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The Study of Electrical Energy Consumption Generated from Solar Energy as A Renewable Energy Resource Applied by Theme Park in Malaysia

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ABSTRACT

The vast amounts of energy are required to keep theme parks operating. Thus, the problem of air pollution may be exacerbated by the increased use of electricity to power the attractions and facilities. Renewable energy technology is vital in reducing energy consumption and maintaining a clean environment. The purpose of this study is to identify the energy consumption of electricity generated from renewable energy technology of solar and to identify the barriers to implementing renewable energy technology at Malaysia's theme parks. Different parameters of energy systems such as electricity consumption and electricity charges have been proposed to answer the energy consumption of electricity generated from renewable energy technologies applied by theme parks in Malaysia. The investigation involved site observation and interviews at two theme parks in Malaysia, followed by questionnaire surveys at eleven theme parks that did not use renewable energy technologies. It is found that using renewable energy technology such as solar energy at ESCAPE theme park saves the cost of electricity charges by about 44%. The total cost of the ESCAPE theme park is not higher cost for about RM 1,074,644.60 compared to the total cost of Lost World of Tambun, which is about RM 1,849,784.40, based on a five-year estimation of all three costs for the theme park management in terms of initial cost, installation cost, and operation & maintenance cost for solar energy and electricity. The findings of this study can assist Malaysian theme parks to reduce energy usage and; as a result, spending less on electricity by utilising renewable energy technologies.

1. Introduction

People nowadays are constantly seeking better ways to spend their time. Good theme parks are a momentous occasion in the life of cities, and certain regions are well renowned for having the largest theme parks in the world. With an estimated 119 large theme parks, the global theme park industry has grown to be a significant component of leisurely, recreational, and tourism lifestyle habits in the industrialised world, with a market value of US$11 billion or AU$10.72 billion. According

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to Energy Saving Trust, over 250 million people visited a theme park in 2018. While in 2019, about 254 million visitors attendance is visiting amusement and theme park around the world.

Theme parks contribute indirectly to air pollution because vast quantities of energy are required to assure theme park functioning. According to Amusement parks and electricity by Scott Disney, pretty much all theme parks in this world use electricity, a lot of electricity for lighting up parades and floats. Many theme parks use power lines just like how people get to their homes, just amusement parks take way more electricity and amusement park electric bill is huge. With the number of visitors per year, it is very worrying towards the environmental impact. As a result, several big firms in the amusements sector are embracing sustainable and eco-friendly options in order to attract environmentally concerned clients. Therefore, numerous theme parks have evolved and are attempting to use renewable energy to power their rides and other attractions.

Natural resources that are continually renewed are the source of renewable energy, delivered on a schedule that is reasonable for people. Typically, this energy is used for things like transportation, heating, and the creation of electricity. This is due to the fact that they are more affordable and accessible thus, renewable energy sources are gaining popularity. Additionally, it can benefit community health as less fossil fuel usage is anticipated to have a positive impact on climate change and global warming scenarios. The production of energy from renewable sources also decreases air pollution and emits no greenhouse gases (GHGs). As energy demand increased by 2.3%, it has been noted that worldwide GHG emissions increased by around 1.7% in 2018 to a record high of more than 33 billion tonnes [1].

The use of solar, wind and other renewable energy sources allows these parks to save money, minimise carbon particle emissions into the atmosphere, and contribute to corporate obligations by being environmentally beneficial. Utilizing solar photovoltaic (PV) technology is one of the most widely accepted ideas and a critically important strategy for reducing the amount of energy consumed by projects, taking into account that the capacity to generate electricity is the primary crucial element of green facility design by Amran *et al.,* [2]. According to the International Energy Agency as described by Islam *et al.,* [3], worldwide energy consumption will increase by 53% by 2030, with emerging nations accounting for 70% of the increase in demand. The utilisation of boilers, generators, refrigeration systems, and other equipment in theme parks accounts for almost 91% of all greenhouse gas emissions, according to internal Disney corporate data. Additionally, the department is in charge of 73% of Disney's whole electrical use.

Solar energy has been described by Jayamaran *et al.,* [4] as the most promising source of clean, renewable energy is the conversion of sunlight into electricity using a solar cell placed in a solar panel and the power source with the most potential to address the world's energy challenges. According to Li *et al.,* [5] the usage of photovoltaic solar energy applications is the best technique to gather the sun's power, which would cut fossil fuel use. Singh [6] stated that conventional solar photovoltaic systems employ light energy to create electricity. Other than that, environmental pollution and global warming problems that were remarked by Al Waeli *et al.,* [7] might be decreased to lower ecologically dangerous gases that are routinely created in the generating of electricity. Since solar energy is an infinite, clean and safe source of energy, it has attracted a lot of attention as one of the most promising contenders to replace traditional fuels for power supply. Besides, Alamdari *et al.,*[8] stated that regardless of the country's condition, solar energy is the main engine for economic growth.

Solar according to Eicke *et al.,* [9] is not only frequently not just the most environmentally friendly option but also the most cost-effective. Because small-scale solar systems are becoming more economically appealing, decentralized photovoltaic capacity might rapidly expand. The typical solar photovoltaic panel on a commercial or industrial property might help firms save between 25 to 50% of their electricity costs. Aside from that, due to its availability, lack of pollution, and renewability,

solar energy has emerged as a promising alternative source. The efficiency of solar energy conversion is mostly determined by the photovoltaic panels used to generate power. This is the outcome of several efficiencies cascading into each other has been described by Piegari and Rizzo [10], the energy from the sun is delivered to the alternating current load via the solar array, regulators, batteries, cabling, and an inverter. Then the weather circumstances also have an impact on solar energy efficiency which is non-linearly related to irradiance and temperature.

Akikur *et al.,* [11] concluded that the renewable energy technology is one of the remedial strategies for global environmental issues and rising energy demands. Furthermore, solar energy in its different forms provides mankind with a clean, environmentally friendly, plentiful, and inexhaustible energy supply. Solar energy is divided into four categories by Singh [6]; such as solar heat, solar photovoltaic, solar thermal electricity, and solar fuels. Solar power is the direct or indirect use of photovoltaic or concentrated solar power to convert sunlight into energy. A renewable energy source known as solar energy involves capturing the sunlight energy and turning it into electrical power. The ability to capture and use solar energy has significantly increased since the middle of the 20th century, enabling homes and businesses to rely on renewable energy sources rather than more conventional methods of producing electricity. Most researchers thought that solar energy could be among the world's potential strategic power sources [12].

The first solar photovoltaic technology infrastructure installed at the ESCAPE theme park was has been proven to provide better electrical energy consumption at the theme park. The area is located at a base camp area for lighting use and the outdoor area of the park is also for lighting use. The Coronavirus outbreak in Malaysia in 2020 prevented ESCAPE theme park from achieving its goal of using renewable energy 100% in their theme park. However, only 40% of their goal to use solar energy in 2021 which was used for outdoor lighting at the base camp site, waterpark area, entrance, and wastewater treatment plant was really accomplished. As a result, the ESCAPE theme park still uses electricity in several locations.

Solar photovoltaics uses semiconducting materials to convert light into energy. It will be a financially feasible energy source for many applications by 2020. Concentrated solar power is a different technical method for generating energy from solar radiation. Nonetheless, according to Eicke *et al.,* [9], in 2017 solar power contributed for less than 3% of total worldwide electricity output. Solar photovoltaic, after hydropower and wind power, is the third most significant renewable energy source in terms of global capacity. World Energy Outlook published by the IEA [13], was described, in the Stated Policies Scenario, by the year 2035 solar photovoltaic may be the most advanced technology in terms of installed capacity worldwide. According to Ilham *et al.,* [14], Malaysia's climate, with its elevated amounts of sunlight is ideal for the development of solar energy, with an average daily solar insolation of 5.5 kWm2, or 15 MJ/m2. Malaysia's monthly sun irradiation is anticipated to be between 400 and 600 MJ/m2, and the country has the capacity to produce up to 6500 MW of solar energy.

Eicke *et al.,* [15] discovered that solar energy investment cost is by far the most expensive component. Sun energy has near zero variable operating costs since it needs no fuel other than free solar radiation. This cost structure differs fundamentally from typical generating methods. The installation of a solar photovoltaic system costs between 5,000 and 10,000 USD/kW. Moreover, Eicke *et al.,* [9] stated that solar photovoltaic panels have a 25-year lifetime. The lifespan of other minor components of a solar photovoltaic system, such as the converter, batteries, and others, ranges from 5 to 15 years. This advancement will reduce the cost of solar to less than 0.5 USD/W, making solar directly competitive on the grid and photovoltaic the preferred roof cover material globally. Photovoltaic cells can be used to charge electric cars, recharge mobile phones in distant regions, and

power corrosion-protection electrodes. Hence, photovoltaic systems are low-maintenance and have a normal lifespan of 20 years.

The ESCAPE theme park is now working to install solar energy as a fully integrated part of the theme park by 2023. In keeping with its green ecotourism concept, ESCAPE theme park will be the first in Asia to implement renewable energy technology features. The amusement park will use less energy and be carbon neutral due to solar panel installations. In their planning solar photovoltaic technology infrastructure will be installed at the ESCAPE theme park on a 6,000 square metre space. The area is located in a passive space of a sewage treatment plant. It will be entirely powered by renewable energy technologies. The ESCAPE theme park will become greener by relying entirely on renewable energy technologies.

However, the issue of sustainability, which comprises ensuring the security and stability of energy supply as well as diversifying alternative energy sources, is the main challenge facing Malaysia's power industry. The problem of security of supply and reliability is crucial to the successful implementation of development initiatives aimed at promoting Malaysian economic growth, although energy supply diversity is crucial to ensure that the country is not completely reliant on a single source of energy. The problems in establishing clean energy at Malaysia theme parks include a lack of experience and aptitude, then overlapping responsibilities amongst government agencies, and poor industry follow-through on government platforms.

According to Hanib [16], the majority of the knowledge during the design concept connected to sustainable theme park development is less competent in the theme park operating systems. Furthermore, the obstacles in improving technical and operational aspects such as a shortage of technical expertise, problems in the event of technological failure, other than that insufficient energy supply, and a lack of training facilities have been identified as part of the implementation of a green theme park. Kariuki [17] mentioned that previous research has revealed 7 categories of barriers to renewable energy adoption, including overreliance on fossil fuels (coal), political and regulatory barriers, technical barriers, market related-barriers, social-cultural barriers, financial and economic barriers, and geographical and ecological barriers.

2. Methodology

This study used a mixed-method research methodology. The methodology utilized two complementary methods that are qualitative methods and quantitative methods. A series of semi-structured interviews of energy consumption of electricity generated from renewable energy technology of solar energy being applied at the ESCAPE theme park and semi-structured interviews of energy consumption of electricity generated from non-renewable energy used at Lost World of Tambun. This method is used to identify the energy consumption of electricity generated from renewable energy technology of solar energy that is applied by Malaysia theme parks.

A questionnaire survey was used to collect data and information from respondents at 11 theme parks in Malaysia. There were consists of 32 variables of the barriers to implementing renewable energy technology at the Malaysia theme park. A pilot test and a reliability test were also conducted on the questionnaire instrument to identify errors in the questionnaire design. The Cronbach's Alpha reliability statistics are evaluated through a pilot test given to 30 respondents. To arrange the data acquired for this study, the Statistical Package Social Science (SPSS) version of IBM SPSS Statistics 24 was used. All acquired data are recorded using the widely recognised statistical analysis programme SPSS.

2.1 Electricity Charges between Escape Theme Park before Implement Solar Energy and Lost World of Tambun non Implementation Solar Energy for year 2020

Based on Figure 1 (a) in the year 2020, ESCAPE theme parks have not yet implemented a renewable energy technology of solar energy likewise Lost World of Tambun was not implementing solar energy at theme parks. Respectively, the highest electricity used by ESCAPE theme park and Lost World of Tambun in January 2020 is 64,897.84 kW/h and 80,621.51 kW/h. Therefore, the electricity charges in January 2020 for the ESCAPE theme park are RM33, 033.00 and the electricity charges for Lost World of Tambun are RM41, 036.35. However, Figure 1 (b), it can be seen that when making a study on electricity consumption between the ESCAPE theme park and Lost World of Tambun in 2021, it shows that ESCAPE theme park experienced a reduction in electricity consumption compared to Lost World of Tambun. This is because ESCAPE theme park has taken an initiative towards the use of clean energy by installing solar energy for the use of lighting in their theme park. For example, in December 2021 is the maximum value when the theme park started to open to visitors and operate, as usual, ESCAPE theme park only uses its electricity of 52,043.00 kW/h compared to Lost World of Tambun, the electricity used is 83,222.28 kW/h. About 31,179.28 kW/h differences in electricity consumption in December 2021 between the ESCAPE theme park and Lost World of Tambun. This is proven, although ESCAPE theme park does not use solar energy entirely in its theme park, only a small amount of solar energy is used for the lighting part only, it can also save in terms of electricity consumption in kW/h.

Month / Year	Dec 2020	Nov 2020	Oct 2020	Sept 2020	Aug 2020	Jul 2020	Jun 2020	May 2020	Apr 2020	Mac 2020	Feb 2020	Jan 2020
Escape theme park (Before implement solar energy)												
kW/h	47,740.67	20,235.76	47,740.67	36,345.78	41,846.76	47,937.13	24,950.88	47,740.67	36,345.78	47,937.13	64,897.84	64,897.84
Electricity charge (RM)	24,300.00	10,300.00	24,300.00	18,500.00	21,300.00	24,400.00	12,700.00	24,300.00	18,500.00	24,400.00	33,033.00	33,033.00
Lost world of tambun (Non-implementation solar energy)												
kW/h	62,376.03	48,694.70	18,344.13	11,837.21	11,279.17	10,550.69	26,576.19	65,102.95	22,826.72	59,208.25	40,554.03	80,621.51
Electricity charge (RM)	31,749.40	24,785.60	9,337.16	6,025.14	5,741.10	5,370.30	13,527.28	33,137.40	11,618.80	30,137.00	20,642.00	41,036.35

(a) (Electricity charges between escape theme park and lost world of tambun in year 2020)

Month / Year	Dec 2021	Nov 2021	Oct 2021	Sept 2021	Aug 2021	Jul 2021	Jun 2021	May 2021	Apr 2021	Mac 2021	Feb 2021	Jan 2021
Escape theme park (After implement solar energy)												
kW/h	52,043.00	31,445.00	11,864.00	7,666.00	7,306.00	6,836.00	17,175.00	42,031.00	38,228.00	14,756.00	26,193.00	39,638.00
Electricity charge (RM)	26,475.09	15,990.71	6,023.98	3,887.19	3,703.95	3,464.72	8,727.28	21,378.98	19,443.25	7,496.00	13,317.44	20,483.50
Lost world of tambun (Non-implementation solar energy)												
kW/h	83,222.28	50,265.50	38,582.26	12,219.06	11,643.06	10,891.06	27,432.32	67,203.08	61,118.27	23,563.06	41,862.28	64,388.80
Electricity charge (RM)	42,360.14	25,585.14	19,638.37	6,219.50	5,926.32	5,543.55	13,963.05	34,206.37	31,109.20	11,993.60	21,307.90	32,773.90

(b) (Electricity charges between lost world of tambun and escape theme park in year 2021)

Fig. 1. (a) Electricity charges between escape theme park and Lost World of Tambun in 2020
(b) Electricity charges between Lost World of Tambun and Escape Theme Park in 2021

2.2 Reliability Test for the Barriers of Implementing a Renewable Energy Technologies at Malaysia Theme Park

The purpose of reliability analysis is to determine the reliability of the questionnaire. The reliability test was carried out on 30 respondents in a Malaysian theme park that was Fantasia Aquapark from the eleven targeted theme parks in Malaysia. Cronbach Alpha was utilised to assess the reliability test in this study. According to Piaw [18], the acceptable results for the reliability test are above 0.7 and below 0.95.

Based on to Table 1, the indication of reliability test for the statement in the questionnaire of the 32 variables of the barriers to implementing renewable energy technologies at Malaysia theme park is .767. As a result, the reliability test for this part is satisfied. Based on the findings, demonstrates a questionnaire that was designed to match and be reliable by testing the responses.

Table 1
The result of reliability test of 32 variable of the barriers of implementing a renewable energy technologies at Malaysia theme park

Reliability statistics	
Cronbach's alpha	N of items
.767	32

3. Results and Discussion

The results were obtained from the output of electricity charges from two theme parks in Malaysia that are ESCAPE theme park and Lost World of Tambun. The first result of electricity bill charges from the ESCAPE theme park and Lost World of Tambun required to analyse was the energy consumption of electricity generated from renewable energy technology of solar energy being applied by the Malaysia theme park followed by the second result of the 32 barriers of implementing renewable energy technology at Malaysia theme park which has been proposed and the result of recommendation for the effective way for Malaysia theme parks to implement a renewable energy technology in the future for operating theme park.

3.1 The Energy Consumption and Charges of Electricity Generated from Renewable Energy Technology of Solar Energy that Being Applied by Malaysia Theme Park

Based on figure 2, the outcome result for the average year 2020 for the electricity cost of the ESCAPE theme park before the implementation of solar energy is RM22, 422.16 per month however the average year 2021 for the electricity cost of the ESCAPE theme park is RM12, 532.67 per month. Based on this average year for electricity cost at the ESCAPE theme park before and after implementing solar energy, ESCAPE theme park has saved 44%. In accordance with the previous above, as stated by Ng Wei Wei the UOB Malaysia deputy chief executive officer, a typical solar photovoltaic panel on the commercial or industrial property might help firms save between 25 to 50% on electricity costs. However, when practised in the real site, with this result, it can be concluded that ESCAPE theme park has proven successful in saving 44% of the cost of electricity charges after installing solar energy used for lighting in its theme parks in 2021. This is because solar energy is clean energy. Shafie *et al.,* [19] emphasized that solar energy is the most promising source of clean, renewable energy with the most promise for solving the world's energy problems. Therefore, by

using solar energy in the ESCAPE theme park, the cost of electricity charges can be saved by about 44%.

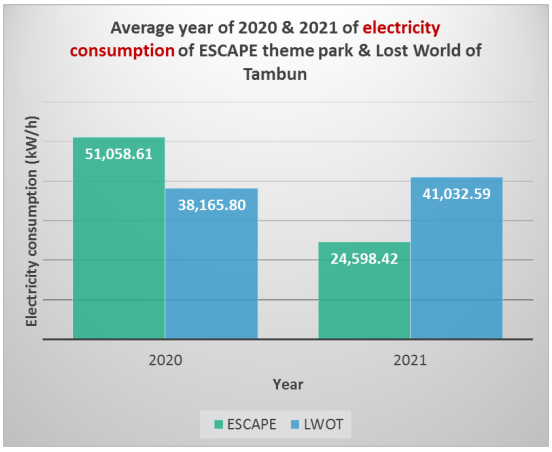

Fig. 2. Average year of 2020 & 2021 of electricity consumption of ESCAPE theme park & Lost World of Tambun

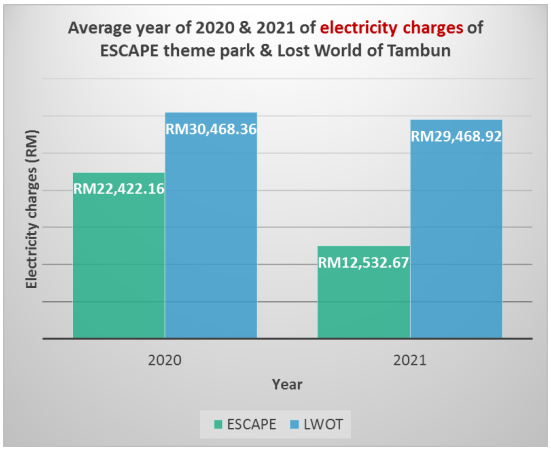

Fig. 3. Average year of 2020 & 2021 of electricity charges of ESCAPE theme park & Lost World of Tambun

Furthermore, Christian [20], theme park consumes around 200,000-megawatt hours of electricity each year. Additionally, according to AWANI news on 20th July 2022, in 'Dewan Rakyat' conferences, as stated by Minister of Energy and Natural Resources, Datuk Seri Takiyuddin Hassan, electricity subsidy may not be given again in the future. Therefore, the government hopes that the users will adopt the attitude of saving electricity as the subsidy given by the government will not be forever. Along these lines, Lost World of Tambun will be charged a high electricity bill in future when maintaining the use of electric power for the entire operation at the theme park.

3.1 The Barriers of Implementing a Renewable Energy Technologies at Malaysia Theme Park

Most of the respondents from 11 theme parks in Malaysia were strongly agree with the high cost of capital of renewable energy technologies and the second highest was agree on the perception of high cost and lack of awareness of environmental impact. This is because 52.50% who are strongly agreed with the high cost of capital, according to Yuosoff and Kardooni [21] reported that the initial capital cost of renewable energy is relatively high when compared to conventional energy sources, raising the cost of renewable energy generation. Furthermore, high investment costs continue to be a major barriers to the deployment of sustainable renewable energy solutions, as many manufacturers strive to keep initial investment costs as low as possible while maximising profits. Many poor countries, for instance, lack appropriate renewable energy technology and must therefore rely on imports from wealthy countries. As a result, initial investment costs are high, deterring potential investors, because imported technology from technologically inventive and wealthy countries is more expensive than locally manufactured technology. Higher costs and yet will decrease the monthly bill through Feed-in Tariff (FiT) as emphasized by Shadman *et al.,* [22].

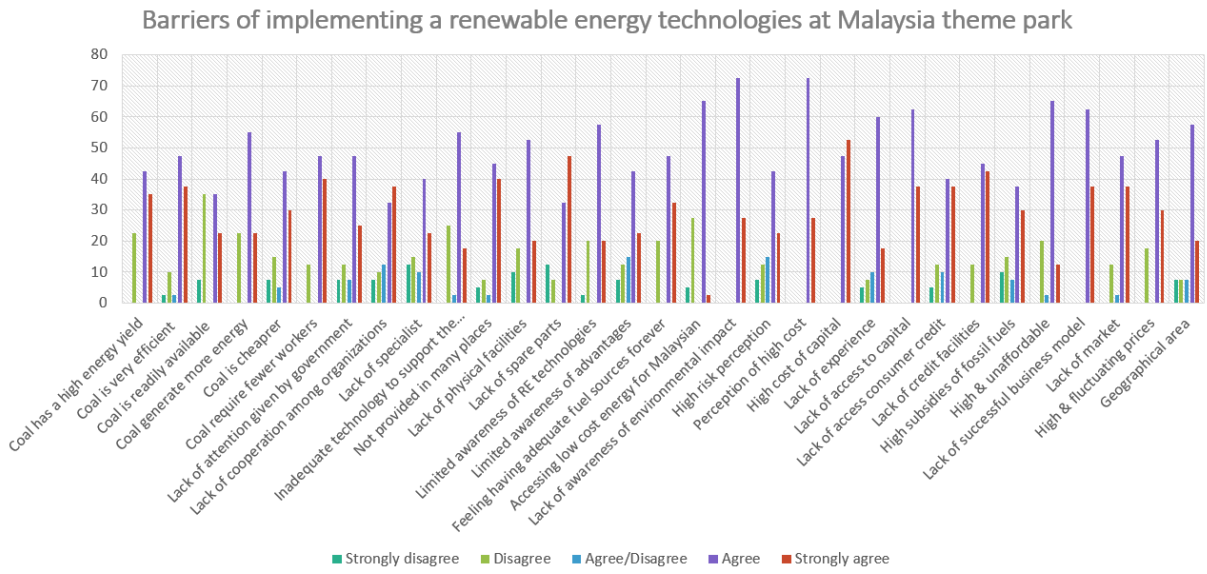

Fig. 4. Barriers of implementing a renewable energy technologies at Malaysia theme park

Meanwhile, the barriers to implementing renewable energy technology at the theme park renewable energy costs are perceived to be unrealistically high can be seen that most of the 11 theme park in Malaysia was agreed with 72.50% of perception of unrealistically high costs of renewable energy. It can be interpreted that majority 11 theme park in Malaysia are agreed with perception of unrealistically high costs of renewable energy this is most likely stated by Xiao *et al.,* [23], where the renewable energy compared to fossil technologies have proportionately high initial investments especially the major expenditure is the plant itself. Implementing sustainable infrastructure will be demanding for a company with limited financial resources. Additionally, as this will be a long-term profit return, the investor or developer will be more concerned with its profitability than environmental sustainability[24].

Additionally, in Figure 4 clearly shows that most of 11 theme park in Malaysia was exhibit agree of lack of awareness of the societal and/or ecological impact of non-renewable energy sources with the a value of 72.50%. This is because 72.50% who are agreed with the lack of awareness of the societal and/or ecological impact of non-renewable energy sources referred to Dalal-Clayton and Bass [25], in many countries the basic problem is a general lack of environmental awareness at all levels, which inhibits environmental decision-making by governments or more local authorities, as well as non-governmental actors' actions both large and small industries, users of natural resources, citizens, and others. This problem is arguably caused by the fact that many of these countries' education systems do not address environmental concerns. Therefore, when decision-makers reach such positions, they have little understanding of the concerns, and others are unaware of the potential environmental consequences of their actions.

3.3 Discussion of 5 Year Estimation Cost for Theme Park Management in Term of Initial Cost, Installation Cost, Operation and Maintenance Cost for Solar Energy and Electricity at ESCAPE Theme Park and Lost World of Tambun

It can be concluded that, from Figure 5, the outcome result obtained for 5-year estimation cost for theme park management in terms of initial cost, installation cost and operation & maintenance cost, the total cost for solar energy and electricity at the ESCAPE theme park and Lost World of Tambun can be seen that the total cost for the ESCAPE theme park is RM 1,074,644.60 lower than

the Lost World of Tambun is RM 1,849,784.40 for 5 years estimation total cost. The difference in total cost between both theme parks is about RM 775,139.80. The initial cost for solar lighting that was used in the ESCAPE theme park is RM 16,000.00 while the initial cost for normal lighting that was used in Lost World of Tambun is RM 10,666.00. However, the installation cost of solar lighting at the ESCAPE theme park is RM 10,000.00 meanwhile, the installation cost of normal lighting at Lost World of Tambun is RM23, 000.00. Besides that, the operation and maintenance cost for 5 years of solar lighting implementation at the ESCAPE theme park is RM 1,048,644.60 while the operation and maintenance cost for 5 years of normal lighting implementation at Lost World of Tambun is RM 1,816,118.40.

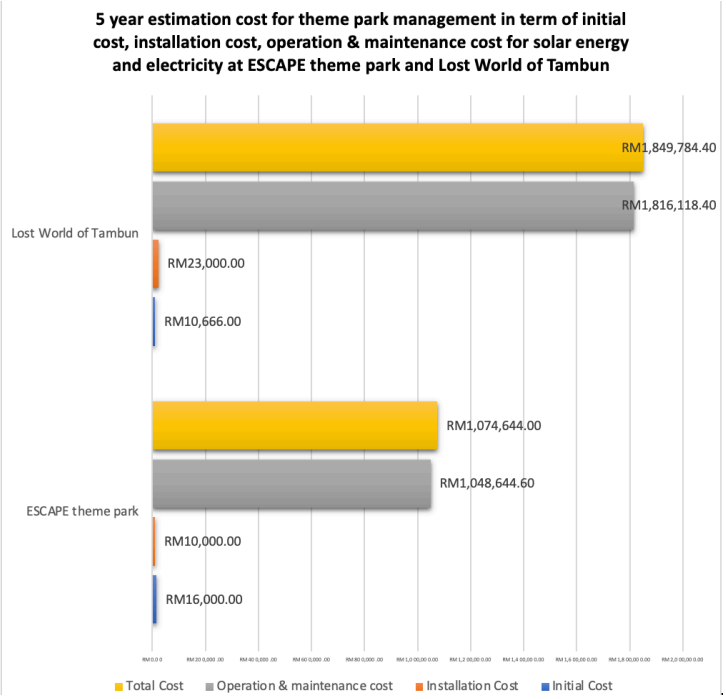

Fig. 5. 5 year estimation cost for theme park management in term of initial cost, installation cost, operation & maintenance cost for solar energy and electricity at ESCAPE theme park and Lost World of Tambun

It can be described that the total cost for solar energy implementation for 5 years estimation at the ESCAPE theme park is a lower cost compared to the total cost for electricity implementation for 5 years estimation at Lost World of Tambun is a higher cost. Solar lights, as described above by Becky Johanson, in the basics most common solar lighting economics, requires less maintenance than conventional lighting systems. According to SOLARVEST, solar energy also will save a lot of money and not only will it also increase property value. Moreover as indicated by Just Energy, solar energy has the potential to eliminate long-term energy expenditures while also lowering short-term energy bills. This is most likely stated by Ng Wei Wei the UOB Malaysia deputy chief executive officer, usually typical solar photovoltaic panels on commercial or industrial premises might help firms save between 25 to 50% of their electricity costs.

4. Conclusions

Theme parks have air pollution concerns due to the large amount of electricity required to keep the theme park running. For instance, fossil fuels have been consumed in order to power the rides

and amenities, moreover, it is also used for cooling the buildings and not only powering any lamps located along the theme parks. Theme park energy consumption can be reduced to 0% by using entirely renewable energy technology for theme park operation. Therefore, the total cost for solar energy implementation for 5 years estimation at the ESCAPE theme park is a lower cost compared to the total cost for electricity implementation for 5 years estimation at Lost World of Tambun is a higher cost. Findings of this study found that the use of renewable energy technology such as solar energy at ESCAPE theme park saves the cost of electricity charges by about 44%. The total cost of the ESCAPE theme park is not higher cost for about RM 1,074,644.60 compared to the total cost of Lost World of Tambun, which is about RM 1,849,784.40, based on a five-year estimation of all three costs of theme park management in terms of initial cost, installation cost, and operation & maintenance cost for solar energy and electricity. The results of this study, using renewable energy technologies can enable Malaysian theme parks to use less energy and, consequently, pay less for electricity. This also contributes to Malaysia's government's goal of achieving 50% renewable energy adoption by 2050. The government can provide other incentives or attractive offers such as offering affordable installation packages or rebates for the installation of solar panels in the theme parks industry in Malaysia.

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