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Readiness of Malaysian on Sustainable Development in Solar Energy Application

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Abstract: Solar energy is a non-vanishing renewable source of energy that is eco-friendly. However, the solar energy adoption rate in Malaysia remains low due to the low readiness level among the Malaysian. This phenomenon should be emphasized where solutions need to be figured out to encourage the adoption of solar energy in buildings. Thus, this research was conducted to explore the readiness and challenges of the Malaysians in adopting solar energy. A mixed research method was adopted where a total of 200 sets of online questionnaire surveys were distributed to the public, and a semi-structured interview was carried out to obtain the opinions from the expert in the industry. Based on the findings of the questionnaires, the top 3 challenges in solar energy adoption are (1) high setting up cost of solar panels, (2) limited public awareness of solar energy and (3) efficiency of the solar panel depends on the weather. Next, the qualitative study found that 48.9% of 139 respondents were willing to adopt solar energy in the future. The findings show that that breaking down the barriers of high investment cost and long return investment would further enhance the solar energy adoption rates at the residential scale. Since this study had explored the challenges and solution to these barriers, the outcomes of this study can be used by the policy maker as the fundamental to encourage the adoption of solar energy in the existing buildings where the current adoption rate is low.

Keywords: Malaysia, readiness, renewable energy, solar energy, sustainable development

1. Introduction

Solar energy is the energy converted from sunlight which provides electrical energy (Hassan et al., 2021; Hossain & Illias, 2022; Mostafaeipour et al., 2021; Sreenath, Sudhakar, A.F, et al., 2020). Solar technologies can be used for a variety of purposes (Burnett & Hefner, 2021; Heng et al., 2019; Mohd Chachuli, Ahmad Ludin, et al., 2021; Mohd Chachuli, Mat, et al., 2021). This includes generating electricity, creating, and providing an unrestrained comfortable interior environment. At the same time, solar energy will not produce any harmful gas to the environment. The population growth causes energy consumption to increase, and it is expected to grow in the future (Hassan et al., 2021; Qahtan, 2019; Sovacool, 2021; Sreenath, Sudhakar, & Yusop, 2020). As time goes by, the energy demand is still growing, but the energy supplies such as non-renewable energy (NRE) resources are decreasing (Alani et al., 2022; Neupane et al., 2022; Obaideen et al., 2021; Ren et al., 2022). Hence, it is necessary to seek alternative energy such as solar energy to ensure the stability of the energy supply (Yu et al., 2022). Malik and Ayop (2020) mentioned that

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Malaysia is in the equatorial zone. It is blessed with a natural tropical climate with average daily solar radiation of 4500 kWh m-2 and abundant sunshine for about 12 hours per day. It gives a plus point for Malaysia for using solar power energy instead of NRE. Malaysia has become an international hub for the manufacture of solar technologies such as solar photovoltaic (PV) cells, modules, and wafers (Malik & Ayop, 2020). However, Southeast Asian countries, including Malaysia, use solar energy comparatively slowly at home. This situation results from government policy that focuses on fossil fuels to generate electricity consumed by the population instead of solar energy. This indicates readiness is stalling.

2. Literature Review

The notion of people's lifestyle leads to more energy consumption. For instance, air-conditional is preferable in hot weather countries. This situation caused the demand for electricity to increase gradually. The statement is supported by the handbook published by the Malaysia Energy Statistics Handbook 2019 where it reported the peak demand for three leading electricity providers in Malaysia in 2017 and 2018, which are Tenaga Nasional Berhad (TNB), Sabah Electricity Sdn Bhd (SESB), and Sarawak Energy (SEB). The TNB's peak demand increased 3.1% (17,790MW to 18,338MW), the SESB's peak demand increased 1.8% (938MW to 955MW), and SEB's peak demand rose 6.1% (3302MW to 3504MW). From the perspective of Shared Prosperity Vision 2030, Key Economic Growth Activities (KEGA) 11, Malaysia's government has set an achievement of the renewables accounting for national power generation capacity stated that there will be a large-scale of auctions that will continue to be conducted by the government. Renewable energy (RE) is estimated to contribute 20% to electricity generation by 2025. Muhammad-Sukki et al. (2011) and Lau et al. (2020) mentioned that more than 4.12 million buildings in Peninsular Malaysia are suitable for solar PV cells installation, which can help generate approximately 34,194 MW of electricity. It is believed that the amount of power generated can satisfy the current demand for electricity in Malaysia. This study aims to shed some light on the barriers that impede the application of solar energy in Malaysia, amongst others, that can explore the readiness and challenges of the Malaysians in adopting solar power.

2.1 Solar Energy

Lan et al. (2021) and Mohammad et al. (2020) stated that the solar energy application is a technology that obtains solar irradiance and converts them into voltage for electricity generation using PV cells. Yasmeen et al. (2022) defined that solar energy as a truly renewable source as it is non-polluting, not creating unbeneficial gases and waste that must be stored. Solar energy also reduces noise pollution compared to fuel-based points (Yasmeen et al., 2022). National Renewable Energy Laboratory mentioned that the sun provides more fuel on the earth in one hour compared to the energy used by humans. The clean green solar power sourced from sunlight is often used for generating electricity or providing warmness by using some technologies. Electricity is generated from solar PV panels fitted and installed on the roof of homes and buildings by applying the theory of turning daylight into solar radiant energy (Anang et al., 2021; Yasmeen et al., 2022). The benefits of using solar energy pr properly include renewable energy sources, cost saving in electricity bills, low maintenance cost, eco-friendly investment return, and diverse applications (Mostafaeipour et al., 2021). Yasmeen et al. (2022) contended that most of the area on Earth could receive and collect some amount of solar power. Some scientists from The National Aeronautics and Space Administration (NASA) predicted that the sun would last another 6.5 billion years to provide energy to the Earth before it dies, which means that the sun will continue transferring sunlight radiant for the next 6.5 billion years. Therefore, the energy gained from the sun is renewable and free of charge.

2.2 The Readiness of Investing and Adopting Solar Energy Application

Readiness of Public Sector: The Malaysian government has implemented numerous energy-related policies to fight climate change due to the mass usage of fossil fuels throughout the years (Yasmeen et al., 2022). Lan et al. (2021) stated that RE had been targeted to be an essential contributor to the total electricity supply. Muhammad-Sukki et al. (2011) and Lau et al. (2020) added to advertise a broader usage of the PV technologies incorporated in the buildings and reduce the Greenhouse Gases (GHG) emissions from the electricity sector. Building Integrated Photovoltaic Technology Application (BIPV) is a solar system integrated into the design of a structure that replaces conventional building materials (Yu et al., 2022). Islam et al. (2019) and Arnaout and Ii (2019) contended that the implementation of MBIPV was to reduce BIPV technology cost in the local market and to widespread the BIPV application in the nation. Approximately 65,100 tons of GHG emissions are expected to be avoided throughout the project's lifetime. Malaysia also enforced some energy-related policies such as the Renewable Energy Act 2011 (RE Act 2011) to focus on the RE development and Sustainable Energy Development Authority Act 2011 to keep a close watch over the management and implementation of RE and Feed-in Tariff (FiT) program (Tam, 2013).

The purpose of Malaysia FiT is to reward the RE investors whenever they generate electricity (Montoya-Duque et al., 2022). According to Tam (2013), Renewable Energy Fund (RE Fund) is the dominant component to support the lifeline of FiT. RE Fund is proposed under RE Act section 23 and can only be used to pay the appropriate FiT payment

claimed from power utility firms and cover the administrative expenses related to the FiT program. Hoo et al. (2020) mentioned that TNB will pay the investors a certain amount of money per kWh of electricity generated by RE sources, and solar PV has the highest tariff of RM1.78 per kWh. The target of 985 MW was achieved by implementing the FiT program, which contributed 5.5% of RE to the country's electricity generation mix (Solangi et al., 2015). The Malaysian government also introduced the Net Energy Metering (NEM) in 2016. NEM acted as a solar PV initiative executed by the Energy and Natural Resources Ministry (KeTSA) and regulated by the Energy Commission (EC). At the same time, SEDA Malaysia was the implementing agency to encourage the adoption of RE in the country (SEDA Malaysia, 2018). Vaka et al. (2020) stated that the latest NEM scheme provides a chance for more building owners to go solar and help the solar panel users reduce the electricity bill as NEM 3.0 offers the same quota (500 MW) allocated NEW 2.0. It is valid from 2021 to 2023. They added NEM 3.0 also outlines the concept of a 'one-on-one' offset mechanism which allows the solar panel users to consume the electricity generated from the solar system and sell the excess energy in kilowatt (kWh) collected during the sunlight hours to the TNB to offset the electrical consumption at night.

Readiness of Private Sector: The financial institutions which corporate with and support the government in financial by funding the implementation of the RE. Oh et al. (2010) mentioned that the five years MBIPV project received co-financing from various aspects, including the Global Environment Facility (GEF), United Nations Development Program (UNDP), government of Malaysia, and private sectors. Many NGOs have taken the initiative to corporate with the government's vision on RE development, such as Science of Life Studies 24/7 (SOLS 24/7). Wong (2016) and Malik and Ayop (2020) stated that SO, LS 24/7, a non-government and non-profit humanitarian organization focusing on education and social empowerment programs, set up a solar academy to train the younger generations to become "solopreneurs." The solar lab and academy by SOLS 24/7 enable the students to gain skill and knowledge of solar PV energy and access a promising future, subsequently increasing the awareness of the energy among the society.

Table 1 - Summary of readiness of public and private sectors

Citations	Public sector	Private sector
Vaka et al. (2020)	√	
SEDA Malaysia (2018)	√	
Wong (2016)		√
Hoo et al. (2020)	√	
Solangi et al. (2015)	√	
Lan et al. (2021)	√	
Yu et al. (2022)	√	
Tam (2013)	√	
Arnaout and Ii (2019)	√	
Yasmeen et al. (2022)	√	
Muhammad-Sukki et al. (2011)	√	
Islam et al. (2019)	√	
Oh et al. (2010)		√

2.3 The Challenges in Adopting Solar Energy in Malaysia

Solar energy has several shortages, such as incapable of providing consistent power to satisfy energy demand due to the season (John et al., 2021; Laajimi & Go, 2019). John et al. (2021) stated that the government has put in a few policies, legislative frameworks, and implementation mechanisms to push and catapult Malaysia into a sustainable and low-carbon emission future. The participation of the private sector in developing the solar industry also contributed a big step for the country to go green. However, the progress in convincing the people to switch to RE from the use of NRE remains slow and uncertain in Malaysia. This is considering the numerous barriers in the RE technologies development, including the application of solar energy (Laajimi & Go, 2019; Zhang et al., 2021).

Competition from Traditional Fuel: According to the report prepared by U.S. Energy Information Administration (2021), fossil fuels are expected to supply about 78% of the energy used globally in 2040. Fossil fuels are used commonly compared to other energy sources because they are abundant and readily available, mainly the coal in Malaysia. Malaysian Minerals Year Book 2010 prepared by Minerals and Geoscience Department Malaysia (2011) identified that the largest coal mine in Malaysia is located at Merit Pila, Sarawak, and Meliau Basin, Sabah. More than 80% of the total coal resource is reserved from these two fields. Coal became the dominant fuel source because coal is abundant, accessible, and cheap. The price of coal is low due to its abundance point, but the price is rising in the global market today. This phenomenon has promoted some merchants to invest in solar panels to save money over the long run. However, fossil fuel sources are still categorised as a cheaper alternative to RE in the short run.

High Initial Cost: One of the reasons that the adoption of solar energy remains low in Malaysia is that setting up a solar PV system is expensive. Teoh et al. (2020) and Anang et al. (2021) emphasized that solar is a more expensive electricity source than conventional fuel like coal and natural gas. Florez and Ghazali (2020) and Shaikh (2017) supported that the high initial cost of solar panels is associated with the required investment to install the system. The purchase price of a solar PV system ranges from RM52, 000 to RM110 000, including the application of FiT, installation & design of the system, and material costs.

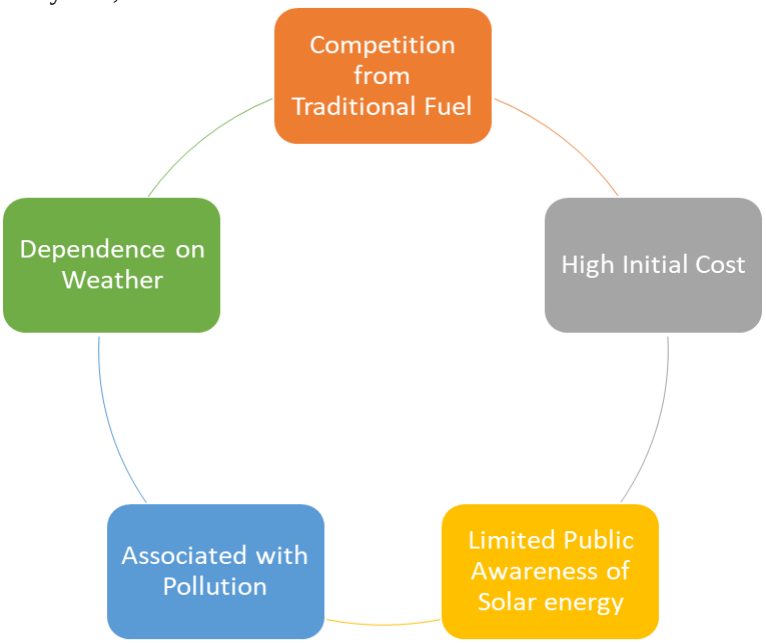


Fig. 1 - The challenges in adopting solar energy

Dependence on Weather: The efficiency of solar panels depends on the weather. Shaikh (2017) mentioned that there would be no energy generation when the sun is not shining. Some types of solar panels cannot perform well in collecting energy during non-sunny days. Khamisani (2019) and Saleheen et al. (2021) defined that the Off-Grid Solar Power System with solar batteries is not connecting to the public electricity grid. Suppose there is heavy downfall happened in the daytime. In that case, the solar power generator may not collect a sufficient solar energy capacity, inconveniencing the end-users in daily life (Zhang et al., 2021). Al-Amayreh and Alahmer (2022) mentioned that the solar panel with a dual-axis tracking system would decrease 50% of the efficiency of collecting solar energy during cloudy days.

Associated with Pollution: Lofthouse et al. (2015) reported that the fabrication of solar panels requires corrosive chemicals such as silicon tetrachloride (SiCl4), sodium hydroxide (NaOH), and hydrofluoric acid (HF). At the same time, this process uses water and electricity which the production of this mix produces GHG and waste. The output of PV emits CO2 and increases the carbon footprint in the country. Besides, hazardous chemical substances like hydrochloric acid, sulphuric acid, nitric acid, hydrogen fluoride, 1,1,1-trichloroethane, and acetone are used to clean and purify the semiconductor surface of solar panels (Berger et al., 2010). Suppose the substances and manufacturing waste products are not disposed of appropriately. In that case, they may cause harm to the workers who are exposed to the chemicals and bring adverse effects to the environment like water and soil pollution. The ecosystem may also be disrupted because a larger utility-scale of solar facilities is built to generate energy. Li et al. (2020) emphasized that removing trees and forests is required to provide space for solar power facilities resulting in CO2 emission as high as 36g CO2 kWh-1. Deforestation then leads to direct loss of animal shelters or habitat destruction, resulting in the ecological imbalance of the ecosystem.

Limited Public Awareness of Solar Energy: Muhammad-Sukki et al. (2011) studies show that Malaysian has limited awareness and knowledge of solar PV systems and the government program and incentive related to solar energy. A survey conducted by Florez and Ghazali (2020) found that most homeowners know the solar energy system, but 70% of the respondents claimed that they did not know any solar panel supplier around the housing area. Malik and Ayop (2020) mentioned a lack of information and awareness on the benefits of RE and special incentives from the government. Muhammad-Sukki conducted a survey found that 63.1% of the 214 Malaysian respondents were not aware of any encouragement from the government for RE. In 2018, Zakaria et al. (2019) studies also showed that 50.6% of the 83 respondents did not know about the government incentive on RE. Although the government implemented the FiT mechanism as stated in the 10th Malaysia Plan to increase the public awareness in solar energy adoption, the result

indicated that more than 50% of the respondents do not seem concerned about the source of power as long as the electricity is supplied to their houses (Lau et al., 2020; Muhammad-Sukki et al., 2011).

Table 2 - Sources of constructs

Challenges / Sources	Financial		Environmental		Socio-cultural
	Competition from traditional fuel	**High initial cost**	**Dependence on Weather**	**Associated with pollution**	**Limited public awareness**
U.S. Energy Information Administration (2021)	√				
Mostafaeipour et al. (2021)		√			
Irfan et al. (2021)					√
Agbo et al. (2021)			√		
Mostafaeipour et al. (2021)		√			
Florez and Ghazali (2020)		√			√
Khamisani (2019)			√		
Zakaria et al. (2019)					√
Shaikh (2017)		√	√		
Lofthouse et al. (2015)		√		√	
Minerals and Geoscience Department Malaysia (2011)	√				
Muhammad-Sukki et al. (2011))	√				√
Li et al. (2020)				√	
Malik and Ayop (2020)					√
Berger et al. (2010)				√	
Al-Amayreh and Alahmer (2022)			√		
Othman et al. (2008)	√				

3. Methodology

This study adopted a mixed research method which means both quantitative and qualitative approaches were used to collect the primary data. The rationale of adopting a mixed research method is that the questionnaire is a well-structured and social research design suitable to survey many populations. Then, the interview will provide insight into the problems and answers from the respondents is opened based on the interviewees' experiences and perspectives. Interview with the expert helps gain more in-depth information on the effectiveness of using solar energy and review the barrier to the adoption of solar energy in Malaysia. This is agreed by Mostafaeipour et al. (2021), where their research used the qualitative method to obtain experts' opinions. As a result, this method can provide more reliable information and efficient data to support the development of many respondents. According to RVSPK et al. (2020), the "10-time rule" required the minimum respondents for quantitative research should be 10 multiply with the number of indicators in the study. As this study is having 21 indicators, that means at least 210 (21 indicators x 10-time rule) respondents should have respond to the questionnaire. As Poynton et al. (2019) and Nayak and Narayan (2019) said that the normal response rate of online questionnaire is ranged from 20% to 30%, questionnaires in this study were distributed to 1000 targeted respondents who living in Malaysia through email and internet platforms to ensure at least 210 respondents can be achieved.

These 1000 targeted respondents were chosen based on the types of building that they are currently staying as this will reflect the readiness of the respondents to adopt the solar energy application in their house. The questionnaire intends to collect data related to the readiness of Malaysians in adopting solar energy and the challenges they face. Next, the data collected by the questionnaire were analyzed using reliability and validity analysis to ensure the collected data reflected the actual conditions in Malaysia. Then, descriptive analysis was carried out to identify the current conditions of solar energy adoption, the challenges respondents face in adopting solar energy, and respondents' readiness to adopt solar energy. Lastly, the study proceeded to the qualitative stage. The results from the descriptive analysis were used as the fundamental to develop the interview questions used in the interview session. A semi-structured interview with a solar panel vendor is chosen to ensure the interviewee has freely expressed this/her opinions. The entire interview process is recorded using a sound recorder for research study purposes.

In this study, the Cronbach's Alpha analysis was used to measure the internal consistency, which refers to the reliability of multiple Likert questions in a questionnaire that forms a scale. Data collected from the questions using a 5-points Likert scale in this study were analyzed through Cronbach's Alpha analysis. The reliability of the data and

internal consistency based on how closely related a set of items were as a group was measured. Descriptive statistics were applied for all the data collected from the questions in the questionnaire and interview to indicate the mean and ranking of the data and identify the most critical element that should be considered. Besides, frequency analysis was categorized under descriptive analysis where it could indicate the frequency distribution of the data collected and determine the preferable element from the respondents. After all the examination and tests were completed, the research findings were tabulated and presented in the histogram, graph, table, or another suitable form.

4. Results and Discussion

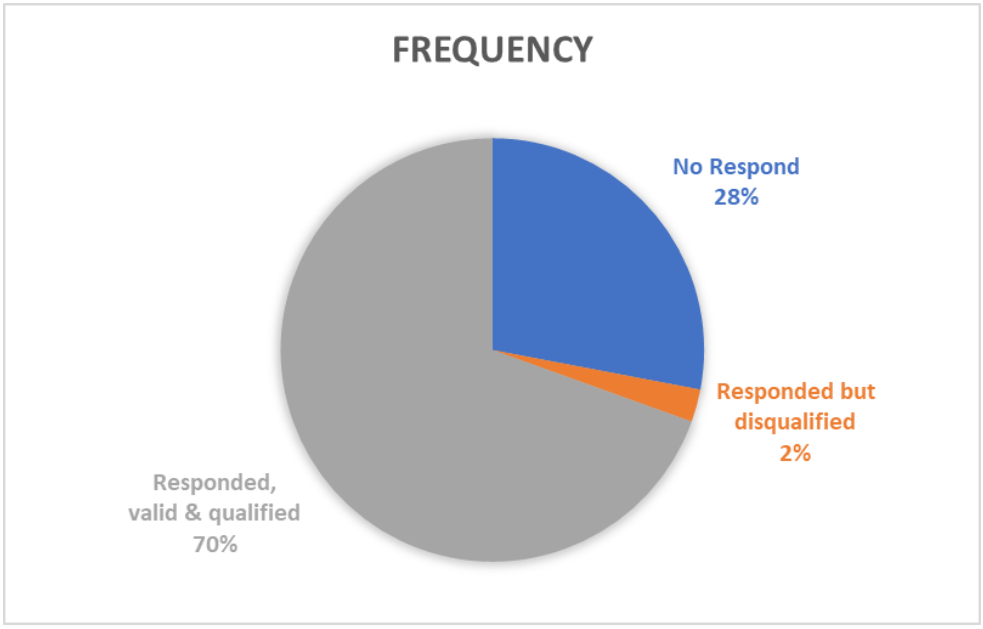
Among the 200 questionnaires distributed, 139 valid and qualified responses were returned and received, resulting in a response rate of 69.50%. Besides, 5 (2.50%) of the reactions were disqualified as the respondents answered 'not sure' on the question-related type of land title for their building. Lastly, 28.00%, with 56 targeted respondents, did not respond to the questionnaire form distributed.

Fig. 2 - Shows the summary of data collection

The respondents' general demographic information includes types of building that the respondents are currently staying in, the land title of the building, the current ownership status of the building, and everyday household occupancy is collected. Meanwhile, the subsequent questions are whether the respondents are aware of the environmental changes caused by fossil fuels, whether the respondents support the development of RE, and whether the respondents have experience using solar energy. The frequency analysis is used for data analysis in the section. Among the 139 responses received, 94 respondents (67.6%) stayed in the low-rise building, i.e., single/double-storey terrace house, semi-detached house, detached house, and building with or below 4-storey. Twenty-four respondents (17.3%) reported that they are staying in high-rise buildings, and 21 respondents (15.1%) involved are staying in mid-rise buildings.

Table 3 - Summary of demography detail of respondents

Demographic Variable		Frequency	Percentage (%)
Types of Building	High-rise building (above 13-story)	24	17.3
	Mid-rise building (between 5 to 12-storey)	21	15.1
	Low-rise building	94	67.6
	Total	139	100.0
Land Title	Freehold land title	97	69.8
	Leasehold land title	26	18.7
	Strata title	16	11.5
	Total	139	100.0
Current Ownership Status	Renting	33	23.7
	Owning	106	76.3
	Total	139	100.0
Household Occupancy	Staying alone	12	8.6
	Staying with family	109	78.4
	Staying with friends	18	12.9
	Total	139	100.0



The majority of 69.8% of the respondents are staying in a freehold land title, while 18.7% responded that their building is under leasehold land title. The remaining 11.5% (16 respondents) remain in the building with the strata title. The respondents were asked whether they were renting or owning their building. The result is that 106 respondents (76.3%) own their building while the remaining 33 respondents (23.7%) are currently renting their building. The respondents' household occupancy is determined in the following question. The finding shows that the respondents who stayed with family had participated the most in the questionnaire, which consisted of the highest frequency of 109 respondents (78.4%). This is followed by the respondents who stayed with friends, contributing 12.9% of 139 respondents; the remaining 8.6% reported staying alone without friends and family members.

Next, 5-points Likert scale questions related to the benefits of solar energy adoption were asked in the questionnaire. The pros of solar energy adoption include renewable and clean energy sources, cost saving in electricity bills, low maintenance cost, eco-friendly investment return, and diverse applications. In this study, the reliability test is applied to the questions with a 5-points Likert scale to study the internal consistency between individuals' items in the hierarchy. The test is generated through Reliability Analysis which is available in SPSS 21.0 software. The result of Cronbach's Alpha reliability test for advantages of solar energy adoption is tabulated in Table 4.

Table 4 - Reliability statistics

	Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
Challenges in adopting solar energy	0.790	0.791	11
Readiness in adopting solar energy	0.845	0.852	10

Cronbach's Alpha coefficient for challenges in adopting solar energy is 0.790. This means that the internal consistency for the scales of 11 items is acceptable by referring to the Cronbach's Alpha rule of thumb. Hence, the scale for this section for barriers to adopting solar energy is accepted for data analysis. Lastly, the scale for selecting readiness in adopting solar energy is consistent and reliable as Cronbach's Alpha coefficient is 0.845. This allows a relatively high level of internal consistency among the scales of 10 items for undergoing a further accurate data analysis.

Table 4 indicates the frequency and percentage of research constructs, respectively. Out of the 139 respondents, there are 110 respondents (79.1%) answered "Yes" while only 29 respondents (20.9%) responded "No." Consequently, the results indicated that most respondents are aware of the environmental problems caused by burning fossil fuels. Next, respondents were asked to tell whether they support the development of sustainable or renewable energy. From the data obtained, there is a total of 130 respondents (93.5%) supported the development of sustainable

energy while only nine respondents (6.5%) answered "No" in this question. Almost all respondents who participated in this questionnaire survey support sustainable energy like solar energy.

Table 5 - Frequency distribution of the research constructs

		Frequency	Per cent	Valid Percent	Cumulative Percent
Awareness of the changes in the environment	Yes	110	79.1	79.1	79.1
	No	29	20.9	20.9	100.0
	Total	139	100.0	100.0	
Support the development of sustainable energy	Yes	130	93.5	93.5	93.5
	No	9	6.5	6.5	100.0
	Total	139	100.0	100.0	
Previous experience in applying solar energy	Yes	43	30.9	30.9	30.9
	No	96	69.1	69.1	100.0
	Total	139	100.0	100.0	

Lastly, several questions were asked to investigate whether the respondents have experience using solar energy. This question shows 68.1%, with 96 respondents having no experience using solar energy while the remaining 43 respondents (30.9%) have experience with it. It can be concluded that the current adoption rate of solar energy in Malaysia is considered slightly low. This question is essential for the data analysis for the benefits and challenges of solar energy adoption as they may have reliable and genuine experience in applying solar energy. Henceforth, this study can detect and reflect the benefits and challenges of solar energy adoption.

Next, 139 respondents were asked to indicate their level of agreement for 11 challenges, including five main challenges as discussed in the literature review and six possible obstacles to be confirmed through the questionnaire survey. There are 11 challenges in adopting solar energy listed in the questionnaire challenges in adopting solar power. The respondents were required to express their level of agreement on the challenges. Table 6 tabulates the barriers, including 11 challenges in applying solar energy in Malaysia.

Table 6 - Result of challenges in adopting solar energy

Factor	Challenges in adopting solar energy	N	Mean	Mean Rank
C1	High cost of setting up a solar panel	139	4.0791	1
C2	Limited public awareness of solar energy	139	3.9856	2
C3	The efficiency of the solar panels depends on weather	139	3.9065	3
C4	High maintenance cost of solar panel	139	3.5612	4
C5	Staying in high rise building where no space for solar panel installation	139	3.5324	5
C6	Orientation of building towards the north which hard to obtain sunlight	139	3.3885	6
C7	Unsuitable rooftop design for solar panel installation	139	3.3022	7
C8	Solar panel uses a lot of space	139	3.2950	8
C9	Manufacture process of the solar panels brings pollution	139	3.2590	9
C10	Fossil fuel is cheaper than solar energy	139	3.1942	10
C11	The design of solar panels is not attractive	139	2.8273	11

Based on the finding, the most significant barrier in applying solar energy is the high setup cost of solar panels, with the highest mean score of 4.0791. This result indicated that a more substantial number of the respondents 'strongly agree' that the solar panel has a high initial cost of installation, and this might be the main reason why the public is not going solar currently. The previous study conducted by Florez and Ghazali (2020) and Shaikh (2017) also show similar results. Hence, it is ranked in the first place among the 11 challenges. Limited public awareness scored the second highest mean score (3.9856) in the challenges of solar energy adoption. The finding is supported by Muhammad-Sukki et al. (2011), (Lau et al., 2020) and Islam et al. (2019), who stipulated that most Malaysians lacked knowledge and awareness about the advantages of solar energy, the solar PV system, and the government incentives related to solar power. The survey conducted by Zakaria et al. (2019) showed that approximately 50.6% of 83 respondents did not know of RE's current government incentive program.

The efficiency of the solar panel depends on the weather falls on the third ranking of the mean score. The mean score of 3.9065 indicated that the majority of the 139 respondents tend to 'agree' on this challenge, at the same time proving what Shaikh (2017) has opined that solar energy will not generate power when the sun is not shining. The ranking of the barriers in adopting solar energy is followed by high maintenance cost of solar panels, staying in tall rise building where no space for solar panel installation, the orientation of building towards the north which hard to obtain

sunlight, unsuitable rooftop design for solar panel installation, the solar panel uses a lot of space, manufacture process of the solar panel brings pollution, fossil fuel is cheaper than solar energy and design of the solar panel is not attractive. These challenges are considered average factors in affecting solar energy adoption.

Except for the challenges stated in Table 6, the respondents also suggest external challenges. Some respondents opined that solar panels need rechargeable lithium batteries, which are expensive, and the panels are difficult to recycle. One of the respondents stipulated that little attention has been paid to the public on tax allowance for solar energy consumers. One respondent reckoned that the challenge in adopting solar energy in Malaysia might be the management initiative. Most people tend to stay in a comfortable space instead of trying out new things beneficial for humans and the ecosystem. These challenges are considered the recent findings that have not been included and discussed in the literature review of this research. They are recommended to be further studied and discussed in the future.

4.1 Readiness of the Public in Adopting Solar Energy

The public readiness to adopt solar energy was tested in this study. The primary data collected from the questionnaire about the preparedness of the public to adopt solar energy is analyzed and tabulated. Table 7 lists the statements of readiness in adopting solar power.

Table 7 - Result of statements on readiness in adopting solar energy

Factor	Reports on readiness in adopting solar energy	Mean	Mean Rank
R1	I am ready to adopt solar energy if setting up is below my budget.	4.2230	1
R2	I am ready to adopt solar energy if I have sufficient knowledge about solar energy.	4.2158	2
R3	I am ready to adopt solar energy if the government subsidies the solar panel installation.	4.0935	3
R4	I am ready to adopt solar energy if the efficiency of the solar panel is consistent all the time.	4.0000	4
R5	I am ready to adopt solar energy if I stay in a low-rise building.	3.9928	5
R6	I am ready to adopt solar energy if the regular maintenance cost is below RM500.00.	3.8705	6
R7	I am ready to adopt solar energy if the solar panel does not occupy ample space.	3.8129	7
R8	If the solar panel design is revised and improved, I will adopt solar energy.	3.5971	8
R9	I am ready to adopt solar energy if the rooftop design is suitable for solar panel installation.	3.5540	9
R10	I am ready to adopt solar energy if the regular maintenance cost is below RM1000.00.	2.7626	10

Out of the ten statements, the statement "I am ready to adopt solar energy if the cost of setting up is below my budget' is ranked in the first place with the mean value of 4.2230. The result is met with challenges in adopting solar energy shown in Table 6, where most people strongly agreed that the high setup cost of the solar panels is the main barrier in adopting solar power. Thus, it can be concluded that more publics are ready to go solar if the initial installation cost of the solar panels is adjusted and below their budgets. The statement highlighting "I am ready to adopt solar energy if I have sufficient knowledge about solar energy" obtained a mean score of 4.2158 and ranked second. This means that majority of the respondents strongly agreed that they would apply solar energy if they had sufficient knowledge and awareness about the solar power and solar panel system. The result is also in line with the second main challenge in adopting solar power, as discussed in Table 6. The respondents think that lack of awareness is one of the main barriers to solar energy adoption in Malaysia. It can be anticipated that if the public has enough and sufficient understanding and knowledge about solar energy, the adoption rate of solar energy in Malaysia may increase.

In addition, Table 7 indicated that the statement stating "I am ready to adopt solar energy if the government subsidies the solar panel installation" is placed in third place among the ten words—a subsidy program was launched by the government, as mentioned by Hoo et al. (2020). However, the findings indicated that many respondents are not aware of the government subsidy program related to solar energy.

4.2 Respondents' Willingness in Adopting Solar Energy in Future

Lastly, several questions of the questionnaire survey asked whether the respondents are willing to adopt solar energy in the future. Fig. 3 presents the frequency analysis result on the question.

Out of the 139 respondents, the number of respondents who answered "Yes" in this question is 48.92%, slightly higher than 46.04% of respondents who responded "Maybe." Meanwhile, only seven respondents (5.04%) answered

"No" in this section. Therefore, it indicated that most of the respondents are willing and considering trying solar energy in the future. This result may reflect the future increment in the adoption rate of solar energy in Malaysia.

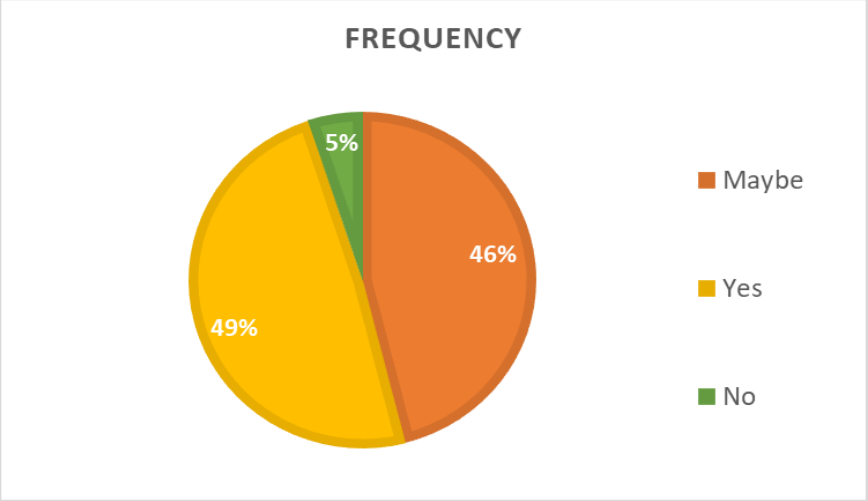


Fig. 3 - Frequency distribution of the respondents' willingness in adopting solar energy in future

4.3 Qualitative Analysis

A semi-structured interview was conducted to obtain more valuable and realistic data from the expert who worked in the solar panel manufacturing sector. The online discussion was carried out with a solar panel vendor. A total of two questions were posed; the answers for the pre-set questions from the interviewee were recorded, arranged, and analyzed in this section to support the data obtained from the questionnaire survey. Table 8 shows the feedback from the interviewee during the online interview.

Table 8 - Interviewee's feedback

Questions	Answers
Q1: What are the current challenges in adopting solar energy in Malaysia?	High investment cost and extended return of investment compared to other forms of renewable energy.
Q2: With acknowledging the current challenges, will you apply solar energy in the future? Why?	Yes. Solar energy has a vast potential for improvement. One day, the efficiency will make the investment cost more acceptable to the community.

The interviewee opined that the most significant challenges in adopting solar energy in Malaysia were high investment costs and extended investment return compared to other RE. This has met the justification by Florez and Ghazali (2020) and Shaikh (2017), stating that high capital for initial setup is required to invest in solar PV systems. However, the finding of a long period for investment return is not in line with Renewable Energy World, which supported that the investors could enjoy the return of investment since the first day of utilising the solar energy.

The last question was about the interviewee's willingness to adopt solar energy to acknowledge the current challenges. The result indicates that the interviewee is willing to adopt solar power as he thinks solar energy has a significant potential for improvement in the future. He also believes that one day the efficiency of the solar panel will be improved, making the high investment cost more acceptable to the public. Based on the finding and analysis from the interview, it is believed that the solar panel will be more cost-efficient in the future. With the higher efficiency and lower cost of investment, the adoption rate of solar energy is possible to rise dramatically.

5. Conclusion

To conclude, the challenges of solar energy adoption are indicated through a literature review, including competition from fossil fuels, high set-up cost, dependence on weather associated with pollution, and lack of public awareness of solar energy. The ranking for the barriers to adopting solar energy was (1) the high cost of setting up the solar panel, (2) limited public awareness of solar energy and (3) efficiency of the solar panel depends on the weather. The interviewee enlightened high investment cost and extended return of investment in the current main barriers in solar energy adoption. About 48.9% of 139 respondents are willing to adopt solar energy in the future. Besides, the interviewee is ready to adopt solar energy in the future. He believes that solar energy has enormous potential for improvement in cost and efficiency in the future. The level of agreement and opinion on challenges in applying solar energy is gathered from the public, resulting in a rise in accuracy and reliability of data obtained. Besides, the barriers

in adopting solar energy identified and discussed in the study allow sharing knowledge to improve cohesiveness in applying solar energy and explain why the number of people adopting solar energy is still relatively low. The government and private sectors' identified readiness toward solar energy adoption is expected to increase the awareness and confidence of the respondents in adopting solar energy. The adoption of solar energy in Malaysia is expected to increase because the results indicated that most respondents are willing to go solar in the future.

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