

**6th UNDERGRADUATE
SEMINAR ON BUILT
ENVIRONMENT
AND TECHNOLOGY
(USBET) 2023**

**SUSTAINABLE BUILT
ENVIRONMENT**

25 - 27 SEPTEMBER 2023

E-PROCEEDING

USBET 2023



e-Proceeding

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Published by,

Department Of Built Environment Studies And Technology
Faculty Of Architecture, Planning & Surveying
Universiti Teknologi MARA Perak Branch, Seri Iskandar Campus
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eISSN 2821-3076



02 October 2023 | Perak, Malaysia
Universiti Teknologi MARA, Perak Branch, Seri Iskandar Campus

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CHALLENGING FACTORS AMONG HOMEOWNERS ON SOLAR PANEL UTILIZATION FOR RESIDENTIAL BUILDING IN SERI ISKANDAR, PERAK.

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ABSTRACT

Energy consumption in this world has significantly increased in recent years as a result of the population growth, industrialization, and development of emerging economies. Solar power only meets a low percentage of the world's energy demands especially for residential buildings. Hence, this study was conducted to change the perception and improve the thoughts of homeowners regarding solar panel utilization for residential building with the main objectives of to identify the challenging factors among homeowners on solar panel utilization for residential buildings, then to suggest the most challenging factors among homeowners on solar panel utilization for residential buildings. This research involved both qualitative and quantitative method. Virtual interview session been carried out to selected experts that have closely related to the field scope of this study. Meanwhile, quantitative methods were used where questionnaires distribution to the homeowners of selected case study have been done and the collected data was analyzed using the Statistical Package for the Social Science (SPSS) software. The overall findings of this research indicated the most challenging factors that influence solar panel utilization among homeowners for residential building are financial or cost barriers, lack of awareness and knowledge, and lack of government incentives. In order to change the perception of homeowners regarding solar panel utilization for residential building, several recommendations are being provided to solve the problem for the purpose of further research.

Keywords: *challenging factors, solar panel utilization, homeowners, residential building*

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INTRODUCTION

Energy consumption in this world has significantly increased in recent years as a result of the population growth, industrialization, and development of emerging economies. Malaysia, a developing country, used fossil fuels with other resources to produce 90% of its electricity. Furthermore, the fossil fuel combustion releases carbon dioxide, that has potential to harm the ecosystem, contribute to global warming and cause the greenhouse effect (Abul et al., 2020).

Energy resources that are environmentally friendly and sustainable can be used to produce renewable energy. Many countries currently are using a variety of renewable energy sources, including solar, wind, hydro, and biomass. Research in developing world concentrated more attention to solar energy than other renewable energy sources. As it transfers sunlight directly into electrical energy, solar energy is thought to be an acceptable alternative to conventional renewable energy sources (Abul et al., 2020).

Despite the fact that currently only meets a low percentage of the world's energy demands, solar power has a great future ahead of it. This is because solar energy is still considered as the most expensive type renewable energy. Nevertheless in certain areas of the world, solar power can very well be the best option for a distributed energy supply (Islam et al., 2010). This research is about to explore the challenging factors of solar panel utilization for residential building.

LITERATURE REVIEW

The energy sources utilization nowadays can be classified into two categories such as renewable and non-renewable. Renewable energy is generated from ongoing natural processes that replenish it. It is generated by the sun or heat produced deep beneath the earth in one of its many forms. Worldwide electricity generation from renewable sources such as geothermal, solar, wind, combustible renewable, and waste are included in the definition, as well as electricity and heat produced from solar, wind, ocean, hydropower, biomass, geothermal resources, biofuels, and hydrogen derived from renewable resources. Coal, oil, and natural gas are examples of non-renewable energy sources that cannot be replenished anytime soon. The generation of secondary energy sources like electricity and hydrogen are feasible using both renewable and non-renewable energy sources (Jayaraman et al., 2017).

The electricity industry in Malaysia usually depends on fossil fuels and non-renewable fuels like natural gas. The Malaysian government has made a number of attempts to

encourage investment in solar PV installations. Solar panel is one of the main types of clean, renewable energy that is produced by the sun. Additionally, to reduce greenhouse gas emissions, industries all over the world have placed a focus strategy on the installation of sustainable and renewable energy systems (Jayaraman et al., 2017).

Renewable energy sources must be used due to the rising demand for sustainable electricity producing sources. Since Malaysia benefits from high sun radiation throughout the year, solar energy has been utilised in various industrial buildings as a source of electricity generation. Despite widespread interest in the sector, solar energy is still not utilized in residential buildings (Florez & Ghazali, 2020).

The objective of the Malaysian government is to enhance the usage of renewable energy (RE) in the country's electricity sector. Malaysia currently derives 2% of its energy from renewable sources compared to all other sources, and it needs to meet 20% penetration by 2025. Natural gas and coal are the majority of Malaysia's existing energy mix, which is used to generate electricity (Abdullah et al., 2019).

Solar Panel

A solar panel is a type of electronic device that converts sunlight directly into electricity. A current and a voltage are produced by light turning the solar cell to create electricity. A substance that increases an electron to a higher energy level upon light absorption is required for this process. The conditions for photovoltaic energy conversion can theoretically be met by a variety of materials and methods, although in fact practically all photovoltaic energy conversion involves semiconductor materials (*Mohammad Bagher, 2015*). Although it currently only meets a small percentage of the world's energy needs, solar power has tremendous future potential. This is because solar energy is still regarded as the most expensive kind of renewable energy.

Residential Building

A residential building consists one or more family dwellings, apartment houses, flats, and private garages of such buildings. It also includes a building in which sleeping and living accommodation is given for typical residential purposes, with kitchen facilities (*Kosanke, 2019*). Everyone has a basic need for housing or residential and as the population and income have grown, so has the need for housing. Florez & Ghazali (2020) suggest that in Malaysia, energy is still primarily produced by burning non-renewable resources, despite the sun's abundant radiation and the government's efforts, and solar energy has not yet been widely developed.

Challenging Factors On Solar Panel Utilization For Residential Building

Financial or cost barriers

High financing costs for research & development activities and deployment are a result of this uncertainty. When compared to the standard alternative, efficient equipment frequently has a much greater initial cost, and the payback period or economic return may be too considerable (Mustapa et al., 2009). Although it presently only meets a small percentage of the world's energy demands, solar power has great future potential. This is because solar energy is still regarded as the most expensive kind of renewable energy (Islam et al., 2010). The respondents who earlier indicated that they would participate in the Feed-In Tariff (FiT) programme changed their minds and withdrew. Possible reasons include the capital cost is considered as very expensive (Muhammad-Sukki et al., 2011). The establishment of large-scale solar power systems has a bright future. Due to the high price of photovoltaic (PV) cells and solar electricity tariff rate, solar energy is still in its infancy (Mekhilef et al., 2012). The initially high cost of acquiring solar energy technology is a significant barrier to the use of PV panel systems (Jayaraman et al., 2017). Financial or cost barriers has been identified as the challenging on solar panel utilization on residential building. According to Florez & Ghazali (2020), one of these barriers is cost. It is thought that residents are prevented from installing PV systems by high installation costs and advanced technology. It is clear from the survey that the installation cost is the public's major consideration (Abul et al., 2020). Despite the fact that solar energy technology helps both urban and rural residents, difficulties like initial cost restrictions for solar system installation represent a significant barrier to the widespread application of solar PV technology (Zamri et al., 2021).

Lack of awareness and knowledge

The advantages of renewable energy are not universally acknowledged or comprehended (Mustapa et al., 2009). The government can also develop technical skills and provide detailed knowledge about the application of solar technology (Ab Kadir et al., 2010). The energy crisis that the world is currently witnessing. Therefore, everyone should raise awareness of solar energy because the government also intends to do a lot to raise awareness of renewable energy sources (Islam et al., 2010). At all levels of society, there is a lack of awareness about solar energy (Jayaraman et al., 2017). It is clear from the research exists that there is limited understanding of home energy management system. Customers may not make investments in new energy-efficient technologies due to a lack of knowledge. The number of renewable energy devices installed in homes was low, with only 6.5% for a photovoltaic system and 2.6% for a solar thermal system (Ahmed et al., 2017). The advantages of installing solar panels and its long-term investment are not widely

known among Malaysians, nor are they as well-known as solar PV systems and government programmes (Florez & Ghazali, 2020). More than half of the participants in the poll on public knowledge of advantages for renewable energy have no knowledge what these are (Abul et al., 2020). Installing solar residential panels in Malaysia may be concerning due to a lack of product and knowledge (Zamri et al., 2021).

Lack of suppliers to install and maintain solar pv systems

Lack of installers and maintainers of solar PV systems is another significant issue (Florez & Ghazali, 2020).

Lack of government incentives

There is a clear need for more channels for information distribution as well as for government agencies to assist and guide applicants and potential consumers on how to apply for renewable energy incentives (Mustapa et al., 2009). One of the most significant thing Government and Non-Governmental Organization (NGO) can do is spreading awareness among the people such as benefits of solar energy and financial issues (Ab Kadir et al., 2010). Additionally, there is no government incentive to encourage consumers to buy solar equipment (Jayaraman et al., 2017). The current government programmes are not well-supported in their efforts to persuade people to switch to renewable energy sources (Florez & Ghazali, 2020). This study clearly shows that the public's perspective is focused on the government awareness program's lack of effectiveness (Abul et al., 2020).

Lack of awareness on environmental performance

One of the most important thing Government and Non-Governmental Organization (NGO) can do is spreading awareness among the people such as benefits of solar energy and environmental advantages (Ab Kadir et al., 2010). Therefore, residents in Malaysia fear using PV because of its environmental performance (Jayaraman et al., 2017). There is a lack of public awareness of environmental issues that has been recognised as a barrier (Zamri et al., 2021).

Lack of awareness on governments' incentives

Apart from that, the following round of the survey aimed to discover out how much residents of Malaysia were aware of Malaysia's government incentives for renewable energy. Approximately 63.1% of respondents didn't know Malaysia offered any incentives for renewable energy (Muhammad-Sukki et al., 2011).

Summary of challenging factors on solar panel utilization for residential building

Table 1: Summary of Challenging Factors on Solar Panel Utilization for Residential Building

No.	Author	1	2	3	4	5	6
1.	(Mustapa et al., 2009)	✓	✓		✓		
2.	(Ab Kadir et al., 2010)	✓	✓		✓	✓	
3.	(Islam et al., 2010)	✓	✓				
4.	(Muhammad-Sukki et al., 2011)	✓					✓
5.	(Mekhilef et al., 2012)	✓					
6.	(Jayaraman et al., 2017)	✓	✓		✓	✓	
7.	(Ahmed et al., 2017)		✓				
8.	(Florez & Ghazali, 2020)	✓	✓	✓	✓		
9.	(Abul et al., 2020)	✓	✓		✓		
10.	(Zamri et al., 2021)	✓	✓			✓	
TOTAL		8	8	1	5	3	1

- 1 – Financial or cost barriers
- 2 – Lack of awareness and knowledge
- 3 – Lack of suppliers to install and maintain solar PV systems
- 4 – Lack of government incentives
- 5 – Lack of awareness on environmental performances
- 6 – Lack of awareness on government incentives

From this summary of findings, three (3) factors have been chosen as the main factors in this research study. From the chosen main three factors, there are four (4) sub-factors under each of the main factors.

- **Factor 1: Financial or cost barriers**
 - F1 (a): Financial constraints
 - F1 (b): Solar panel installation cost
 - F1 (c): Solar panel maintenance cost
 - F1 (d): Return Investment
- **Factor 2: Lack of awareness and knowledge**
 - F2 (a): Limitation of knowledge
 - F2 (b): Lack of exposure in learning about solar panels
 - F2 (c): Lack of involvement of technologists
 - F2 (d): Lack of awareness on Sustainable Development Goals (SDG)
- **Factor 3: Lack of government incentives**
 - F3 (a): Restricted initiatives of government towards solar panel utilization
 - F3 (b): Current government programs are not well supported

- F3 (c): Lack of channels for information distribution to assist and guide consumers on how to apply for renewable energy incentives
- F3 (d): The introduction of individual tax rebates

METHODOLOGY

This research involved both qualitative and quantitative method. The qualitative data collection method was used in the first phase where interview session have been done. It is important in determining whether the professionals that consists of academicians and experts understand the topic well enough to read through the questionnaire and determine whether the questions effectively capture the topic under study. Second method which is quantitative data collection method is using a survey questionnaires form that being distribute to the homeowners as respondents. For this research purpose, all the questions in the questionnaires form are designed to achieve the second objective which is to suggest the most challenging factors among homeowners on solar panel utilization on residential buildings. There are three (3) sections in this questionnaire which consist of Section A, Section B, and Section C. For Section A, the questions are about the background of the respondents, Section B is an investigation of the challenging factors among homeowners on solar panel utilization for residential building, and Section C is the identification of other challenging factor among homeowners on solar panel utilization for residential building.

For qualitative method, two respondents that consists of an academicians and an expert in solar panel were chosen for interviews. The study conducted virtual interviews due to distance issue. After interviewing the first respondent, the second respondent provided new data. Quantitative methods of collecting data were also used for this research where survey questionnaires form distribution have been done to the homeowners as targeted respondents.

Background of Respondents

Table 2: Respondents' Data (Qualitative Method)

RESPONDENT 1 (R1)	
Respondent's Age	41 years old
Respondent's Qualification	Phd in Architecture
Respondent's Position	Academician
Respondent's Experience	8 years
RESPONDENT 2 (R2)	
Respondent's Age	28 years old
Respondent's Qualification	Bachelor Degree in Civil Engineering
Respondent's Position	Solar Panel Installer
Respondent's Experience	3 years

RESULT AND DISCUSSION (QUALITATIVE METHOD)

Table 3: Result and Discussion (Qualitative Method)

RESPONDENT	F1				F2				F3			
	F1 (a)	F1 (b)	F1 (c)	F1 (d)	F2 (a)	F2 (b)	F2 (c)	F2 (d)	F3 (a)	F3 (b)	F3 (c)	F3 (d)
Respondent 1	/	/	/	/	/	/	/	/	/	/	/	/
Respondent 2	/	x	/	/	/	/	/	/	/	/	/	/

Agree (/)

Disagree (X)

Factor 1 : Financial or Cost Barriers

F1 (a): Financial constraints

The factor of financial constraints is the contributing towards financial or cost barriers in challenging factors among homeowners on solar panel utilization for residential building is agreed by both of the respondents. R1 and R2 stated that this subfactor play an important role due to the current economic condition that are rising. R2 come up with the statement from the government as minimum salary is RM1500 and it can be a burden the homeowners.

F1 (b): Solar panel installation cost

For this subfactor, it is agreed by R1 but R2 disagree. R1 voiced out that solar panel installation cost is also an important element as it will the maintenance performance depend on the management. If the cost for management is secured so there will be no problem for the staff to do their job. However, R2 disagreed due to the solar panel installation cost is not an issue that need to be mainly focused for solar panel utilization for residential building. Solar panel installation cost is fixed as the workload is still the same.

F1 (c): Solar panel maintenance cost

This subfactor is agreed by both of the respondents. R1 mentioned that solar panel maintenance cost will determine whether the maintenance can be done with a good result or poorly. R2 stated that the price of specialist is way higher than a regular technician but their work is guaranteed worth the price paid.

F1 (d): Return Investment

This subfactor is also agreed by both of the respondents. R1 mentioned that solar panel utilization need for a long-time period for its return investment. R2 stated that this way can cause the homeowners need to wait for a-long time period to to satisfy with their choices as to install the solar panel.

Factor 2 : Lack of Awareness And Knowledge

F2 (a): Limitation of knowledge

First subfactor for lack of awareness and knowledge which is limitation of knowledge are agreed by the two respondents. R1 and R2 expressed that this subactor is the main reason for why the homeowners did not obtain the solar panel for their residential.

F2 (b): Lack of exposure in learning about solar panels

This subfactor is also agreed by the both of the respondents. R1 expressed that the students can gain the knowledge through their study learning in university while there is lack of exposure among homeowners about solar panel utilization. R2 mentioned that direct interaction with people especially the homeowners is important because it can lead to increased an interest engagement, motivation and help them improve their knowledge about solar panel.

F2 (c): Lack of involvement of technologists

This subfactor is agreed by the two of the respondents. R1 stated that involvement of technologists among researchers or university staff in sharing knowledge about solar panel utilization are important as to gain knowledge among students. R2 agreed with statement for involvement of technologists. Technologists have their own expertise in terms of solar panel. This is because experience technologists can deliver a good job even though they might be required high cost to be hired.

F2 (d): Lack of awareness on Sustainable Development Goals (SDG)

The last subfactor in lack of awareness and knowledge are also agreed by R1 and R2. R1 mentioned that the homeowners aren't widely aware of the Sustainable Development Goals (SDG) on the use of solar panels. R2 voiced out that it is important to know about the government's goal in terms of the Green Campaign because it can give advantages to homeowners.

Factor 3 : Lack of Government Incentives

F3 (a): Restricted initiatives of government towards solar panel utilization

For this subfactor, it was agreed by the respondents of R1 and R2. Both of them mentioned that current government need to introduce, create and increase incentives in terms of the use of solar panels in residential building as to attract an interest of the homeowners to obtain the solar panel.

F3 (b): Current government programmes are not well-supported

This subfactor is agreed by the two of the respondents. Both of the respondents declared that the current government program towards encouraging people especially homeowners to use solar panels is still lacking and low level. R1 suggested that government programmes need to consist of detail knowledge as to inform the public about what solar panels are and what are the advantages of utilizing them.

F3 (c): Lack of channels for information distribution to assist and guide consumers on how to apply for renewable energy incentives

For this subfactor, it was also agreed by the both of the respondents. R1 stated that mass media such as books, magazines, radio, movies, television, and the Internet need to need to publish an articles or news that related to solar panels so that the public knows more about solar panels. Then, R2 mentioned that the relevant parties can hold programs such as the Green Campaign in addition to holding exhibitions on solar panels.

F3 (d): The introduction of individual tax rebates

The last subfactor in lack of government initiatives are also agreed by R1 and R2. Both of them expressed that the government need to introduce individual tax rebates for potential solar users especially for the homeowners.

Other critical factors

Besides all of the critical factors mentioned earlier, R1 and R2 found other critical factors among homeowners on solar panel utilization for residential building. R1 mentioned other critical factor is difficulties in terms of resources to obtain solar equipment are limited and far from residential building area. R2 added by giving his perspective from weather issue. For any state that often occur heavy rain that may lead to flood, it may be one of the factor because the solar panel might be damage and affect for long term usage.

RESULT AND DISCUSSION (QUANTITATIVE METHOD)

According to distribution questionnaire data, more than the minimal number of respondents for small-scale research indicated in the preceding chapter had returned questionnaires in total. The total number of returned questionnaires has likewise surpassed the study's original target population of 200 to 250 respondents. As a consequence, this research study includes 240 respondents, which exceeds both sample population criteria, and the response rate is adequate to proceed with the analysis.

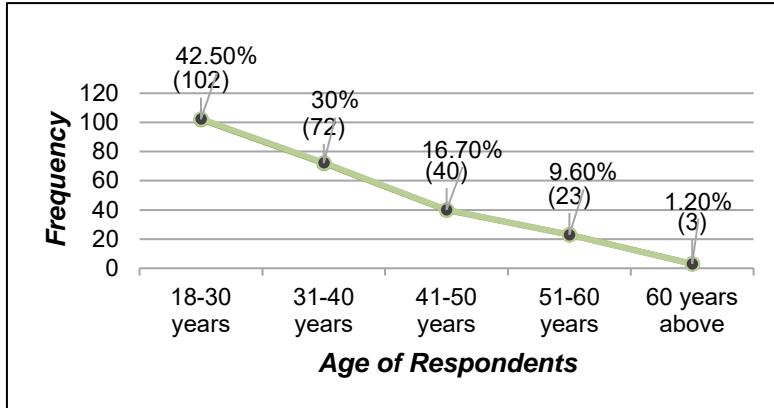


Figure 1: Age of Respondents

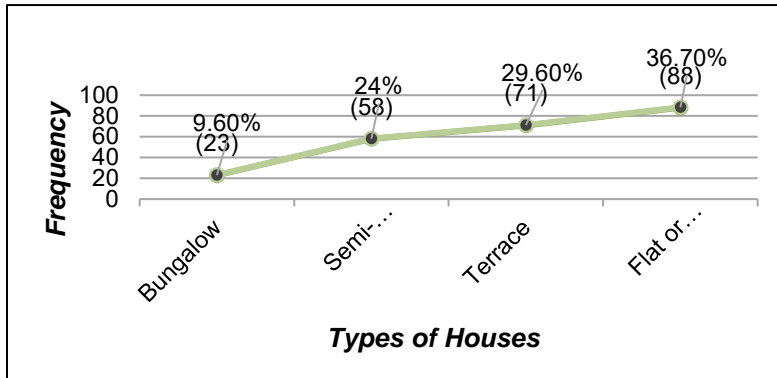


Figure 2: Types of Houses

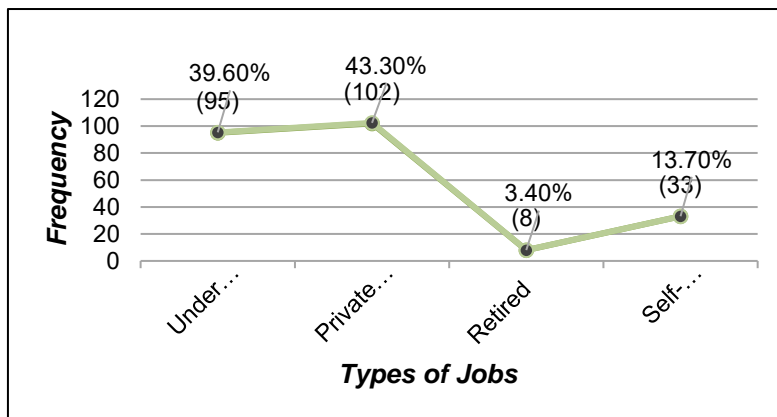


Figure 3: Types of Jobs

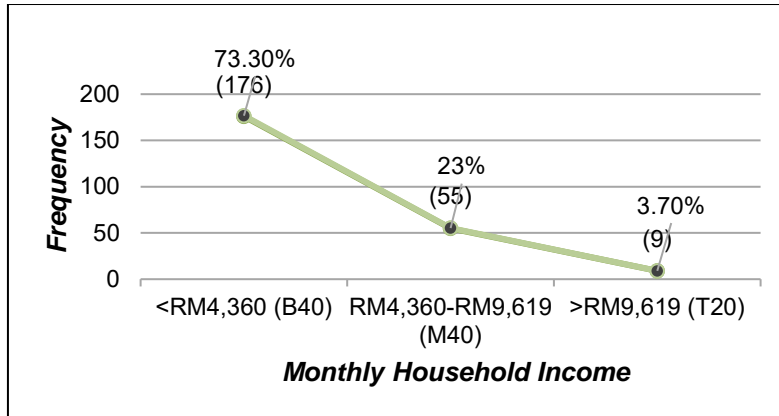


Figure 4: Monthly Household Income

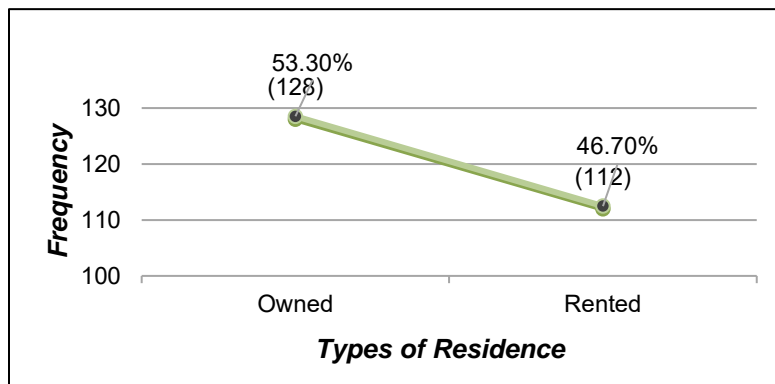


Figure 5: Types of Residence

The section B will be focused on the three (3) factors that have been chosen as the main factors in this research study. From the chosen main three factors, there are four (4) sub-factors under each of the main factors. These are the classification of the main factors and sub-factors:

- **Factor 1: Financial or cost barriers**
 - F1 (a): Financial constraints
 - F1 (b): Solar panel installation cost
 - F1 (c): Solar panel maintenance cost
 - F1 (d): Return Investment
- **Factor 2: Lack of awareness and knowledge**
 - F2 (a): Limitation of knowledge
 - F2 (b): Lack of exposure in learning about solar panels
 - F2 (c): Lack of involvement of technologists
 - F2 (d): Lack of awareness on Sustainable Development Goals (SDG)
- **Factor 3: Lack of government incentives**
 - F3 (a): Restricted initiatives of government towards solar panel utilization

F3 (b): Current government programs are not well supported
 F3 (c): Lack of channels for information distribution to assist and guide consumers on how to apply for renewable energy incentives
 F3 (d): The introduction of individual tax rebates

Table 4: Result of Factor 1- Financial or Cost Barriers

Factor 1: Financial or Cost Barriers				
Likert Scale	F1(a)	F1(b)	F1(c)	F1(d)
Strongly Disagree	1.3%	0.4%	0.8%	1.7%
Disagree	1.7%	1.7%	3.8%	4.6%
Neutral	6.7%	10.0%	10.4%	16.3%
Agree	37.9%	49.6%	50.8%	42.1%
Strong Agree	52.5%	38.3%	34.2%	35.4%

Table 5: Result of Factor 2- Lack of Awareness and Knowledge

Factor 2: Lack of Awareness and Knowledge				
Likert Scale	F2(a)	F2(b)	F2(c)	F2(d)
Strongly Disagree	0.8%	0.8%	1.7%	0.8%
Disagree	1.7%	0.8%	5.4%	1.3%
Neutral	8.3%	10.0%	26.3%	9.2%
Agree	46.3%	50.4%	42.9%	47.1%
Strong Agree	42.9%	37.9%	23.8%	41.7%

Table 6: Result of Factor 3- Lack of Government Incentives

Factor 3: Lack of Government Incentives				
Likert Scale	F3(a)	F3(b)	F3(c)	F3(d)
Strongly Disagree	0.8%	2.1%	1.3%	5.0%
Disagree	1.7%	3.3%	2.1%	15.0%
Neutral	15.4%	20.4%	13.3%	11.3%
Agree	43.8%	43.8%	53.3%	34.6%
Strong Agree	38.3%	30.4%	30.0%	34.2%

Table 7: Index Mean Value by Statistical Package for the Social Science (SPSS) software

Factors	N	Minimum	Maximum	Mean
F1(a)	240	1.00	5.00	4.39
F1(b)	240	1.00	5.00	4.24
F1(c)	240	1.00	5.00	4.14
F1(d)	240	1.00	5.00	4.05
F2(a)	240	1.00	5.00	4.29
F2(b)	240	1.00	5.00	4.24
F2(c)	240	1.00	5.00	3.82
F2(d)	240	1.00	5.00	4.28
F3(a)	240	1.00	5.00	4.17
F3(b)	240	1.00	5.00	3.97
F3(c)	240	1.00	5.00	4.09
F3(d)	240	1.00	5.00	3.78

The section of result and findings in section C will be focused on the respondent opinion towards challenging factors among homeowners on solar panel utilizations for residential building. There are several challenging factors that being mentioned by respondents for this research study. Nine (9) from all mentioned factors are being chosen and stated in the graph below.

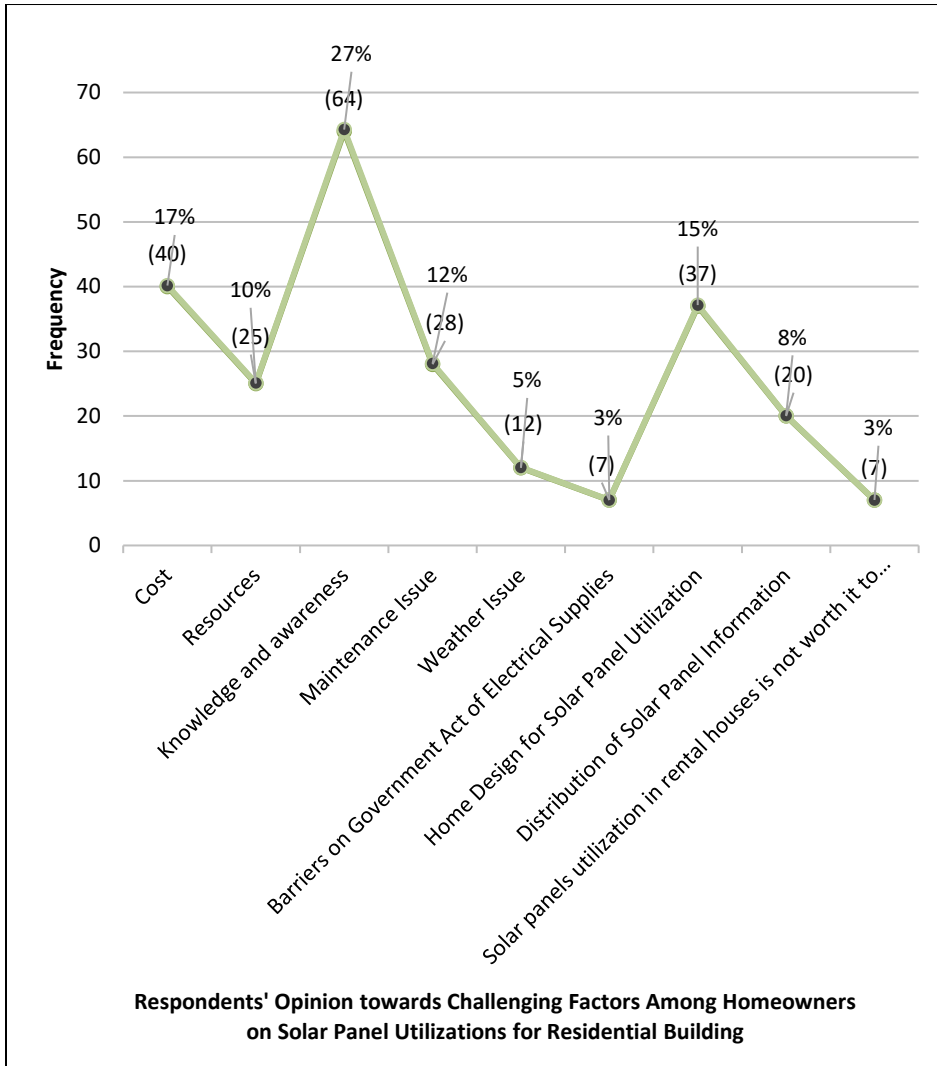


Figure 6: Respondents' Opinion towards Challenging Factors Among Homeowners on Solar Panel Utilizations for Residential Building

CONCLUSION

In conclusion, this study clearly described the challenging factors among homeowners on solar panel utilization for residential building and the conclusions gave clear insight into the study's purpose. The challenging factors among homeowners on solar panel utilization for residential building are influenced by financial or cost barriers, lack of awareness and knowledge, and lack of government incentives. To improve their knowledge and interest about solar panel

utilization for residential building, the homeowners need to increase their knowledge and awareness about solar panel utilization, encourage community engagement and create a sense of responsibility for sustainable energy practise, review the success stories of those who have previously installed solar panels, conduct a feasibility study to assess the viability of solar energy for residential building as prior installing solar panels and upkeep and surveillance of system's performance. Some recommendations for raising awareness among students, lecturers, and people especially homeowners regarding the advantages of utilizing solar panel. It is being provided to encourage people to improve their knowledge and interest about solar panel. These are some of the recommendations that being provided.

- The homeowners need to increase their knowledge and awareness about solar panel utilization for their residences.
- Encourage community engagement and create a sense of responsibility for sustainability energy practices.
- Review the success stories of those who have previously install solar panels to their residence.
- Conduct a feasibility study as it is imperative to assess the viability of solar energy for residential building as prior installing solar panels.
- Upkeep and surveillance of system's performance bymonitor the performance of solar panel system on regularly to ensure it is running at its optimum efficiency.

Further research needed to ensure that the research is properly equipped and increase the accuracy of the data collected. By doing more research regarding this topic, it will help the respondents comprehend the aim of the questionnaire and make it easier for them to respond. More accurate and thorough grasp of the study research, and more expert respondents were sought out. Proposed the most challenging factors to increase the level of awareness of solar panel utilization among homeowners for residential building. Increase the quality of respondents to collect more exact data that can be examined for more accurate study.

ACKNOWLEDGEMENT

The authors would like to express deep gratitude and extend a special thanks to the Universiti Teknologi MARA Perak Branch, Malaysia, for an invaluable support, funding, and professional contribution to this research project. Their commitment to expose, change the perception and improve the thoughts of building users regarding solar panel consumption has played a vital role in raising awareness of the importance of solar panel utilization. The collaboration and guidance from Universiti Teknologi MARA Perak Branch have been instrumental in the successful completion of this research. The expertise and resources provided by the university have greatly enriched the quality and depth of the study. The researchers have benefitted

tremendously from the academic environment and intellectual engagement offered by the university.

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Surat kami : 700-KPK (PRP.UP.1/20/1)

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