREEN TECHNOLOGY
ACADEMIC YEAR: 2023
MGBE29910 PROJECT

"APPLICATION OF SOLAR PHOTOVOLTAIC TECHNOLOGY IN THE CONSTRUCTION INDUSTRY : CASE STUDY IN PERAK STATE"

You are invited to take part in this research carried out by a postgraduate student from **Universiti Tunku Abdul Rahman (UTAR).** Your participation is voluntary and you are allowed to quit from this survey at any time without getting any penalty. Thank you for sparing your precious time to go through this information sheet.

Purpose of Study

This questionnaire is prepared for academic purposes under subject MGBE 29910 Final Year Project. This questionnaire contained four (4) sections; **Section A, Section B, Section C and Section D.** Participants are required to answer **ALL** the sections. This questionnaire will take approximately 10 to 15 minutes to complete.

Confidentiality

Your responses will only be used as academic purposes

Section A: Respondent's Background

In this section, the following respondent's background questions are listed below only to help me to understand your responses as regards to other questions.

Please tick (√) your answer in the box provided or fill in the blank (reason) for each of the following items.

1. Your Age?
   [ ] 20-30 [ ] 40-50
   [ ] 30-40 [ ] 50 Above

2. Your Profession?
   [ ] Client [ ] Architect [ ] Sub-contractor
   [ ] Developer [ ] Contractor [ ] Quantity Surveyor
   [ ] M&E Engineer [ ] Civil Engineer [ ] Project Manager
   [ ] Others, Please Specify:_____

3. Your highest academic qualification?
   [ ] SPM [ ] Master [ ] PHD
   [ ] STPM/A-Level/ [ ] Degree
   [ ] Foundation/ Diploma [ ] Others, Please Specify:_____

4. Your working experience?
   [ ] Below 1 years [ ] 6-10 years [ ] 16-20 years
   [ ] 1-5 years [ ] 11-15 years [ ] 21 years above

5. Do you know that solar energy is a sustainable energy?
   [ ] Yes
   [ ] No
   [ ] Maybe

6.Have you heard about rooftop solar power?

[ ] Yes

[ ] No

[ ] Maybe

7.Your email address?

_____

The following sets of statements related to ***APPLICATION OF SOLAR PHOTOVOLTAIC TECHNOLOGY IN THE CONSTRUCTION INDUSTRY : CASE STUDY IN PERAK STATE.*** The Likert scale of measurement is being used. According to your experience , please read and answer according to what best reflect your opinion.

Strongly Agree (SA)	Agree (A)	Neutral (N)	Disagree (D)	Strongly Disagree (SD)
1	2	3	4	5

Section B: Challenges faced by clients to integrate rooftop solar power into their new projects.

No	Dimension	SA	A	N	D	SD
1.	Difficulty in getting financing and bank loan approval to install rooftop solar system in their units	1	2	3	4	5
2.	Under the Net Energy Metering (NEM) policy, limit on solar PV export capacity hinder full utilization of resource potential for rooftop solar	1	2	3	4	5
3.	Availability of cheaper alternative energy, in which Malaysia provides enormous subsidy that result in a cheap electric price from the national grid, hence making solar PV unattractive to the public	1	2	3	4	5
4.	Limited awareness of the public towards the appreciation of the clean solar energy resource such as solar photovoltaic technology	1	2	3	4	5

5.	Installation rooftop solar PV on the residential houses usually requires huge capital investment and maintenance cost	1	2	3	4	5
6.	Lack of motivation and incentives to attract the clients to install rooftop solar PV panels on their properties	1	2	3	4	5
7.	Clients do not need to consider Solar PV panel installation in their projects , as they don't have obligation to commit to sustainability	1	2	3	4	5
8.	Project team members including consultants, project managers, facility managers and building operators, are lacking technical understanding and knowledge to implement solar PV in the projects	1	2	3	4	5

Section C: Client's priority while implementing new projects

No	Dimension	SA	A	N	D	SD
1.	The project cost is to be priotized, as compared with the long-term operational cost resulted from rooftop solar system	1	2	3	4	5
2.	Priorities are for implementation of green environment or space such as lush greenery , beautifully landscaped lakes or parks complete with leisure amenities, as compared with the implementation of rooftop solar system.	1	2	3	4	5
3.	Human resource development such as continuing education, training and development are to be prioritized as compared with the implementation of rooftop solar system	1	2	3	4	5
4.	Corporate Social Responsibility (CSR) Practise is to be prioritized as compared with the implementation of rooftop solar system	1	2	3	4	5
5.	Project completion time is more important as compared with the implementation of rooftop solar system, which usually consume more construction time as compared with conventional way	1	2	3	4	5
6.	Quality of construction project is to be prioritized as compared with the implementation of rooftop solar system	1	2	3	4	5

7.	Health and safe working environment for the employees to be prioritized as compared with the implementation of rooftop solar system	1	2	3	4	5

Section D : Recommendations to integrate rooftop solar panel into all the new projects

No	Dimension	SA	A	N	D	SD
1.	Policymakers and solar PV practitioners could implement several policies to improve solar PV adoption.	1	2	3	4	5
2.	Enhance clients' knowledge in rooftop solar PV system could encourage solar PV adoption	1	2	3	4	5
3	Financial support from government to encourage small and medium scale industries to use renewable energy such as solar PV	1	2	3	4	5
4	Sustainable Energy Development Authority Act to compel the installation of rooftop solar PV system for new construction projects	1	2	3	4	5
5	Attractive loans and reduced taxes and customs duties on equipment related to solar energy technology	1	2	3	4	5
6	Cooperation between government and non-governmental organizations (NGOs) to enhance present level of public awareness via dissemination of information on solar energy benefits,	1	2	3	4	5
7	Reduce fossil-fuel subsidy benefits and transfer the savings for development of solar technology and solar energy markets, and provide attractive pricing for users and suppliers	1	2	3	4	5
8	Improving developer's knowledge and acceptance of sustainable practice such as rooftop solar PV system	1	2	3	4	5
9	Influence prospective buyers to adopt for sustainable houses such as installation of rooftop solar PV system, will push the housing developers to install solar PV for their houses	1	2	3	4	5

Thank you for your cooperation in helping me to complete this survey,
I am grateful for your help.