GREENING RESIDENTIAL AREA THROUGH CLEANER PRODUCTION STRATERGIES DURING PLANNING STAGE

LOGHESHWARAN M.S.GUNA

MASTER OF SAFETY, HEALTH AND ENVIRONMENT ENGINEERING
FACULTY OF ENGINEERING
UNIVERSITY OF MALAYA
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Field of Study: ENVIRONMENT AND DEVELOPMENT

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GREENING RESIDENTAIL AREA THROUGH CLEANER PRODUCTION STRATERGIES DURING PLANNING STAGE

ABSTRACT

The rapid growth of the population will generate greater demand for housing construction. Throughout the lifespan of a house, the operation phase contributes to an increase in environmental problems such as global warming. This is due to energy usage in the operation phase of a home. To date, the electricity sector in Malaysia is excessively dependent on fossil fuels for electricity generation. The high amount of greenhouse gas (GHC) emissions is being emitted into the atmosphere due to the usage of fossil fuels for electricity generation, which contributes to global warming. Besides that, water usage and waste management also impact the environment during a house's operation phase. With that, a cleaner production strategy was implemented to green the residential area in the planning stage of housing construction. A cleaner production strategy is the continuous application of an integrated preventive environmental strategy to improve the overall efficiency in reducing emissions and wastes. A case study analysis conducted in Taman Templer Suasana residential area found that a small group of respondents practice cleaner production strategies in their homes. From the analysis of the case study, several cleaner production strategy options can be introduced to construct a new house. Twenty-three cleaner production strategies were introduced in greening residential areas in the planning stage of constructing new houses. This strategy compromises energy, water conservation, house design, housekeeping, and material used for constructing a new house.

Keywords:Cleaner Production(CP), Greenhouse Gases (GHG), Sustainable Development

PENGHIJAUAN KAWASAN KEDIAMAN MELALUI STRATERGI PENGELUARAN BERISH DI PERGINGKAT PERANCANG

ABSTRAK

Pertumbuhan pesat penduduk akan menjana permintaan yang lebih besar untuk pembinaan perumahan. Sepanjang jangka hayat rumah, fasa operasi menyumbang kepada peningkatan masalah alam sekitar seperti pemanasan global. Ini disebabkan oleh penggunaan tenaga dalam fasa operasi sebuah rumah. Sehingga kini, sektor elektrik di Malaysia terlalu bergantung kepada bahan api fosil untuk penjanaan elektrik. Jumlah pelepasan gas rumah hijau (GHC) yang tinggi dilepaskan ke atmosfera kerana penggunaan bahan api fosil untuk penjanaan elektrik yang menyumbang kepada pemanasan global. Selain itu, penggunaan air dan pengurusan sisa juga memberi kesan kepada alam sekitar semasa fasa operasi rumah. Dengan itu, strategi pengeluaran bersih telah dilaksanakan untuk hijau di kawasan kediaman di peringkat perancangan pembinaan perumahan. Strategi pengeluaran yang bersih adalah penerapan berterusan strategi alam sekitar pencegahan bersepadu untuk meningkatkan kecekapan keseluruhan dalam mengurangkan pelepasan dan sisa. Dengan analisis kajian kes yang dijalankan di kawasan kediaman Taman Templer Suasana, ia mendapati bahawa sekumpulan kecil responden mengamalkan strategi pengeluaran bersih di rumah mereka. Dari analisis kajian kes, terdapat beberapa pilihan strategi pengeluaran bersih yang boleh dilaksanakan dalam pembinaan sebuah rumah baru. Sejumlah 23 strategi pengeluaran bersih boleh dikenakan di kawasan kediaman penghijauan di peringkat perancangan pembinaan rumah -rumah baru. Strategi ini menjejaskan tenaga, pemuliharaan air, reka bentuk rumah, pengemasan, dan bahan yang digunakan untuk membina sebuah rumah baru.

Kata kunci: Pengeluaran Pembersih , Gas Rumah Hijau (GRH), Pembangunan Mampan

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LIST OF SYMBOLS AND ABBREVIATIONS

CP	:	Cleaner Production
GHG	:	Greenhouse Gases
CO_2	:	Carbon Dioxide
LED	:	Light Emitting Diodes
CFL	:	Compact Fluorescent Lamp

LIST OF APPENDICES

CHAPTER 1: INTRODUCTION

1.1 Background

The growth of the world's population in recent decades has led to an unprecedented demand for housing of about 100,000 households per year (UN ESCAP, 2015). It consumes 40% of the world's raw materials, 12.2% of the total water supply, and 40% of the world's energy. In 2017, Abd Rashid et al. studied housing in Malaysia. An environmental impact analysis found that the period of use in a residential area significantly impacts the environment (Abd Rashid, Idris & Yusoff, 2017). The need for change in the modus operandi is due to global warming. Global warming is a well-known phenomenon of industrialization worldwide. Many studies and reports reveal a disturbing view of the current situation on our planet and its long-term impact on humanity. Understanding the far-reaching impact of global warming on human life and the environment stimulates interest in sustainable development as a global remedy.

Promoting the sustainable development mission has been shaping the practice of all business sectors, including housing development, towards sustainable practice, which balances economic, social, and environmental performance. Promoting sustainable practice in housing development has resulted in developing various green strategies, especially for improving environmental performance in housing development. Existing studies have addressed the importance of green strategy and environmental performance by developers"(i.e., Shen et al., 2010; Waters et al., 2007; Eichholtz et al., 2009) extensively. The term "green strategy" in this study is defined as the approach that developers adopt to improve and gain sustainable competitive advantage by contributing to environmental protection, ecological responsiveness, and social responsibility. Green strategy is considered essential to implement sustainable development principles in the

built environment. Various green sustainable strategies can be implemented, such as(3 Rs- Recycle, Reuse and Reduce), Industrial Symbiosis, and circular economy. This type of method focuses more on the end-of-pipe approach. Whereby causes secondary pollution and waste to be generated. The most suitable strategy that can be used to improve the sustainability of residential areas will be using Cleaner Production (CP).

Cleaner Production (CP) is a driven environmental strategy that goes one step further than waste treatment or management, based on the cradle-to-cradle approach. It considers the cause of the problem (i.e., pollution prevention, P2) rather than its effects and consequences (e.g., treating the end of the pipeline and redoing the fix). CP is also a practical step towards sustainable development, enabling industries and service providers to produce more with less raw materials, less energy, less waste and emissions, and, in general, less impact on the environment. and sustainability (ASCE, 2022). CP has been used successfully in various industries in many countries, including Malaysia. Examples of CP implementations in the industry include the production of lead acid batteries in Australia (Dahodwalla & Herat, 2000), slaughterhouses in Brazil (Teresinha Kist, El Moutaqi and Leandro Machado, 2009), and the industrial production of printed cable boards (PCBs) (Lang) (Tseng, Hsu Lin, and S.F. Chiu, 2009) and Batik Industry in Malaysia "(Masrom, 2012) This strategy promotes industrial sustainability through efficient production, environmental management, and human development.

It is noted that most of the research papers focus on implementing cleaner production in the manufacturing industry. This is because the manufacturing industry has the most significant environmental damage compared with other industries. Besides the manufacturing industry, building residential area also significantly impacts the environment." As mentioned above by Abd Rashid et al., the operation phase of the

residential area contributes to higher environmental impacts due to the lifespan of the building. Thus, it is crucial to implement cleaner production strategies in building residential areas as in other industries(Abd Rashid, Idris & Yusoff, 2017).

1.2 Problem Statement

Malaysia's rapid economic and industrial growth is characterized by the development of urban areas with a mix of residential and industrial areas. These residential areas provide labor for the industry. Agenda 21 for developing countries' sustainable construction promotes economic systems' development (duPlessis, 2002). This is especially true for industrialization, depletion of energy and traditional raw materials, population growth, and rapid changes in the urban environment, contributing to environmental degradation in developing and developing countries due to environmental pollution. The negative internal impact of natural resources, the destruction of diverse flora and fauna for economic purposes, the pollution of water quality, air and noise, and industrial pollutants(Aliax Z, 1992; B. Hamm Muttaghi PK, 2001).

The productive population and housing growth rates in Malaysia are well above the national average. Klang Valley (including Kuala Lumpur and metropolitan areas), Georgetown Butterworth (including suburbs), Johor Bahru, Pasir Gudang Industrial Zone and some industrial areas. West Coast, East Coast and Sabah and Sarawak Regions (STRATEGY, 1998). These high-growth areas are expected to become important areas for economic opportunities, jobs and innovation as a result of rapid industrialization and urbanization. These fast-growing areas are expected to attract more and more people, increasing the demand for housing.

As mentioned above, the rapid growth will generate greater demand for housing construction. Therefore, it must understand the type of property ownership present in Malaysia. There are two types of property ownership in Malaysia: freehold and leasehold. Freehold is a type of ownership of land given to the owner for an infinite period. Where else for leasehold property ownership, the land is given to an individual for a certain period, 30,60,99, or 999 years. Most of the leasehold residential property is for 99 years. It is an essential factor in the housing construction sector. Given the longevity of buildings, this may affect the local environment and ecology locally and globally in the future (CIB, 1998; du Plessis, 2002; IPCC, 2009). Commercial and residential buildings in Malaysia account for about 13% of energy and 48% of electricity consumption (Al-Mofleh, Taib, Mujeebu & Salah, 2009; Energy Commission Malaysia, 2008). Power plants in Malaysia have always been heavily dependent on fossil fuels. According to the Malaysian Energy Commission, fossil fuels accounted for 44.2% of total energy consumption in 2017, with natural gas accounting for 38% and diesel accounting for 0.6 percent of total energy consumption. It is estimated that coal and natural gas combustion for electricity generation releases many greenhouse gases (GHG) into the environment. This contributes to adverse effects on the environment.

Malaysia's government and the community have focused on intelligent and sustainable housing planning. However, current housing laws focus more on the physical development of housing, and socio-cultural issues are often overlooked. A public housing policy or strategy focuses primarily on accessibility rather than permanent housing. Studies on these issues show that house construction is unlikely to be stable. All the information today shows the need to promote a broader understanding of the sustainability of housing in order to improve environmental protection and have a more significant impact on social life.

1.3 Research Questions

1. What are the current sustainability strategies used by the residents in the residential area?
2. What are the Cleaner Production opportunities that is applicable for greening residential area in planning stage?
3. What is the expected outcome in terms of environmental impact due to the conforming to the Cleaner Production strategy?

1.4 Aim and Objectives

This study is aimed in greening residential in planning stage of housing construction by reducing the environmental impact. The objectives of this study are listed below.

1. To determine the current sustainable approach from building the current case study residential area.
2. To identify opportunities of cleaner production in the planning stage of building residential area.
3. To propose improvement in terms of energy and water usage and reduce environmental damages in the long operational life span for residential area using cleaner production.

1.5 Scope of study

This study was carried out in Klang Valley. The current build residential area was analysed and interpreted. The data required for these studies was obtained using quantitative method. A set of questions was distributed to 30 volunteers to perform the survey. The volunteers were diverse in the sense of size of residential area, number of occupant in the house, age, occupations and type of residential property. Based on the survey conducted, the environmental impact from the current build residential area was

reviewed and cleaner production (cp) strategies was proposed for upcoming residential projects.

1.6 Outline of Project Report

As for this research project, the outline for 5 chapters is shown below:

Chapter 1: Introduction

Background introduction of the research project, current problem faced due to development of residential area. The problem statement, objectives, scope of research study were stated in this chapter.

Chapter 2: Literature Review

Global warming was discussed in literature review due to rapid urbanization and demand for construction new residential area. Related environmental issues, greening strategies, cleaner production (CP) and implementation of cleaner production were discussed in this chapter.

Chapter 3: Methodology

In this chapter, a case study will be conducted on a build residential area. The method used for this case study will be conducted using questionnaire/survey forms to determine current sustainable approach being practice in residential area.

Chapter 4: Results and Discussion

Collected data from the questionnaire/survey were analysed. Based on the analysis, a suitable framework for greening residential area using cleaner production strategies was introduced.

Chapter 5: Conclusion and Recommendation

In this chapter, conclusion of the research study about the findings and proposal of recommendation for upcoming studies

CHAPTER 2: LITERATURE REVIEW

2.1 Global Warming

Through much of the late nineteenth century, global average temperatures of the Earth's climate system risen exponentially, and it is expected to continue to climb in the following years and decades as well.

Ever since beginning of the twentieth century, the average surface temperature of the Earth has risen by around 0.8 degrees Celsius (1.4 degrees Fahrenheit), with approximately two-thirds of this temperature hike occurring since 1980. The National Academies Press published a book in 2011 titled It is mostly caused by greenhouse gas (GHG) emissions into the atmosphere that are caused by humans. It is possible to manufacture many types of greenhouse gases that contribute to global warming, and humans do so in a variety of ways. The bulk of carbon dioxide emissions is due to the combustion of fossil fuels in automobiles, factories, and power plants, among other sources.

Since of global warming, which has been a major source of concern since the early 1990s, and because it continues to constitute a serious threat to human life and the environment unless strong steps are taken to tackle the situation. When the United Nations Framework Convention on Climate Change (UNFCCC) was created in 1988, it was to investigate the current impacts of global warming on humans and the environment. After a decade of research, the United Nations Environment Programme published its first assessment report in 1990, which looked at the consequences of global warming on humans and nature. A decade later, the United States Framework Convention on Climate Change (UNFCCC) was established, which recognised climate change as a worldwide

issue that necessitated coordinated efforts and an united path of action by all nations in order to be properly handled.

"The ultimate goal," according to the United Nations Framework Convention on Climate Change (UNFCCC), is to reduce "greenhouse-gas emissions from human-caused sources in the atmosphere to levels that prevent potentially hazardous anthropogenic (human-caused) interference with the climate system" must be created (Ministry of Natural Resources and Environment Malaysia, 2011). A threshold of less than 2 degrees Celsius in global mean temperature rise is advocated by the Paris Agreement, which has been signed by 175 countries, and preferably less than 1.5 degrees Celsius, during the course of the next century, rather than more than 2 degrees Celsius (UNFCCC, 2015). According to current estimates, worldwide annual greenhouse gas (GHG) emissions must be reduced by 42–57 percent by 2050 (particularly when compared to 2010 levels) and 73–107 percent by 2100 in order to meet the 2°C target (IPCC,2015)

Malaysia is the fourth-largest greenhouse gas emitter in the Association of Southeast Asian Nations (ASEAN), trailing only Indonesia, Vietnam, and Thailand, and accounts for 0.52 percent of global carbon emissions. Malaysia is the fourth-largest greenhouse gas emitter in the Association of Southeast Asian Nations (ASEAN). According to Malaysia's climate change commitment, the country's greenhouse gas emissions must be reduced by 45 percent by 2030. The country has already made significant strides in this direction, including the development of carbon-neutral cities, the provision of tax breaks to businesses that report and limit their emissions, the acquisition of more environmentally friendly government assets, and the planting of more than 13 million new trees since 2011. The Star newspaper published an article on September 19, 2016, noting that Malaysia has typically embraced precautionary policies,

which include steps to prevent or adapt to climate change, rather than the inverse of this policy.

According to the International Energy Agency, carbon dioxide, methane, nitrous oxide, and fluorinated gases are the four most significant greenhouse gases that contribute to global warming. As reported by the United States Environmental Protection Agency in 2010, the largest sources of greenhouse gas emissions in the United States include power generation (34%), transportation (27%), industry (21%), commercial and residential (11%) and agricultural production (7 %). As for this calculation, a 15 percent offset is applied. The combustion of fossil fuels for energy, as well as the use of specialised chemical processes to make finished goods from raw materials, are the primary sources of industrial greenhouse gas emissions (USEPA, 2013).

When it comes to climate change, the Ministry of Natural Resources and Environment (2009) advocates for a comprehensive approach to adaptation and mitigation that takes into account all variables. According to the Department of the Environment (DOE), climate change is more than simply a trend that should be taken into consideration. The DOE stated in 2014 that the effects of rising global temperatures would manifest themselves through weather variations. The indirect effects of climate change on human health are in addition to the direct and indirect consequences of climate change on ecosystems, freshwater resources, flooding, forest products (including timber), the coastal system (including low-lying areas and tiny islands), industry, society, and health.

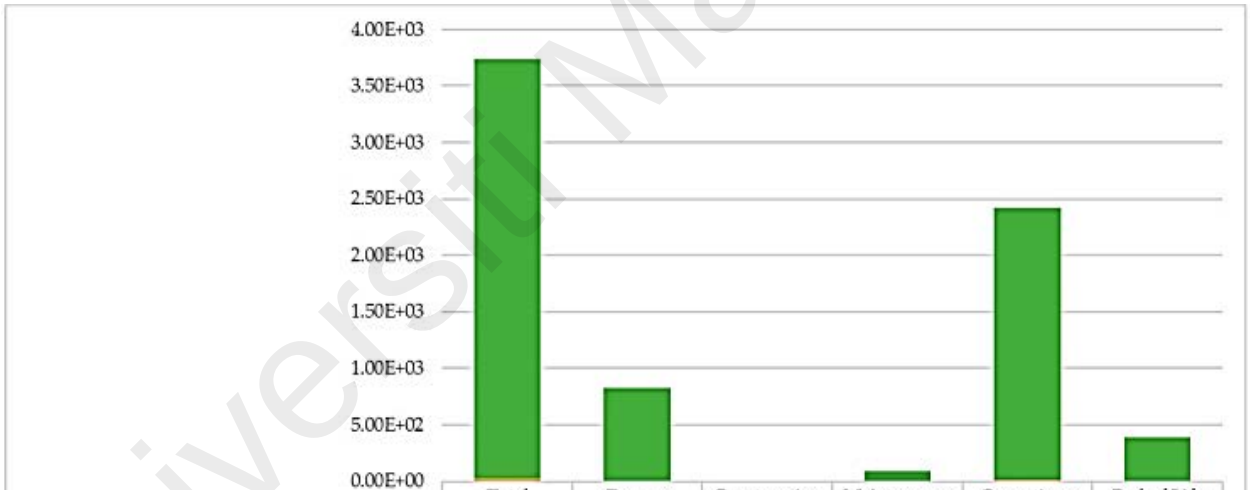
2.2 Construction Industry in Malaysia

In addition to making a significant contribution to the country's cash generation, the construction sector in Malaysia also makes significant contributions to the development of social and economic infrastructure and buildings in the country. Around 800,000 people are employed in the industry, which accounts for around 8% of all employment in the United States. When it comes to high-yielding businesses that contribute to the nation's economic development, the construction industry is one of the best examples. According to the most recent estimates, Malaysia's Gross Domestic Product (GDP) expanded by 5.3 percent in 2007, with the construction sector accounting for 2.1 percent of total GDP (CIDB, 2006). The construction industry is dependent on the provision of housing as a critical component. Reaping the benefits of the exponential increase in population, real estate investment helps to domestic wealth creation through asset accumulation, and it has become one of the fastest expanding businesses in the world in recent years. In terms of economic development, Malaysia has maintained a consistent rate of growth since 1957. Because of Malaysia's consistent economic success since 1957, the country has seen an expansion in the construction of buildings and infrastructures, with little consideration for environmental protection or the welfare of the local populace.

When compared to other industries, the construction sector has made considerable contributions to economic and social growth. However, it is commonly perceived as being one of the most significant sources of pollution and other environmental problems. As a result of the traditional house-building processes employed in Malaysia, this has occurred (UNEP,2007). According to current research, as a result of this, Malaysia is seeing a rise in construction waste material output, energy waste, deforestation, landslides, and harm to endangered animals and flora, among other consequences. Malaysia is also experiencing an increase in soil erosion, deforestation, and landslides (Zainul ,2012).

Construction, according to Roodman et al., contributes to approximately one-third of global freshwater withdrawals, twenty-five percent of global wood harvesting, and forty percent of global material and energy flow.

As a result of certain important repercussions, Ahmad Faiz and colleagues used the Life Cycle Analysis (LCA) technique to undertake a study on the entire home building life cycle, which includes the phases of pre-use, construction, use, and end-of-life. According to the authors' observations, the phase of the house's operation has a significant impact on its global warming potential (GWP). The Life Cycle Analysis is depicted in its entirety in Figure 2.1.



	Total	Pre-use	Construction	Maintenance	Operations	End of Life
Ozone layer depletion (ODP) (kg CFC-11 eq)	3.77E-05	2.39E-05	2.03E-07	9.42E-06	1.31E-07	4.05E-06
Global warming (GWP100) (kg CO_2eq)	3.72E+03	8.25E+02	3.29E+00	9.19E+01	2.41E+03	3.89E+02
Eutrophication (kg PO_4eq)	3.81E+00	6.19E-01	5.04E-03	1.49E-01	1.12E+00	1.92E+00
Acidification (kg SO_2eq)	1.51E+01	3.23E+00	1.74E-02	4.09E-01	1.10E+01	4.62E-01

Figure 2. 1 Life cycle analysis by (Abd Rashid, Idris & Yusoff, 2017).

Comparing global warming contributions from the pre-use and construction phases, as indicated in Figure 2.1, the operation phase is the most significant contributor when the pre-use and construction phases are combined. It is anticipated that the house will utilise fossil fuels to generate energy during the duration of its 50-year existence, which will add to this statistic. According to the author's calculations, the total power

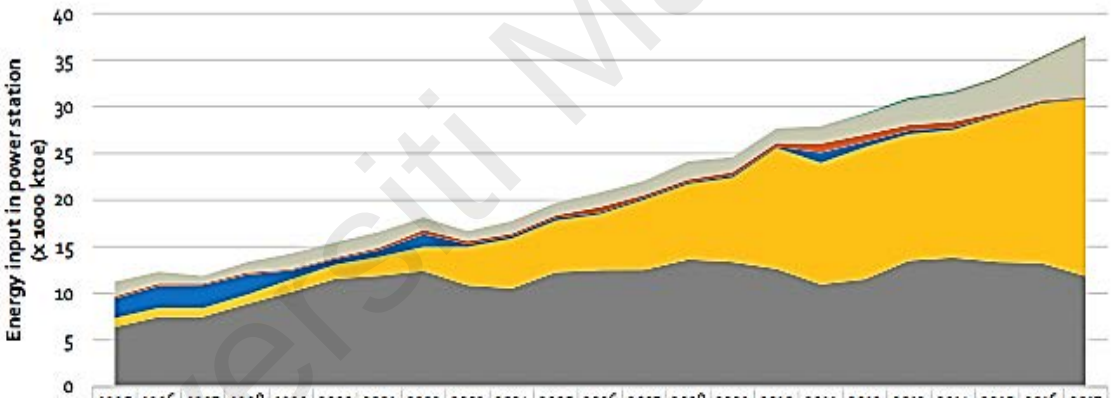
utilised by the house throughout its operation over a 50-year lifespan would be around 2949.78kwh in total. Another point to consider is that, due to the large amount of cement in concrete-based construction sections (varying from 77 percent to 53 percent to 81 percent), pre-use has the biggest influence on the global warming potential of all construction methods (GWP). Furthermore, research has indicated that buildings emit an average of 80% of greenhouse gases (GHG) when they are in use, with the majority of this emission being attributable to the building's lifespan (UNEP-SBCI, 2010; Huovila et al., 2009; WBCSD, 2009).

2.2.1 Electricity Generation in Malaysia

Following the research in Section 2.1, both the pre-use and building phases contribute to global warming, but the operation phase is the most significant contributor overall. It is vital to evaluate the kind of property ownership when determining the phase of operation of a residential neighbourhood's operations. In Malaysia, there are two types of ownership: freehold and leasehold. Freehold ownership is the most common type. The most common type of ownership is freehold ownership. It is a sort of land ownership in which the owner is granted the right to utilise the land for an infinite period of time that is referred to as "freehold." In order for a person to achieve leasehold property ownership, the land must be granted to them for a certain period of time (30, 60, 99, or 999 years). The bulk of residential leasehold property is held on a permanent basis for 99 years, with the exception of a few exceptions (NHBA, 2022). By 2021, the existing property supply in Malaysia is expected to reach 5.9 million units, according to research done by NAPIC and the JPPH Institute. By 2025, it is estimated that the housing supply in the Klang Valley would have increased to 2.1 million units. (NPCI,2022). With an increase in the

supply of housing and an increase in the length of time that people live in their houses, a significant quantity of power is necessary to keep the house operational.

Malaysia's energy input into power plants has always been heavily reliant on fossil fuel suppliers, as illustrated in the chart below. According to the Malaysian Energy Commission, fossil fuels accounted for 44.2% of total energy consumption in 2017, with natural gas accounting for 38% and diesel accounting for 0.6 percent of total energy consumption. There was a 17.1 percent contribution from hydroelectricity, which is a renewable energy source. Figure 2.2.1 depicts the total quantity of energy consumed by power plants from 1995 to 2017, with the most recent data available in 2017.



	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Solar	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.01	0.04	0.06	0.08	0.09	0.09
Biogas	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.01	0.01	0.02	0.02	0.04
Biomass	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.07	0.16	0.10	0.07	0.06	0.05
Hydro	1.5	1.2	0.8	1.1	1.7	1.6	1.7	1.3	1.1	1.3	1.3	1.6	1.5	2.0	1.6	1.6	1.9	2.2	2.7	3.0	3.6	4.5	6.2
Diesel	0.3	0.3	0.2	0.3	0.2	0.2	0.3	0.5	0.3	0.3	0.3	0.6	0.3	0.3	0.4	0.4	1.0	0.8	0.6	0.6	0.3	0.2	0.1
Fuel oil	2.1	2.4	2.5	2.1	1.0	0.6	0.7	1.4	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.1	1.1	0.6	0.4	0.3	0.1	0.2	0.1
Coal	1.0	1.0	0.9	1.0	1.3	1.5	2.0	2.6	4.1	5.3	5.5	6.0	7.5	8.1	9.0	13.0	13.0	14.1	13.5	13.6	15.6	17.1	19.0
Natural gas	6.4	7.5	7.5	8.9	10.2	11.6	11.9	12.4	10.9	10.5	12.3	12.5	12.5	13.7	13.4	12.6	11.0	11.5	13.5	13.9	13.4	13.3	11.9

Figure 2. 2 Energy Input in power station from 1995 to 2017(ECMEI, 2017)

Following coal as the most important source of energy for power generation in Malaysia, natural gas and petroleum have taken second and third places, respectively, in the graph above. It is estimated that the combustion of coal and natural gas for the generation of electricity releases a large amount of greenhouse gases into the environment

(GHG). According to a study conducted by Siti Norasyiqin and colleagues in 2017, entitled "The Status of Energy Resources and Greenhouse Gas Emissions," utilising coal and natural gas to create power increases carbon dioxide emissions, and they got to this result. Figure 2.1.2 depicts the total amount of carbon dioxide emitted over a period of time.

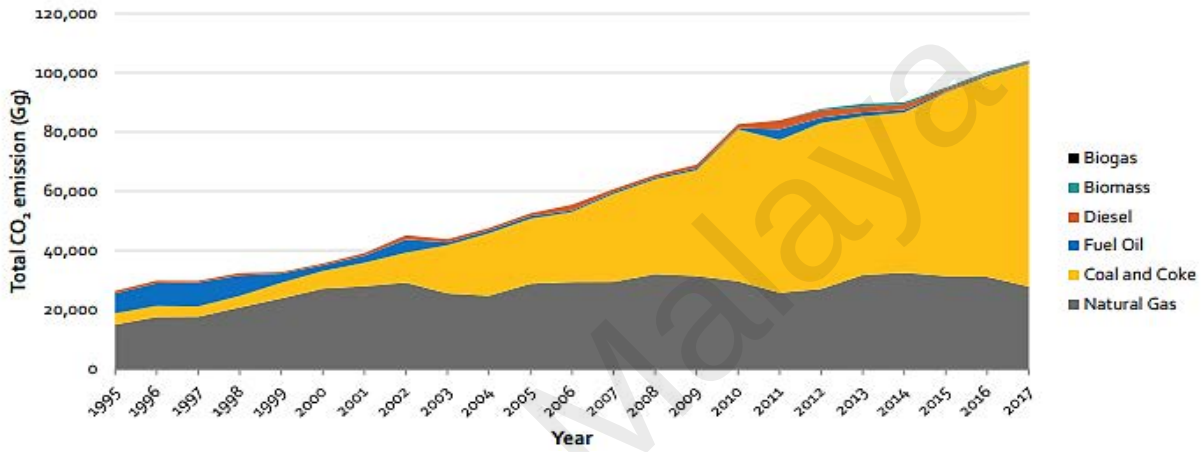


Figure 2. 3 Overall Carbon Dioxide Emmison(Siti Norasyiqin, 2017)

2.3 Sustainable Development in Malaysia

It is widespread knowledge that the term "sustainability" is associated with the United Nations Development Programme, which was established by the World Commission in the late 1980s. The Brundtland Commission's original recommendation in the Brundtland Report was to promote "sustainable development" as a means of achieving environmental protection while also achieving economic growth (Dresner, 2002). This agenda defines sustainable development as development that meets existing demands without undermining future generations' capability to satisfy their own goals. The initial application of this technology was to address environmental challenges resulting from development operations. Its relevance has also been applied to the level of quality in the construction of houses (Choguill, 2007). In the home development industry,

it is critical to maintain a balanced appraisal of social, environmental, and economic demands always.

For numerous decades, the development of Malaysia's sustainable industrial growth has been a national objective. The National Green Technology Policy (NGTP) was developed by the government in 2009 with the goal of promoting long-term economic development (Abualrejal et al, 2017). The National Green Technology Policy (NGTP) encourages the use of green technology in critical areas such as energy, construction, water, waste management, and transportation in order to reduce carbon emissions and safeguard natural resources.

2.3.1 Importance of greening the industry

Specifically, according to the National Technology and Growth Plan, the green industry serves as an effective entry point and motivating force in the transition to a green economy and subsequently to sustainable development. Efforts to improve industry and expand productive capacity while simultaneously lowering resource consumption and harming the environment are emphasised by environmentally friendly industrial practises. In order to achieve one of the objectives, emerging and transition economies are encouraged to actively participate in the creation of solutions that will allow them to continuously improve their environmental performance. (UNIDO)

Environmentally friendly industrial production and development, as defined by the United Nations Industrial Development Organization (UNIDO), is defined as industrial production and development that does not harm the health of natural systems or have a detrimental influence on human health. In order to achieve this, eco-friendly manufacturing aims to integrate environmental challenges such as pollution, climate

change, and social issues into economic activity. It creates a framework for solving global, interconnected challenges by employing a variety of instantly applicable cross-cutting concepts and tactics that take advantage of growing industry and market dynamics, among other things (UNEP, 2015). It is the concept of encouraging environmentally friendly consumption and production practises in the manufacturing of items that is referred to as the "green industry." This includes both the greening of existing commodities and the establishment of green businesses that supply ecologically friendly goods and services to the general population. A green industry requires manufacturers to accept responsibility for the environmental effects of their products or services throughout the product or service's life cycle (UNIDO, 2011).

Green Industry adopts a two-pronged strategy that encompasses both environmental conservation and economic development in order to build an industrial system that does not succeed and expand by relying on ever-increasing consumption of natural resources and pollution. Making existing businesses more environmentally friendly and establishing new “Green industries” is shown in Figure 2.4 (UNIDO,2011).

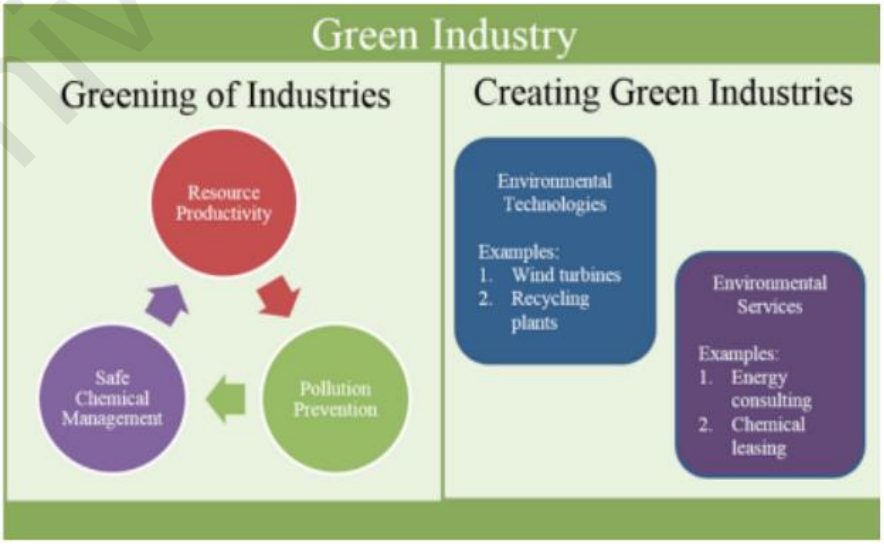


Figure 2. 4 Comparison of greening of industry and creating green industries (UNIDO,2011)

A Green Industry strategy tries to incorporate environmental and social issues into the operations of a firm. This is accomplished through the use of green technologies. This can be accomplished by demonstrating how enhanced resource utilisation can result in cost savings and, as a result, increased competitiveness. It also provides an opportunity for industries, particularly those in emerging and transitioning nations, to actively participate in the development of Green Economy solutions and technology, among other benefits. Through the use of green industry approaches, industrial modernization and production capacity increase can be accomplished while utilising less resources and emitting less pollutants (DCED, 2012).

2.3.2 Advantages of Greening the Industry

When it comes to industrial areas such as operations, processes, and products, implementing greening initiatives has several advantages, including:

1. The implementation of strategies such as the dematerialization of products and value chains, the use of materials with longer service lifetimes, the replacement of virgin materials with recycled materials, the recycling, re-use, and recovery of materials, energy, and water, as well as the use of materials, water, and energy from sustainably managed or low-impact sources can all help to increase the productive use of materials, water, and energy in industrial production.

2. Maximize the efficiency of process operation, monitoring, and maintenance while minimising waste. This includes the application of innovative process technologies that are more efficient and specific in their application. It also includes the recovery of process streams through recycling, reuse, or recovery to reduce and, where possible, eliminate polluting emissions in factories.

Imperative to reduce the risks associated with chemicals and (hazardous) wastes by implementing sound chemical management strategies and phasing out toxic and other environmentally harmful substances (including those that contribute significantly to ozone layer depletion and/or climate change), as well as by implementing Best Environmental Practices and Best Available Techniques to prevent the unintended formation of anodes and other harmful by-products of combustion

2.4 Approach In Greening The Industry

When it comes to greening an industry, there are a variety of practical techniques available. The following are some examples of approaches: (according to United Nations Escap, 2014).

2.4.1 Circular Economy

A "circular economy" is defined as an economy built on revolving dollars, also known as a restorative or regenerative industrial system, and it is characterised by the use of revolving dollars. End-of-life concepts are being replaced by concepts of restoration, renewable energy is being utilised, toxic chemicals are being avoided, and waste is being minimised as a result of improving the design of materials, products, systems, and business models, among other things (Ellen MacArthur & Waughray, 2014). In a circular economy, firms maximise the use of every resource they use by operating in an efficient manner. In part because items are intended to be reused to the greatest extent possible, the initial labour, materials, and capital investments are more valuable than they would have been. Businesses that adopt a circular economy approach have the ability to decouple economic success from the limitations imposed by limited resources. The rise in the price of commodities and energy has played a significant role in this transition in the global economy.

2.4.2 Industrial Symbiosis

Implementing waste (materials, water, and energy) generated by one sector as an alternate input for another sector that is adjacent to it has the potential to be very beneficial. Making the switch to a circular system lowers costs while simultaneously creating jobs. Once an eco-industrial park has been established and connected with other municipal environmental management activities, it can serve as a typical example of industrial ecology. Recently, there has been a tremendous growth in public awareness of the subject in comparing industrial symbiosis in different regions, which has resulted in a better understanding of the phenomena (Rene van Berkel, 2009).

2.4.3 Reduce, Reuse and Recycle

The "3Rs" are the concepts of reducing waste, reusing resources, and recycling materials and other objects. Making the option to use products with caution in order to limit waste generation is known as reducing. Recycling and reusing are different concepts. Reusing is the ongoing use of objects or portions of products that are still usable, whereas recycling is the utilisation of waste as a resource (Department of Environment 2009). Reduce, reuse, and recycle are the three R's of waste reduction, and focusing on the first of these three R's, "reduce," can help you execute your waste reduction more efficiently. The "3Rs" of garbage management are referred to as the trash hierarchy, and they rank waste management solutions according to their attractiveness. The three Rs are intended to function as a priority hierarchy. Over the previous decade, the waste hierarchy has taken on a variety of shapes and forms, but the fundamental notion has remained the same. In recent years, the waste hierarchy has taken on several different shapes, but the fundamental notion has remained the cornerstone of the majority of waste reduction programmes. The goal of the waste hierarchy, as depicted in Figure 2.5, is to obtain the

greatest possible practical benefits from items while producing the least amount of garbage possible (Rissanen, 2010).

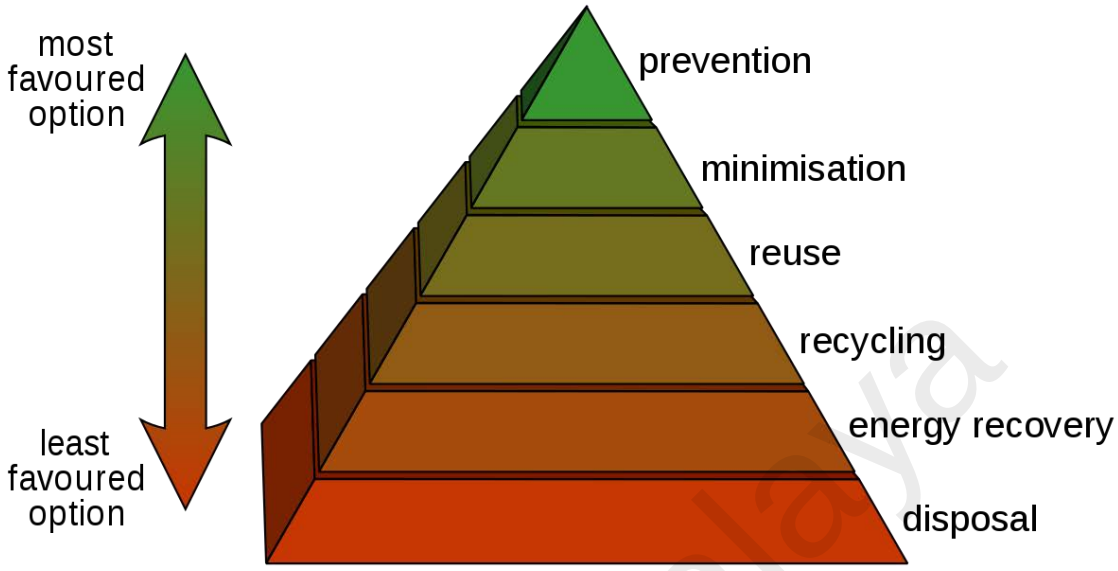


Figure 2. 5 Hierarchy Of Waste Management(Rissanen, 2009)

Typically, the phrase "3R" refers to the concept of minimising waste impacts in terms of quantity or negative consequences by reducing trash, reusing waste products with basic treatments, and recycling wastes by using them as raw materials to create similar or different commodities. A careful approach to resource acquisition and utilisation can help to slow down the rate of resource consumption while simultaneously improving the link between energy and resources. When durable commodities are reused repeatedly, the reduction in waste streams more than makes up for the harvesting of comparable or similar new things, according to the EPA. This reduces the consumption of fresh resources as well as the production of rubbish, both of which are beneficial. Some waste materials can be recycled by being used as raw materials in the manufacturing of new commodities or the same product, while others cannot.

This helps to conserve natural resources while also reducing waste production. Individually or in combination, the 3Rs help to reduce fresh resource exploitation, add

value to previously mined resources, and, most critically, help to prevent trash accumulation and the negative consequences of that accumulation (Department of Environment 2009). Japan's Policy on Reducing, Reusing, and Recycling serves as an example of a country's experience with the 3Rs (reduce, reuse, and recycle) principles. The 3Rs strategy was developed by the Japanese government in order to build a sustainable society - one in which the economy and the environment are in harmony. With the goal of striking a more equitable balance in mind, the government is shifting its focus away from hazardous substance regulation and toward greening the entire economy.

2.4.4 Cleaner Production (CP) Strategies

The notion that prevention is the most successful way of environmental management began to spread in the mid-1970s across large corporations, towns, and governments alike. It is both environmentally and economically beneficial to limit, and if necessary, eliminate, waste and pollution production and emissions. Several terminologies, such as pollution prevention, waste minimization, eco-efficiency, and 3R 33, have been coined to describe these efforts (Reduce, Reuse and Recycle). Cleaner production is a term coined by the United Nations Environment Programme (UNEP) to refer to a variety of unique ideas that are employed in manufacturing (UNIDO, 2014).

"Cleaner Production," as defined by the United Nations Environment Programme (UNEP), is "the continuous application of an integrated preventative environmental strategy to processes and products in order to eliminate hazards to people and the environment." The combination of waste reduction, pollution prevention, and sustainable development is the fundamental focus of the initiative. A complete approach to achieving sustainable development is provided by empowering product and service producers and suppliers to generate more with less raw material, less energy, and less waste, resulting

in a lower environmental impact and more long-term sustainability (Department of Environment, 2010).

The concept of "Cleaner Production" is not new. That urge to save resources and decrease waste is a natural by-product of our society. To do so, an individual must examine their actions and seek better, more efficient ways to carry them out, resulting in improved output while using less resources and producing less waste. Most essential of all is a reduced risk of environmental damage. Environmentally friendly manufacturing practises are always evolving, and while the industrial sector has made significant strides forward in terms of environmental performance over the previous two decades, there is still potential for improvement. The benefits of improvement, when achieved through Cleaner Production, extend to both economic performance and the protection of the environment (ANZECC, 1998). Department of Environment (Department of Environment, 2009) states that the Cleaner Production Plan aims to achieve the following objectives:

- The production process should be as efficient as possible in terms of raw resources and electricity consumption. Excessive use of poisonous raw materials should be avoided, and the quantity and toxicity of all emissions and wastes should be decreased before they exit the manufacturing process.
- Reducing the environmental impact of products throughout their life cycle, from the extraction of raw materials through the final disposal of the product
- Integrating environmental factors into the design and delivery of services is a major priority in the services sector. In order to achieve cleaner production, it is vital to modify attitudes toward ecologically responsible production while also taking technical options into consideration. It is projected that cleaner production

will bring various benefits to the sector, including the following: (U.S. Department of the Interior, 2009)

- In order to keep waste management costs as low as possible, it is necessary to reduce on-site handling expenses, reduce waste storage space (thereby increasing available production space), reduce off-site transportation and disposal costs, as well as reduce paperwork and record keeping costs, among other things.
- Waste can be used or reused directly in a process, and the recovery of secondary material for a separate end use – such as energy recovery – as well as the removal of impurities from waste to produce reasonably clean reusable material are all methods of lowering raw material prices and reducing energy usage.
- Increase the volume of work performed as well as the overall quality of the final product. Cleaner manufacturing, in addition to increasing yields and increasing production capacity, improves the administration of a facility, which results in cost savings, particularly when examined over the long term.

  Improve the health of employees and the public's perception of the organisation by creating a healthier working environment for them and the wider public.
- Decrease the amount of waste generated on the job site, hence minimising the risk of environmental contamination and liability concerns. The reduction in long-term responsibilities connected with treatment, storage, and disposal facilities is another benefit of the programme.

2.5 Greening the Construction Industry In Malaysia

The Green Building Index (GBI) was founded in 2009, ushering in a new green culture in the country's construction sector and writing a key chapter in the country's building construction history. The GBI is a measure of how environmentally friendly a building is. The Pusat Tenaga Malaysia building, which was the country's first Green Building Index (GBI)-rated development, is regarded as a watershed moment in Malaysian environmental history. In recent years, Putrajaya and Cyberjaya have been hailed as model green technology townships that would serve as models for the development of other townships throughout the country.

A fundamental deficit exists in that there is currently no single comprehensive solution, driven by a single organisation, that brings together all building and construction sector participants in Malaysia in order to identify and agree on green building targets for the future. To achieve an agreement on future green building objectives, collaboration among a variety of stakeholders would be required in order to establish the entire ecosystem that would be required in order to generate a sustainable building. It is designed to aid in alleviating the lack of a comprehensive framework by setting aspirations for specific areas where Green Technology (GT) would be developed in order to minimise the negative environmental impact of buildings while not interfering with GDP development.

To be more precise, it is vital to emphasise that the Green Technology Master Plan (GTMP) is a direct product of the Eleventh Malaysia Plan (2016-2020), which designated green development as one of six game changers that will shift the country's growth trajectory. The GTMP, which serves as a framework for mainstreaming green technology

into Malaysia's planned initiatives, takes into account the four pillars of the National Green Technology Policy (NGTP), which include energy, the environment, economic and social development, among other factors. With the National Green Technology Policy as a guideline, the GTMP is being established (NGTP). Energy, manufacturing, transportation, construction, waste, and water were among the six primary sectors targeted by the GTMP in its first implementation. During the intervening period, the GTMP has grown to incorporate new areas. With the GTMP's first version, the purpose is to bring the policy directions of each sector together around a common goal of resource utilisation that is both sustainable and environmentally beneficial. Over the course of each five-year National Development Plan period, the green technology objectives defined for each of these sectors will be gradually realised and fine-tuned through the implementation of policies and actions that will be executed.

Building greenhouse gas emissions are mostly generated during the construction phase, with the remaining 85 percent primarily resulting from occupation and maintenance activities throughout the building's life cycle, according to the Green Building Index (GBI). As a technique for encouraging sustainability in building operations while simultaneously reducing carbon emissions and waste generation, Industrialised Building Systems (IBS) have been championed by the government as a means of minimising greenhouse gas emissions during the construction phase.

The terminology "integrated building system" (IBS) refers to When compared to traditional construction processes, prefabricated components are manufactured in a sterile situation (either off-site or on-site) before being constructed on-site. In Malaysia, the following are the five most common IBS types to be encountered:

- Precast concrete framing, panel, and box systems are used in a variety of applications.
- Prefabricated wood framing systems are available.
- Steel framework systems are used in construction.
- Steel framing systems are used in the construction of buildings.
- Systems based on blockwork

The maximum potential IBS score is one hundred percent. A higher IBS score means fewer site labour, less waste, superior construction, cleaner and safer construction sites, project completion in less time and cheaper total construction costs. A lower IBS score indicates a higher quality construction. Therefore, the IBS system will be critical in reducing the amount of construction waste generated, of which only a small portion is now recycled.

2.6 Green Housing construction In Malaysia

Recent construction projects have failed to meet the most fundamental sustainability standards, and as a result, they are adding to the nation's increasing reliance on fossil-fuel-based energy sources. Many aspects must be considered while designing a house, such as the orientation of the building and the materials used throughout the construction process. These are all essential considerations because they all contribute to higher greenhouse gas emissions. The manner in which houses are constructed will have a considerable impact on the overall condition of the environment. The Malaysian government announced the Construction Industry Master Plan (CIMP) in 2006, which was in conformity with the country's sustainable development plan. (Nazirah Zainul and colleagues, 2013).

The establishment of the CIMP framework in 2009 has resulted in a considerable number of construction companies shifting their attention away from traditional construction and toward greenhouse construction. A variety of phrases used in the construction industry to refer to a variety of different elements include ecologically sustainable, environmentally environmental friendliness, sustainability, high performance, integration with regard to appearance and utility. The phrase "green" refers to a home's design, construction, and operation if environmental factors are taken into account. There are several environmental considerations to keep in mind while constructing a home. These include energy and water efficiency, as well as indoor air quality and waste and pollution management. (LB Robichand et al, 2009).

Simply said, a greenhouse uses consumes less energy, water, and natural resources than a conventional home, makes less waste, and is typically healthier for its inhabitants. (USGBC, 2011).

According to the Malaysian government, a methodology for evaluating the efficiency with which green housing is created has been developed in order to analyse the efficiency with which green housing is constructed. GBI is a technique that enables project developers and property owners are required to enhance the environmental sustainability of their projects by incorporating green design and building methodologies into their projects' development and construction processes. Green Building Index (GBI) ratings are given to structures in order to evaluate the environmental design and performance of the structure. The review process is divided into three major components: a Planning Assessment, a Final Planning Assessment that results in pre-certification, and an Evaluation of Completion and Verification that results in final certification. The Planning Assessment is the first of these three components. First and foremost among

these three components is the Planning Assessment. Certification must be renewed every three years to ensure that the certification is still valid (GBI, 2022).

A total of six sustainable criteria will be evaluated by the Green Building Index, and they are as follows:

1. Energy Efficient Design
2. The Quality of the Indoor Environment
3. Site Planning and Management that is environmentally friendly
4. Efficiency in the use of materials and resources
5. Efficiencies in Water Consumption
6. Innovation

A level of GBI rating is assigned based on the points earned by meeting the six sustainable criteria outlined above. The points, as well as their GBI ratings, are listed in the table below.

Table 2. 1 Points and their GBI Rating (GBI, 2022)

Points	GBI Rating
86-100	Platinum
76 -85	Gold
66-75	Silver
50-65	Certified

Following the implementation of the GBI, a total of 19 residential area structures have been awarded green certification. The list of residential areas in Malaysia that have received green certification is shown in Table 2.3 below (N.zainul, 2012).

Table 2. 2 Type of property and GBI rating

No	Name (Residential)	Type	GBI Malaysia
1	3 Harmoni,Sunway	Townhouse	Certified
2	S11 House Petaling Jaya	Condominium	Platinum
3	Ken Bangsar	Condominium	Gold
4	The Light Point,Penang	Condominium	Certified
5	The Light Lonear, Penang	Condominium	Certified
6	Ken Rimba Legian, Shah Alam	Terrace House	Certified
7	Idea House,Shah Alam	Bungalow	Gold
8	Cascades,Damansara	Condominium	Certified
9	First Residence,Kepong	Condominium	Certified
10	The Treez, Bukit Jalil	Condominium	Silver
11	Ganendra House, Petaling Jaya	Bungalow	Certified
12	Setia Greens Phase 1, Penang	Terrace House	Certified
13	The Enclave Bangsar	Bungalow	Certified
14	Rhombus,Bangsar	Condominium	Silver
15	Verdana, North Kinara Kl	Condominium	Certified

Based on the list of residential area with green certification, the author did not elaborate on the method used greening the residential area.

2.7 Summary of Literature Review

The operation phase of a housing contributes to greater environmental problem compared with construction phase. One of the major environmental problem that can be observed during the operation phase of a housing is emission of greenhouse gases, emission of greenhouse gas occurs due to generation of electricity. In Malaysia, the primary source of electric generation is via natural resources such as coal and natural gas. With increase in number of population, the demand for housing construction increases as well and causes increase in electricity generation. In order to protect the environment the Malaysia government has come up with a framework called National Green Technology Policy (NTGP) as sustainable development approach in addressing environmental problem due to construction industry. As part of the framework, various approach has been taken by the industries to green the industry. The approach taken by the industries are circular economy approach, industrial symbiosis, 3r's and cleaner production(cp) method. As for the construction industry Green Building Index(GBI) was introduced in 2009 as tool for assessing the efficiency of building green buildings. Based on the findings, there are lack of information on methods and approach used in greening the residential area buildings, as this offers an opportunity to propose a suitable strategies to greening residential area using cleaner production(cp) which compromise from building a house to operation lifecycle of a house.

CHAPTER 3: METHODOLOGY

In this part of the chapter, the methodology for this report is discussed. As for this research, a case study in Taman Suasana Templer was conducted using qualitative method. Qualitative research method is used to collecting information from current residents in residential areas based on questionnaire designed. The questionnaire for this study covers the energy usage, water usage, design of the house and house management practices. The questionnaire was distributed via google form survey. The data from the survey is then converted to statistics. From the statistics, the data was reviewed and analysed. Figure 3.1 below shows the framework for this study.

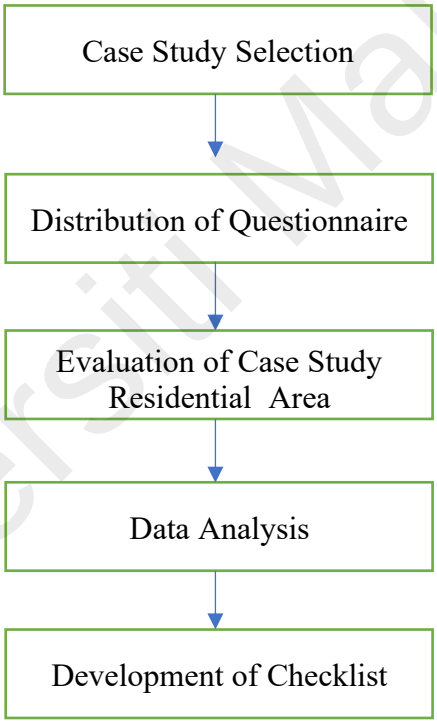


Figure 3. 1 Framework for greening the residential area using cleaner production

3.1 Case Study selection

As part of this study, a case study was conducted in Templer Park Suasana residential area. The 2-storey terrace leasehold house is built on 20' x 70' lot size. It consists of 3+1 bedrooms and 3 bathrooms. There are a total of 62 units of 2-storey terrace and completed in 2005 by Kumpulan Hartanah Selangor Berhad(KHSB). The residential area has been in operation for 17 years and the residential area does not have green building index (GBI) certification.

3.2 Evaluation of selected residential area

The evaluation of the residential area consists of 4 main criteria:

1. Energy Usage
2. Water Usage
3. Housing Management
4. Design of the house

Based on the four criteria mentioned above, a suitable cleaner production strategy can be proposed based on the analysis.

3.3 Overall Evaluation of Templer Park Suasana

In this section, the overall evaluation will be conducted to determine they of sustainable approach taken by the developer.

3.4 Data Analysis

Based on data obtained from the questionnaire, statistical analysis was conducted. Statistical Analysis was conducted using Statistical Package for Social Science (SPSS). SPSS is a tool which provides the flexibility to run different type of test to analyse the data based on the type of expected outcome. The response from the questionnaire was

analysed using Pearson's chi-square test via SPPS tool. The summary of the findings will be identified and presented in table and var chart format.

3.5 Development of Cleaner Production Checklist for Greening the residential area in planning stage

Considering the response via questionnaire in each criteria the information was gathered on type of possible environmental problem by current development of residential area. A guideline in greening residential area using cleaner production strategies in planning stage was formed based on the information obtained.

3.5.1 Cleaner Production Strategies

Based on complete data collection and analyzation, cleaner production strategies were introduced. The strategies will cover from the development of the residential area to operation phase. Implantation of cleaner production strategies will reduce the environmental impact and improve the construction industry in building greener residential area. Cleaner Production Strategies can be implemented as listed below:

1. Material Substitution
2. Design Change
3. Technology Change
4. Housekeeping

CHAPTER 4: RESULTS AND DISCUSSION

4.1 Introduction

In this section of the report, the data collected for the study was interpreted and discussed. The findings was reported accordingly on research objectives. The data source for this study was obtained from via distribution of questionnaire to the residents in Templer Park Suasana Rawang.

4.2 Demographic Analysis

A total of 55 residents respondents out of 62 answered the provided questionnaire. 7 respondents data could not be obtained due to unoccupied residents and privacy reason. Based on the collected responses, most of the respondents have been staying 16-17 years in the residential area. Figure 4.1below shows the average occupancy of respondents in the residential area.

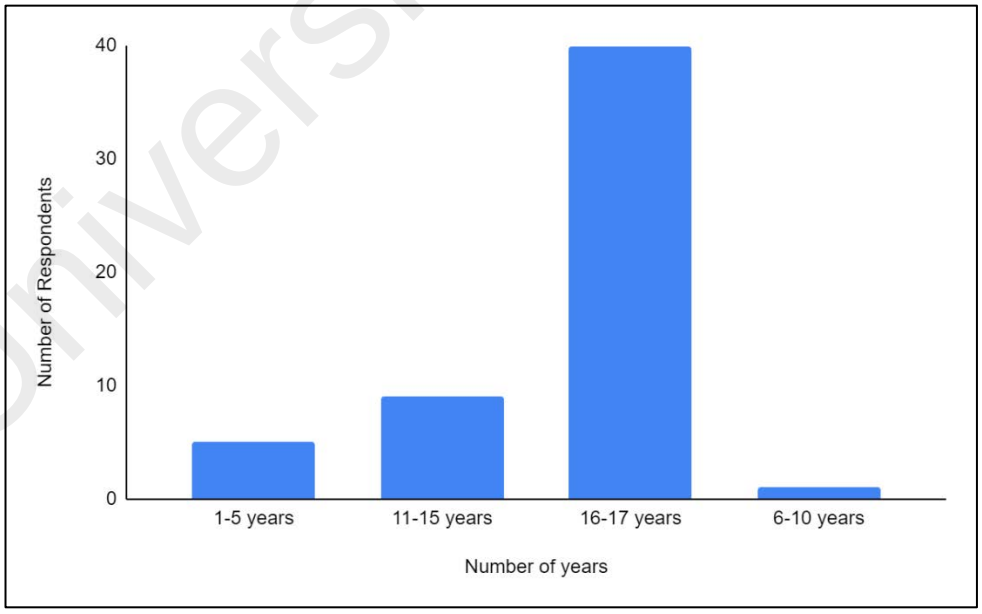


Figure 4. 1 Number of years respondents staying in the residential area

Based on the response obtained from the respondents, around 29 respondents has conducted major renovation towards their property, 15 has done minor renovation and 11 respondents has not done any renovation towards their property. Further interview session was held to determine the type of major and minor renovation had been done towards the property. Major renovation that respondents has done are, extension of rooms, extension of balcony, exterior make overs and interior make over. As for minor renovation, it mostly consist of internal makeover such as, changing flooring tiles, interior designing and minor changes to housing structure. From the interview session, most of the respondents does not focus their renovation concept towards sustainable design. Figure 4.2 below shows the number of respondents and type of renovations.

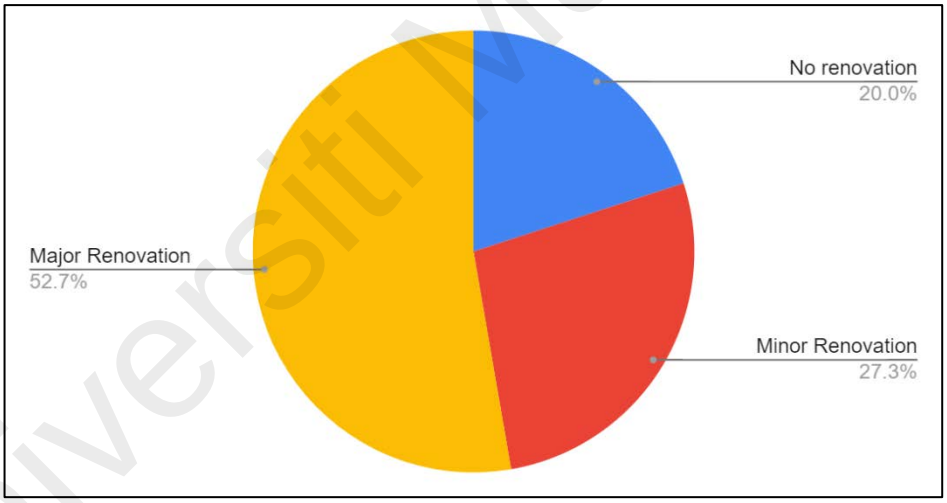


Figure 4. 2 Respondents versus type of renovation

On average, the number of members occupancy in a household stated by the respondents were 3-4 person and number of household member that are working are 1-2 person which 52.7% and 3-4 person which is 34.5 %. The number of occupancy in a household on weekdays is 47.3 % throughout the day, 38.2% in night time and 14.5 % in day time. Figure 4.3, 4.4 and 4.5 shows the recorded responses for each questions.

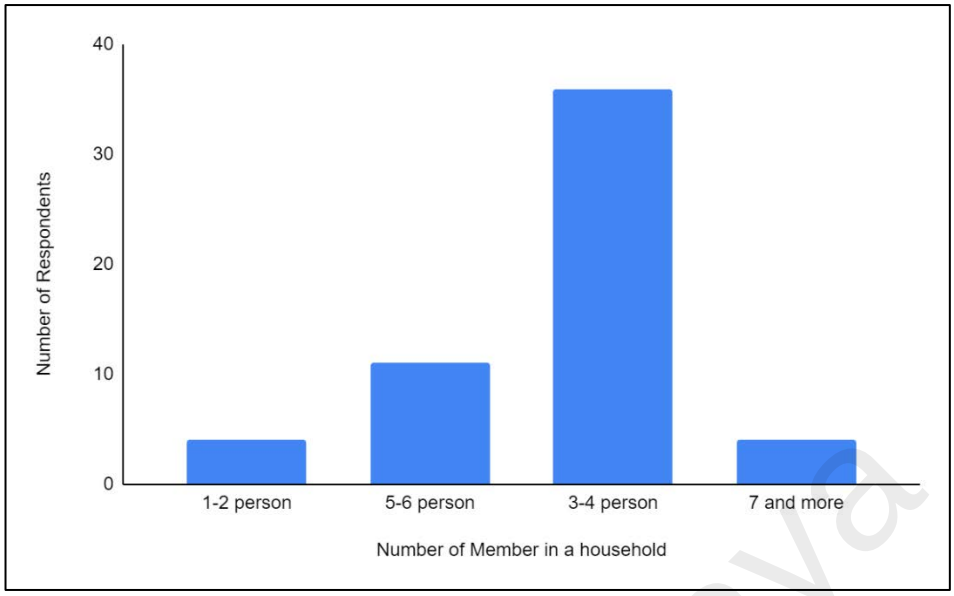


Figure 4. 3 Occupancy response

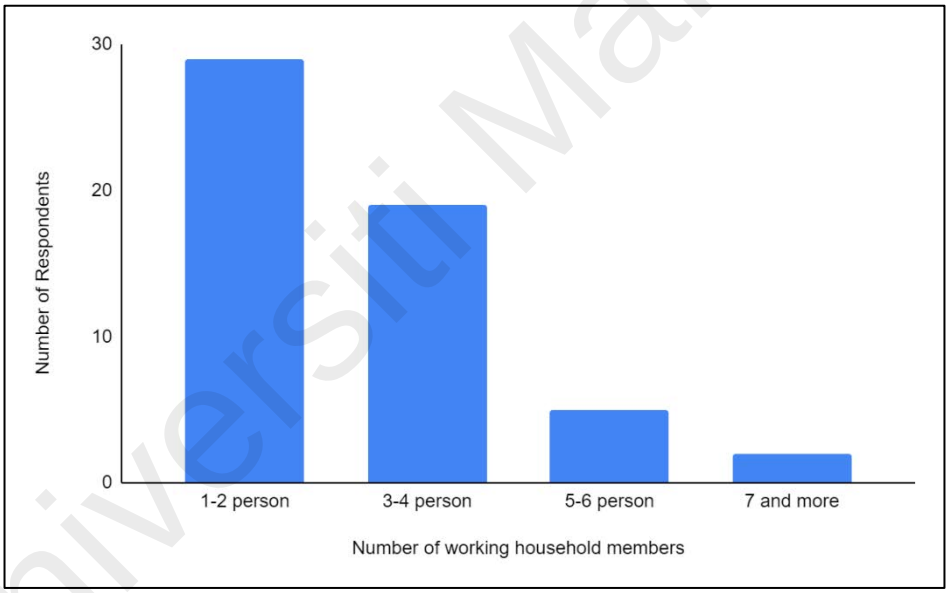


Figure 4. 4 Number of working household members

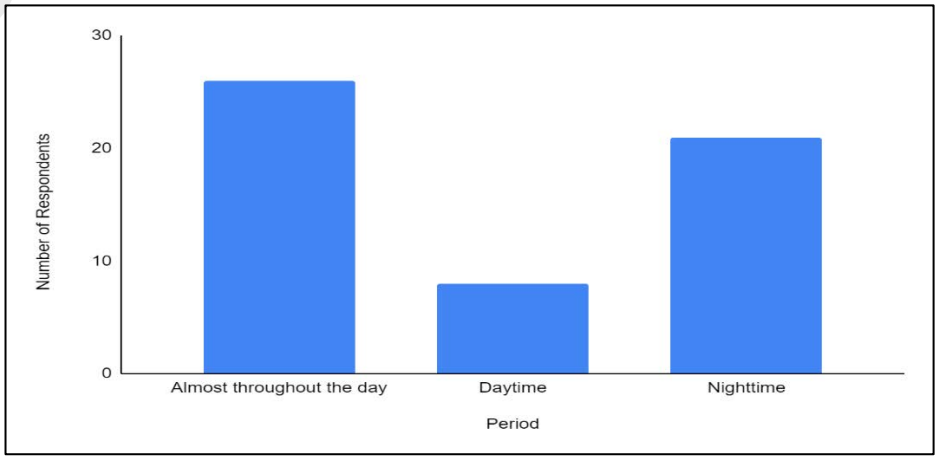


Figure 4. 5 Occupancy schedule response

4.3 Energy Usage Analysis

In this section of the report, the energy usage in each household will be analysed. Figure 4.6 below shows the electricity bill usage for each month by the respondents.

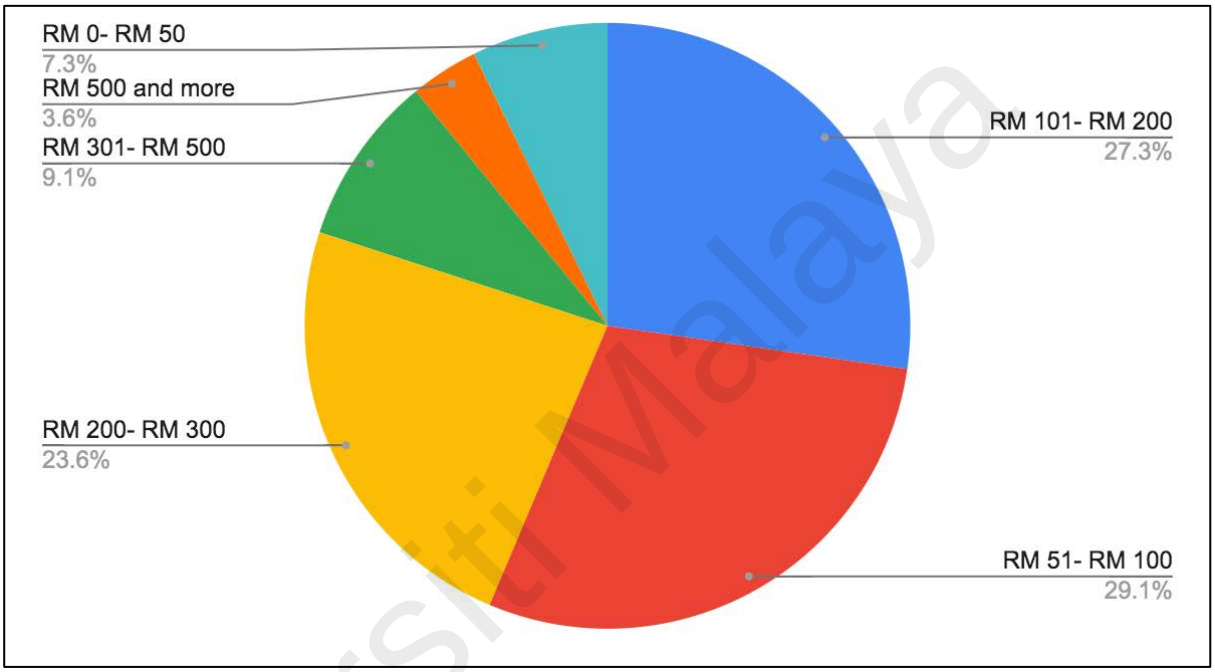


Figure 4. 6 Electricity Bill Response

Based on the figure 4.6 above, the average electricity bill per household is RM51 - RM 100 per month which is equivalent to 240-360 kwh usage of electricity. The usage of electricity is low for this group of respondents due to occupancy hours in the house. The usage of electricity is low for this group of respondents because most of them only occupies the house at night time. This cause low in energy usage for this group of respondents which result in low in electricity bill.. Figure 4.7 shows the occupancy period for usage group RM 51- RM100 Besides that, there is 3.6% of respondents who recorded RM 500 and more for their monthly electricity usage. Their usage is high due to number of occupancy in the house which is 5-6 person. Increase in number of occupancy will lead to increase electricity usage.

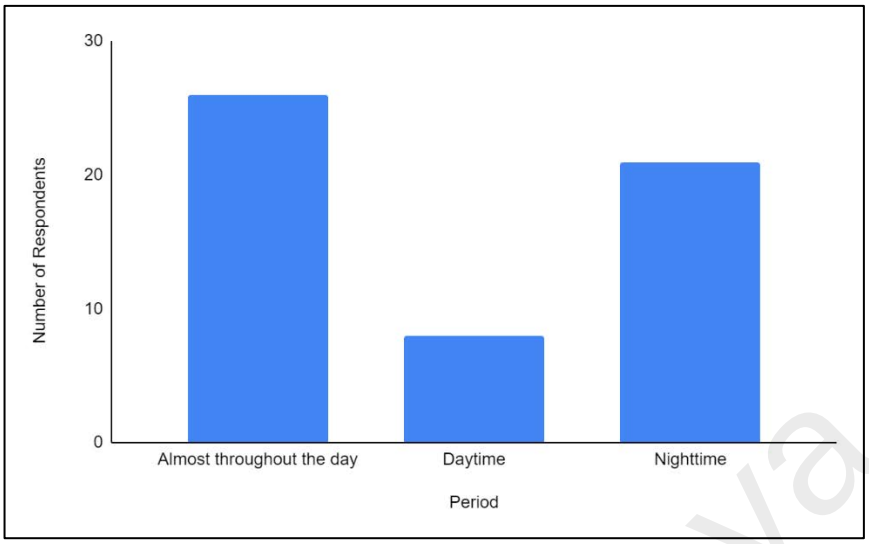


Figure 4. 7 Occupancy of respondents

4.3.1 Air conditioning Usage

As for the air conditioning usage, around 61.8% of respondents has installed 3-4 air conditioning system in their home. In 2011 a study was conducted by Tetsu Kubota on energy consumption of air conditioning in residential building of Malaysia. The author stated that, the yearly electricity consumption caused by usage of air-conditioning system recorded the largest amount, which was 1,167 kwh/year with the usage of 6 hours day. As for our respondents, 65.5% uses the air-conditioning system at night and the average horsepower(hp) rating of the air-conditioning system is 1hp. The average operation hours of the air condition system in a household is 4-7 hours daily. Table 4.0 and 4.1, summarize the number of air conditioning installed, working horsepower and figure 4.8 summarise the usage of air-condition in a day.

Table 4. 1 Number of Air condition installed and percentage of response

Number of Air-Conditioning Installed	Percentage of Response (%)
0	9.1
1-2	14.5
3-4	61.8
5-6	14.5

Table 4. 2 Number of horsepower(hp) per air-conditioning system

Number of Horsepower(hp) per air-conditioning system	Percentage of Response (%)
0	7.3
0.5	27.3
1.0	40.0
1.5	16.4
2.0	9.0

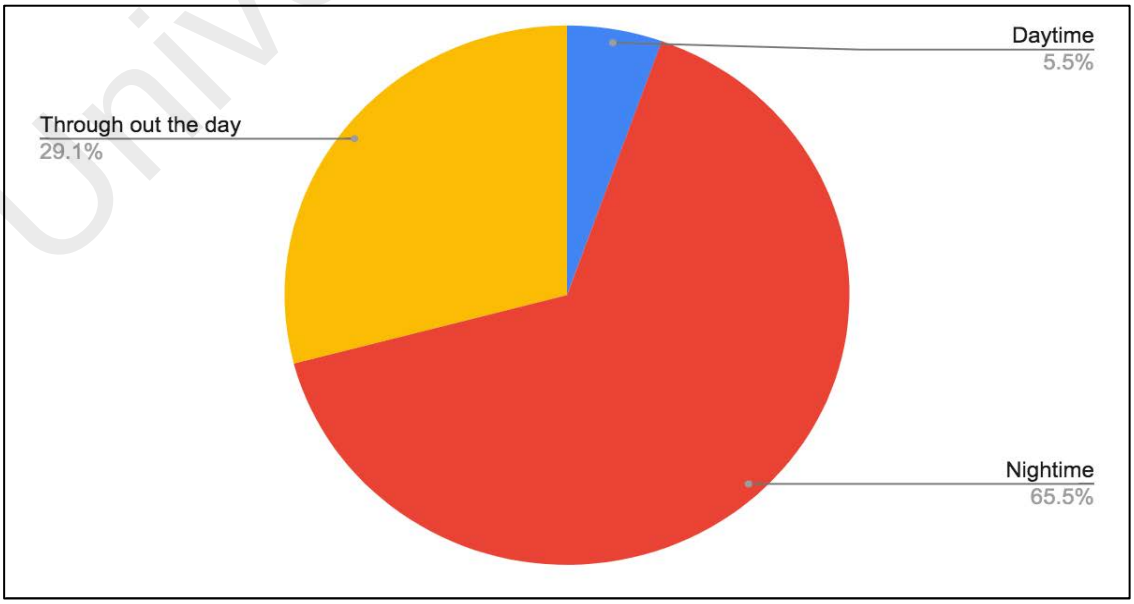


Figure 4. 8 Determination of which part of the day air-condition is being used

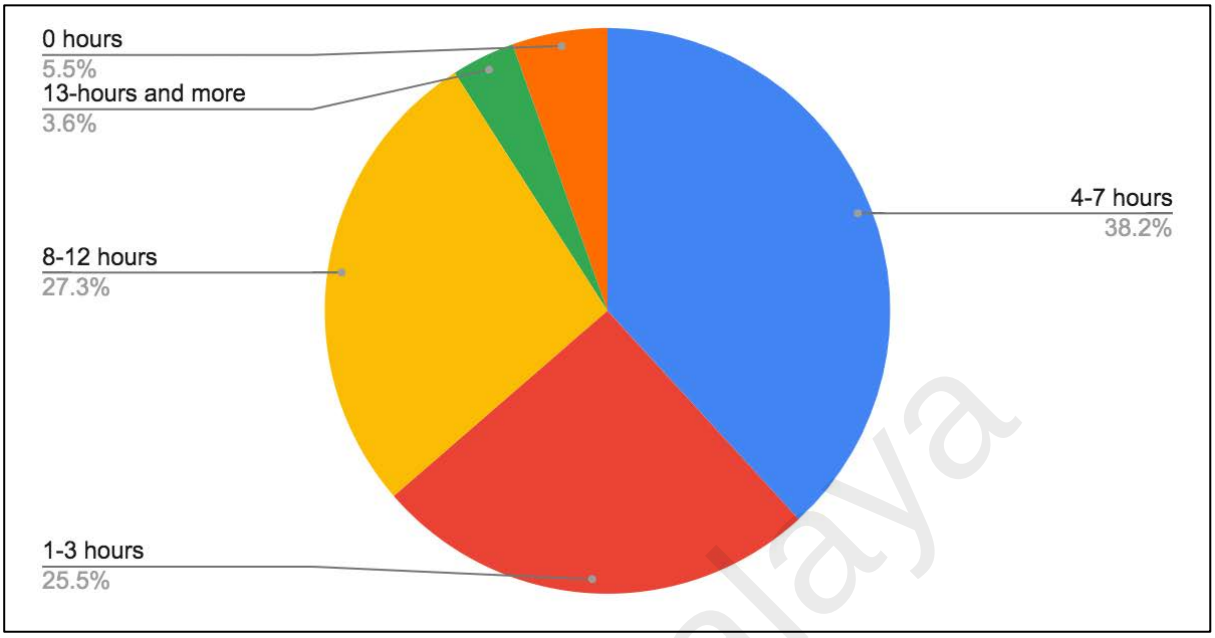


Figure 4. 9 Operation Hours of Air-condition in a day

4.3.2 Lighting Appliance

According to renewable energy world 2022, lighting a home uses 2.8% of the total energy consumption. Although the consumption amount is small, but type of lighting appliance used will have a greater impact in total energy consumption. In this section of report, the type of lighting appliance used would be determined. Based on the respondents response, 58.2% of the respondents uses light emitting diodes(LED) as their lighting appliance. Around 25.5% uses compact fluorescent bulb(CFL), 14.5% uses fluorescent tube bulb and 1.8% halogen bulbs. Fluorescent or CFL bulbs are more energy efficient than halogen/incandescent bulbs, but they are not as efficient as led bulbs. This is because the average life span of a led bulb is 25000 hours of lifetime compared with lifespan of CFL bulb which is around 8000 hours(NOPEC,2022).Besides that, having multiple switch point for operating lighting appliance would be the best option because 50.9 of respondents stated that, they do not have individual control switch over the electrical appliance. Having individual switch control over lighting appliance, the owners able to

switch on the required lights and able to save the electricity consumption in the long run. Figure 4.10 and 4.11 shows the type of lighting appliance used and control options for the lighting appliance.

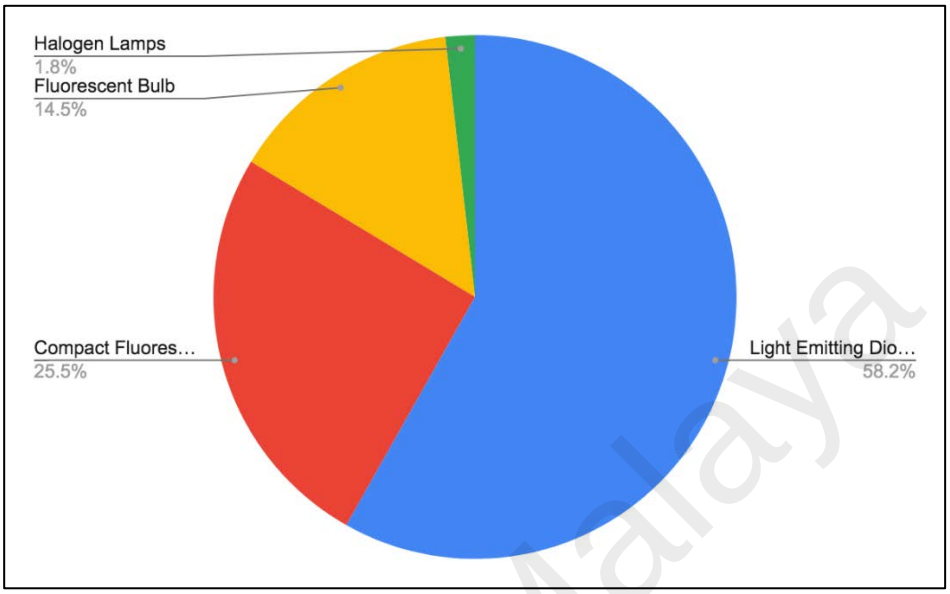


Figure 4. 10 Type of Lighting Appliance

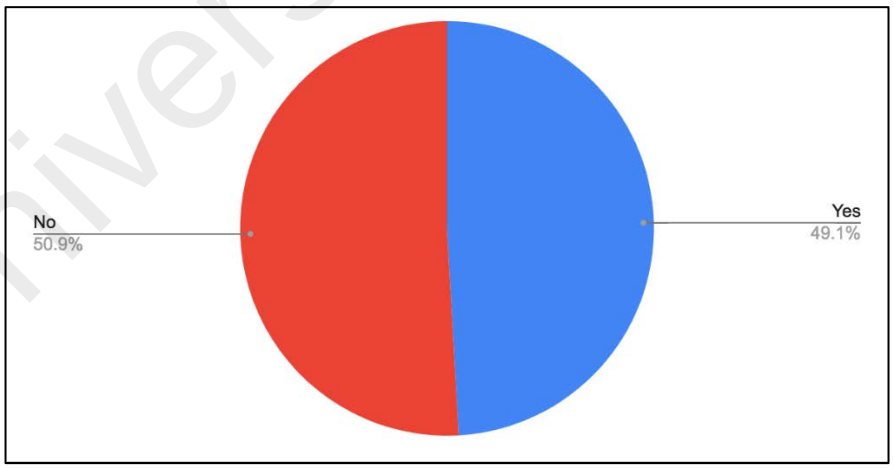


Figure 4. 11 Switch Control

In order to reduce the consumption of energy usage, installation of solar panel would contribute in reduction of energy usage. Solar panel operates by absorbing the sunlight energy and converting into electricity by photovoltaic cells. Figure 4.12 below

summarise the responses towards installation of solar panel and their usage by the respondents.

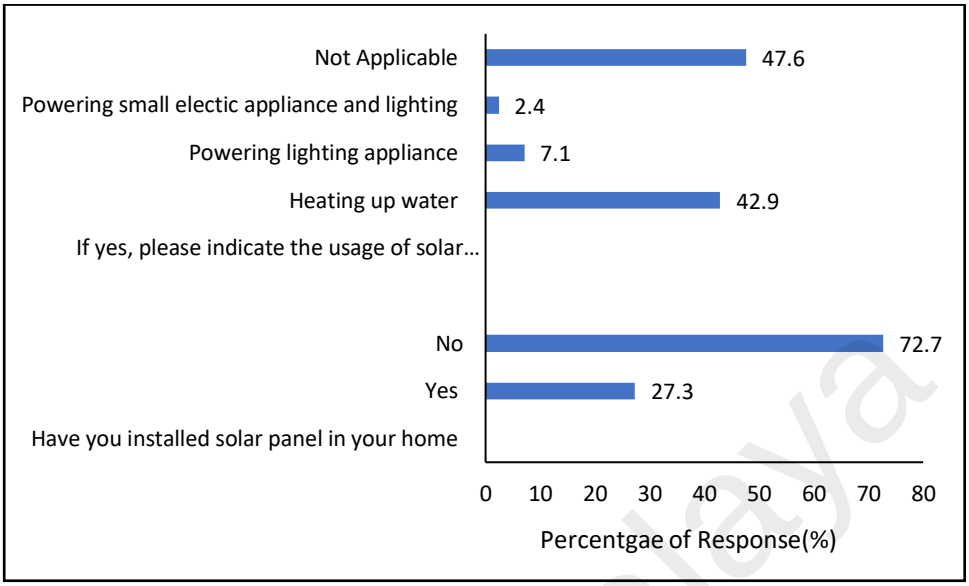


Figure 4. 12 Summary of installation of solar panel and their usage

4.3.3 Water Heater

In Malaysia, the most common type of water heater being installed is instant water heaters. Instant water heaters are normally mounted within shower area. When electricity is turned on, it directly heats up the water that passes through it. Based on the respondents output, 41.8 % have installed 3-4 water heaters and 20 % has installed solar panel to heat up the water. Although, water heater does not consume much electricity as compared with other electrical appliance but having 3-4 water heaters installed would lead to increase electricity consumption. Installation of 3-4 water heaters by the respondents is due number of occupancy in a household. Usage of solar water heaters is an cost effective way to generate hot water for daily uses. It uses sunlight to heat up the water in the tank. Usage of solar powered water heater would have significant impact on electricity

consumption. Figure 4.12 below shows the respondents on type of water heating mechanism used.

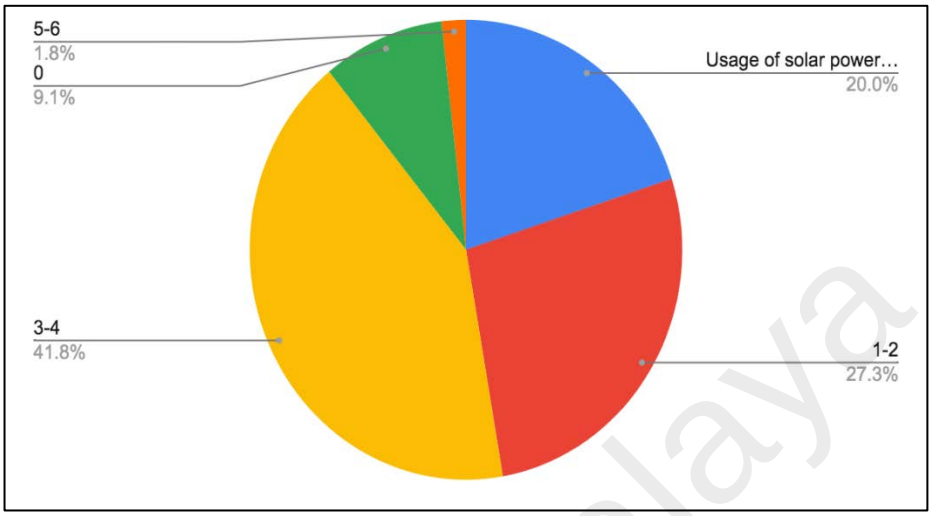


Figure 4. 13 Type of heating mechanism used for shower

4.4 Water Usage

In this section of report, based on respondents response, water usage analysis will be conducted. Figure 4.13 shows the monthly bill for water usage. Around 56.4% of respondents pays RM11-RM30 which is around 30-35 m^3(30000-35000 litres). According to National Water Service Commission(SPAN), on average Malaysians consume 201 litres of water per day by a person. On average a person consume 6030 litres monthly. Based on the respondents response, occupancy of 1-2 person has the lowest water bill usage which is around RM0- RM10. On average, these group of respondents consumes less than 20000 litres monthly. As for group of respondents which have more than 5 person in a household consumes around 47000 litres of water in a month. It can be said, as the number of occupant increases, the usage of water consumption increases as well. Figure 4.14 shows the comparison of water usage bill with different number of occupancy.

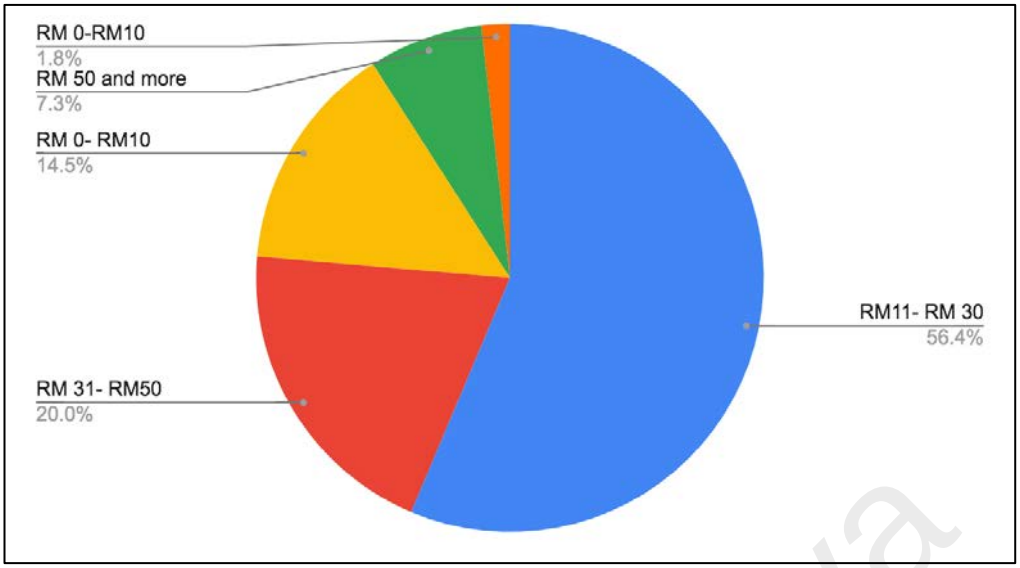


Figure 4. 14 Monthly Usage of Water

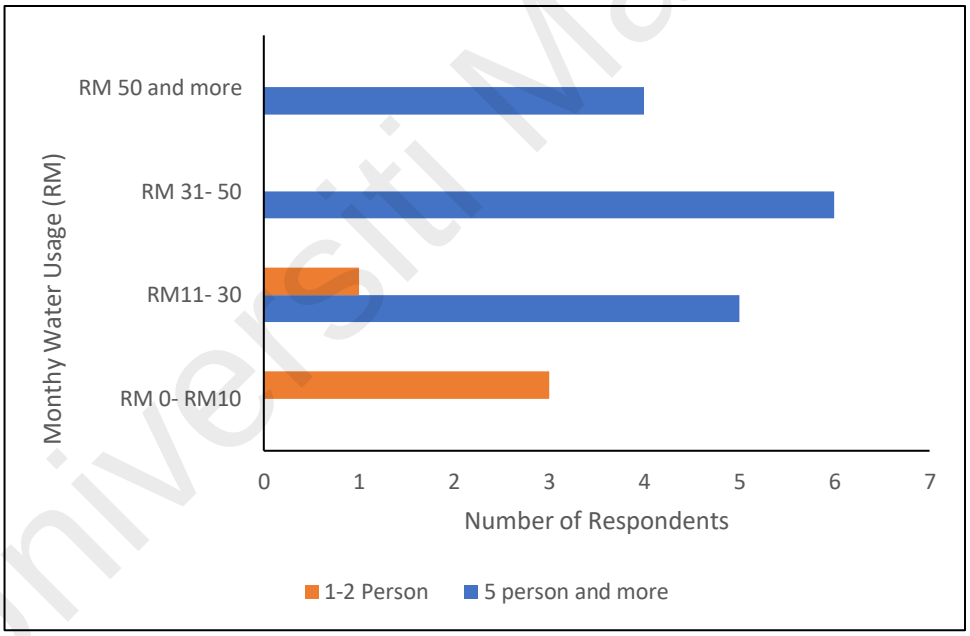


Figure 4. 15 Respondents with different number of occupancy and their monthly water charge

The main consumption of water is due to few activities which is showering flushing the toilet and washing clothes using washing machine. On average 50-100 litres of water is being consumed in a shower by person and a toilet flush takes 7 to 15 litres of water per flush (H2O,2022).According to study conducted by Noor Elaiza Et Al, 2019 on Household Routine on Domestic Water consumption. In the results section, the author

stated that shower/bath has highest water consumption, followed by washing clothes using washing machine and flushing toilet. According to respondents, 87.% has 2-3 shower/toilet in their household where else 12.7% has 4-5 toilet/shower. On average the frequency of shower usage on a daily basis by the respondents are 2-3 times a day and 9.1 % of respondents stated 6 and more times. Figure 4.15 summarise the number of shower/toilet in a household and their frequency of shower.

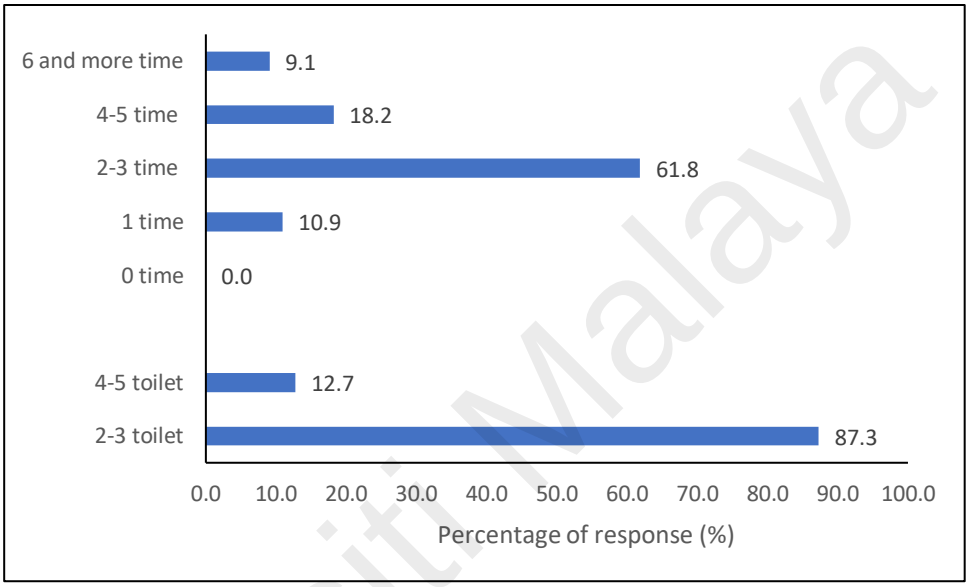


Figure 4. 16 summary of number of shower/toilets in a household and their frequency of shower

As for the toilet flush, 50.9% has dual flush toilet bowl system installed, 36.4% has pressure assisted toilet bowl system and 12.7 % gravity flush toilet bowl system. Dual flush toilet bowl system has two option for flushing, high volume flush for solid waste and low volume flush for liquid waste. Dual flush system typically uses 4-6 litre of water where gravity and pressure assisted toilet bowl consumes which only has one flushing system and consumes 13 litres of water(Water wise,2022) It is good approach taken by the respondents on installing dual flush toilet system. Figure 4.16 summarise the type of toilet bowl installed by the respondents.

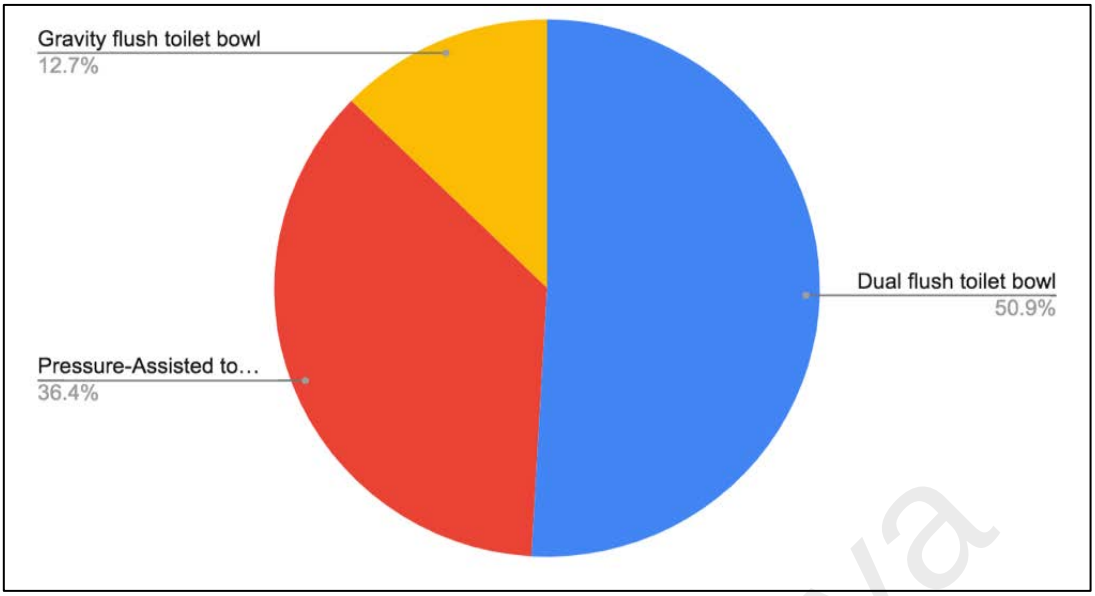


Figure 4. 17 Type of toilet bowl installed

The number of washing machine installed by the respondents can be categorised into 4 groups. 80% of respondents has installed 1 washing machine, 10.9% of the respondents has installed 2 washing machines, 7.3% has 3 washing machine installed and 1.8% has no washing machine being installed. The consumption of water for the washing machine is based on the capacity of washing machine. As for 7-8 kg capacity washing machine, it uses about 130-150 litres of water per wash. Based on the respondents responses, in a week 54.5% of respondents uses the washing machine once a week to wash their clothes and 3.6 % of respondents uses washing machine daily. Figure 4.17 below summarise the number of washing machine installed, size of washing machine and frequency of usage.

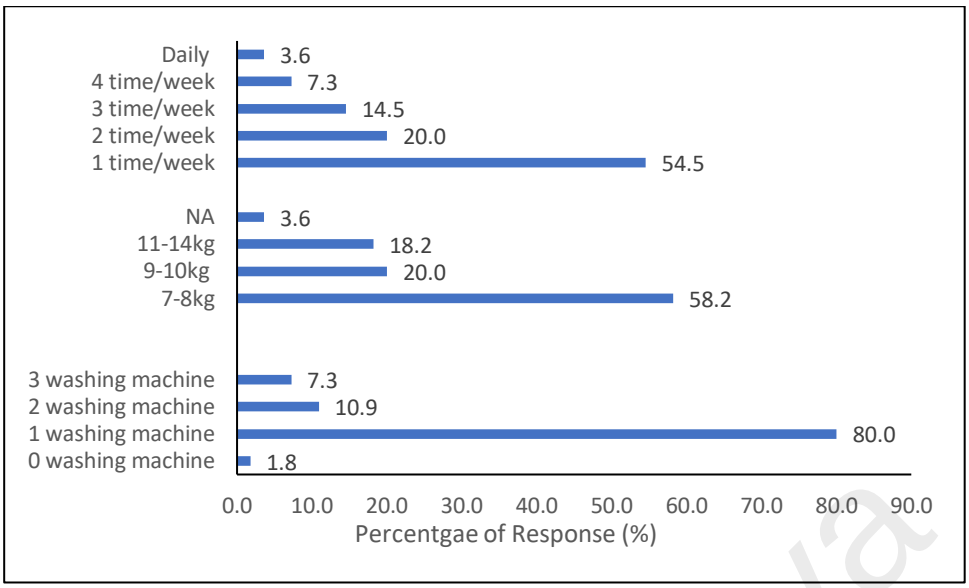


Figure 4. 18 Summary of respondents for number of washing machine installed, size of washing machine and frequency of usage

It is very common to have a hand wash sink in the toilet. Hand wash sink is commonly used to brush teeth, wash face and washing hands. This miscellaneous activity also consumes significant amount of water. According to waterwise org running tap water while brushing teeth wastes over six litres per minute meaning if a person brushes their teeth for two minutes, twice a day that is over 24 litres of water being wasted in a day. Based on the interview session held with the response, 90.9% percent of the respondents uses their hand wash sink to brush their teeth. There are two type of sink being present, traditional hand wash sink and hand wash sink attached to toilet bowl. Figure 4.18 and 4.19 shows the two different type of hand wash sink

Figure 4. 19 Traditional hand wash sink

Figure 4. 20 Hand wash sink attached to toilet bowl

Hand wash sink attached to toilet bowl shown in figure 4.19 is an efficient and innovative way to save water. The used waste water from the hand wash sink is channelled to toilet bowl tanked and can be used to flush. By using this type of integrated system, the user able to save few litres of water in their daily life. Based on the responses from the respondents, 9.1% has installed hand wash sink which connects to their toilet bowl system. This is a good approach taken by them in conserving water. Besides that, type of tap installed plays an important role in water usage. According to Alyssa Harmon 2016 conducted a study on manual water tap and automated water tap. Based on the authors finding, automated water tap has reduction of water usage up to 54% compared with manual water tap. As for this study, 10.9 % of respondents had installed automated water tap in the toilet. It is one of the greatest approach to suitability. Figure 4.20 shows the type of hand wash sink and water tap has been installed.

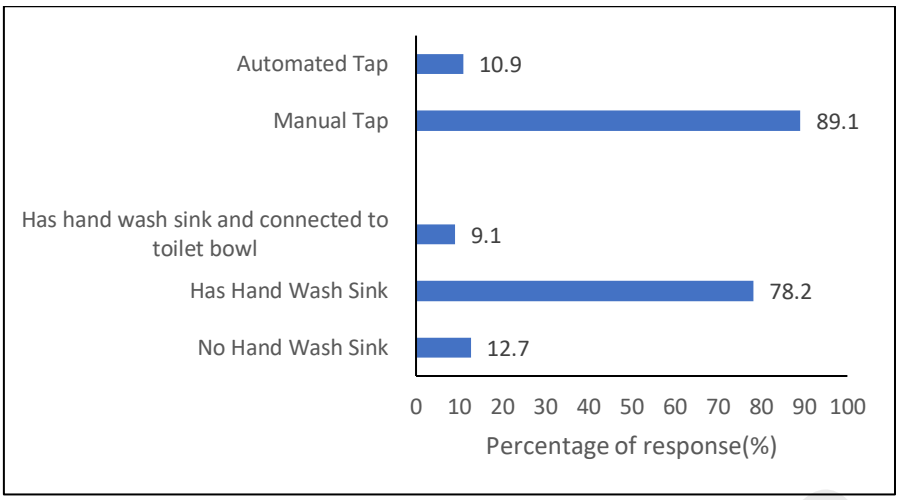


Figure 4. 21 type of hand wash sink and water tap has been installed

As for the final part water usage section, two type of activity has been choose. Washing vehicle and watering the plant. Based on the activity, several questions were asked to the responders what is the source of water used for the activity mentioned above and frequency. Figure 4.21, summarise the findings for the mentioned activities.

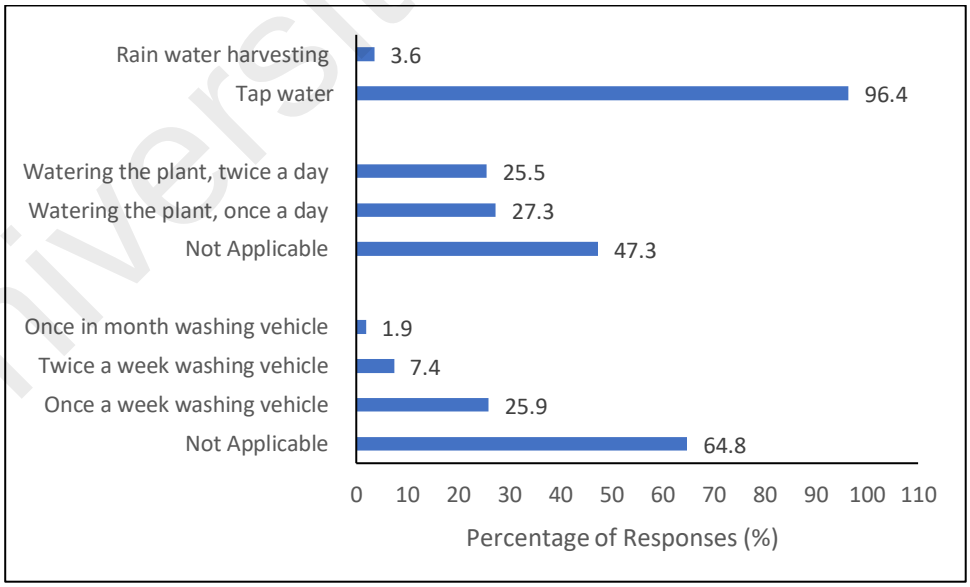


Figure 4. 22 Summary of activities and usage

Based on figure 4.21, majority of the respondents does not wash their vehicle at home and water their plants. As for the group of respondents that uses waster for the mentioned activity on figure 4.21, 96.4% of them uses tap water for the their activity and

only 3.6% uses harvested rain water. Harvested rain water is the collection and storage of rain water rather than allowing to run off. It a good approach taken by the respondents in reducing water consumption.

4.5 Housing Management

In this part of report, housing management of the respondents will be analysed. Housing management consist of few category such as frequency of maintenance that has been carried out, does the housing appliance have energy efficiency label, frequency of painting the house, type of paint used and waste management.

Maintenance of a house is an important thing that every houseowner should conduct to ensure the property is in full functional and operating in its best condition. By having frequent maintenance inspection, this would help the houseowners to fix a problem when it is small. Not only it saves the houseowners money but also saves on the energy and water usage. Based on the respondents in figure 4.22, 49.1% of respondents only conduct maintenance inspection when something is broken/faulty/not performing well and 20% of them has never conducted maintenance in their property. Further interview session was held with two group of respondents and the outcomes were they were busy with their daily routine and some do not realise the importance of having regular maintenance.

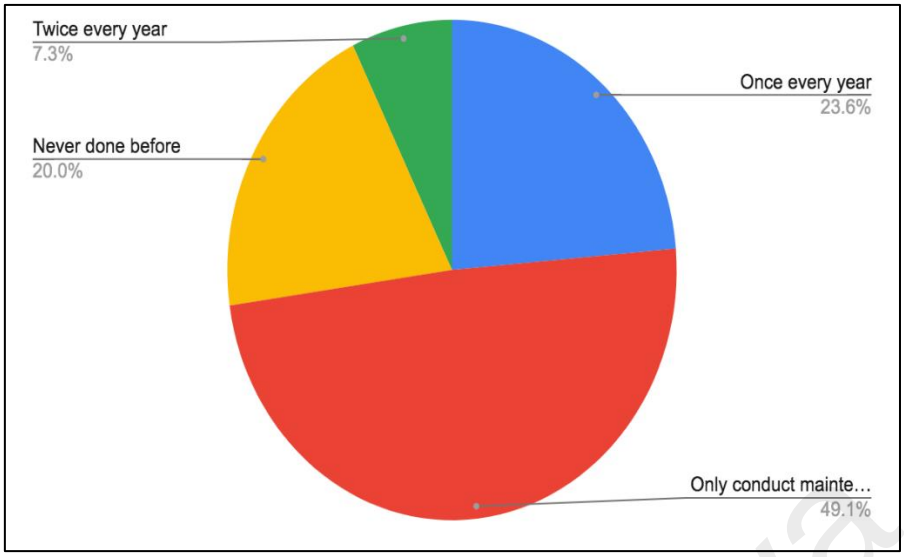


Figure 4. 23 Frequency of maintenance conducted

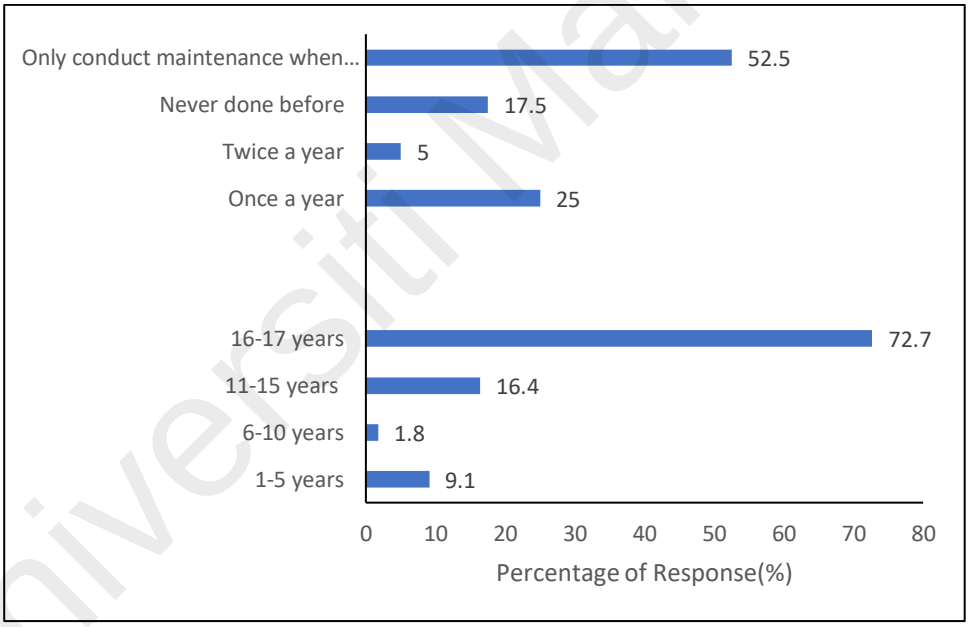


Figure 4. 24 Duration of occupancy and the maintenance frequency for 16-17 years group

Based on figure 4.23, most of the respondents has been in the residential area for 16-17 years and the frequency of maintenance carried out by the 16-17 years group is only conducted when something is faulty/wrong and 17.5% has never conducted any maintenance routine throughout their 16-17 years of occupancy. With the number of air conditioning system installed, washing machine installed without maintenance for this

long period of time, this would lead to increase in energy and water usage and reduce the overall performance of energy efficiency labelled appliances.

Moving on, energy efficiency labelled appliance helps the homeowner by reducing the energy/water bills at home. Energy efficiency label appliance shows the owners the estimated energy consumption of an electrical appliances. Based on the analysis conducted, 74.5% of respondents have energy efficiency labelled electrical appliance, 18.2% does not own energy labelled electrical appliance and 7.3% does not heard about energy efficiency labelled products. As for the 74.5% of respondents, most of them have energy efficiency labelled for their air condition, water heater, washing machine, television and fridge. These electrical appliances are the most energy consuming appliance in a household and the respondents has installed energy efficiency labelled appliance. Figure 4.24 shows the availability of energy efficiency labelled product in their home.

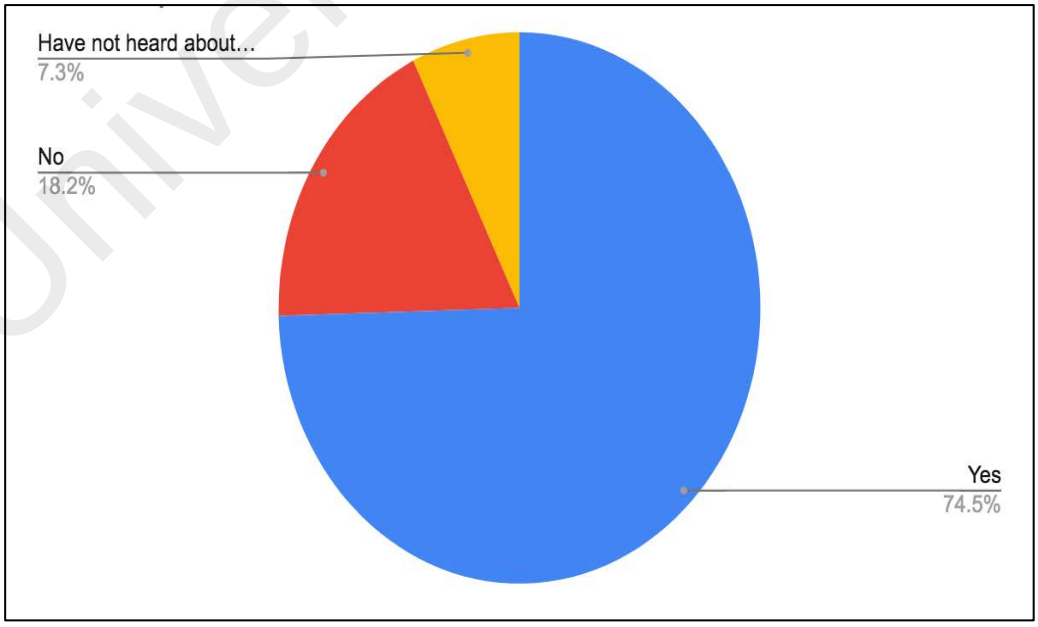


Figure 4. 25 Availability of energy efficient labelled appliances

The next analysis that was conducted under house management was frequency of painting the house interior/exterior. As for the exterior of the house, the wall is being facade to brutal heat and moisture from the constant rains. This would result in damaging in paint layer. Paint layer in the exterior wall provides layer of protection in absorbing heat. Lighter colour paints has the tendency to reduce the overall temperature of the house. Based on the observation conducted, all the respondents has painted their exterior wall of the house in light colours. According to Property Guru 2022, the author stated that the recommended painting of the house is every 5-10 years. Based on respondents response, 63.6% of them paint their house every five years once, 27.3% has not done any paintings to their property. As for painting the house, it is important to choose the type of paints. There are two type of paints present, one is regular paints second is eco-friendly paints. Regular paints are much more cheaper than eco-friendly paints but they have higher content of volatile organic compound mixture compared with eco-friendly paints. Eco-friendly paints are specially developed paints that are low or non in volatile organic compound mixture in the paint and it is safer for the environment. As for analysis, 56.4% of respondents buys eco-friendly paints to paint their house and 30.9% buys the regular paint available in the market. Figure 4.25 shows the summary of frequency of painting and type of paint products used.

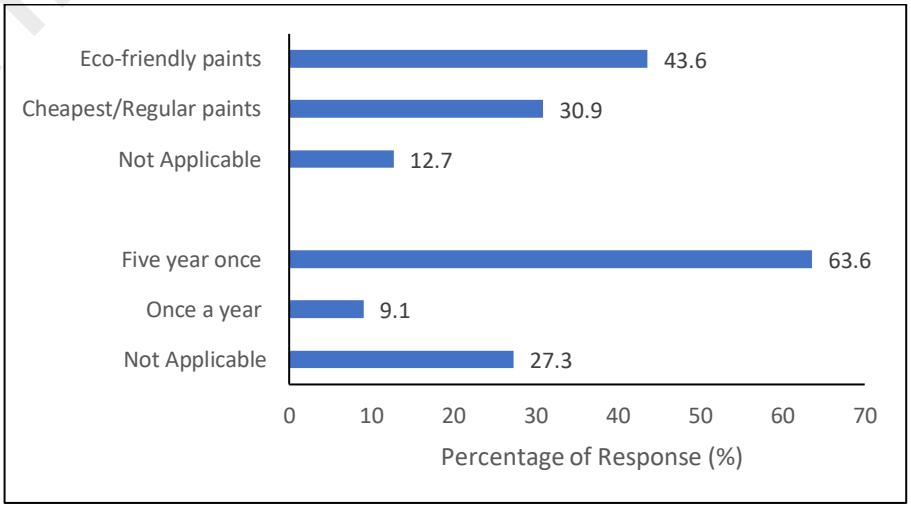


Figure 4. 26 summary of frequency of painting and type of paint products used.

In this part of report, monitoring of energy and water usage will be analysed. Monitoring energy and water usage helps the houseowner to control and conserve their usage. Besides that, monitoring also provide information on faulty appliance or water leakage based on their monthly bill. According to the respondents response, 61.8% does not monitor their electricity usage and 63.6% does not monitor their monthly water usage. This would lead increase in both energy and water usage due to lack of monitoring. To solve this problem, 76.4% of respondents stated that, having a device to monitor their monthly usage of energy and water would be helpful. Having a monitoring device would help the respondents to be aware of their monthly usage and promote in reducing energy and water usage. Figure 4.26 summarise the findings on energy and water monitoring.

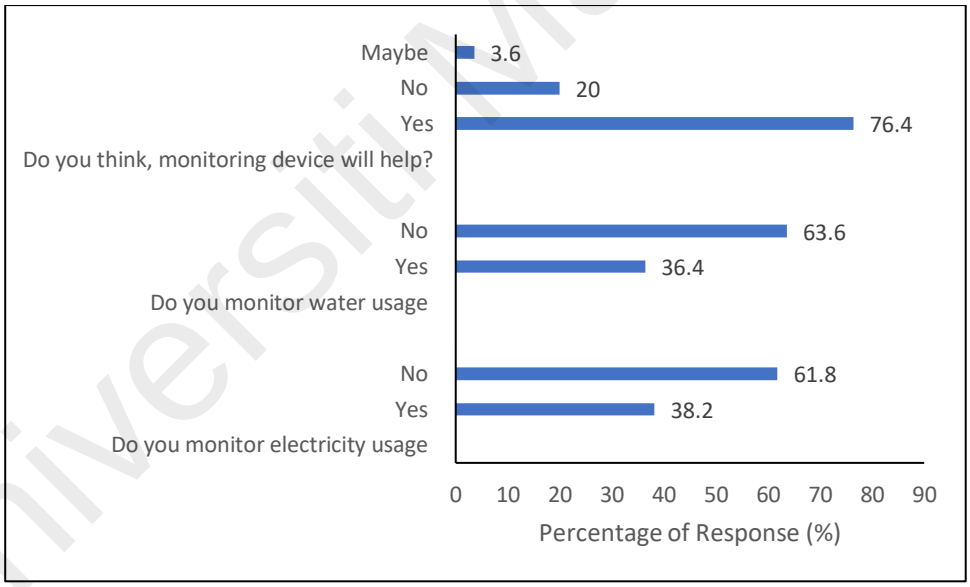


Figure 4. 27 Summary of energy and water monitoring

In the last part of housing management, waste management by respondents were analysed. In 2021, an analysis was conducted by MIDA waste generated in Malaysia is 38,427 tons per day. This causes increase in number of landfill waste. Improper management of waste can lead to soil erosion, water contamination and air contamination. Thus proper waste management approach will save the environment form the toxic effects of inorganic and biodegradable elements present in waste(Eleni Iacovido,2020). One of

the approach of waste management is by sorting out the wastes according to their category. Such as organic waste, toxic waste and recyclable waste. This would help to determine the best waste management practice to be applied such as recovery and recycling, incineration/combustion, compositing or waste to energy(Recover Energy).Based on the respondents analysis, 69.1% does not sort their waste according to their category , only 29.1% practices sorting their waste accordingly. This shows the waste management practiced by the respondents are poor. Figure 4.27 shows the summary of waste management practice by the respondents.

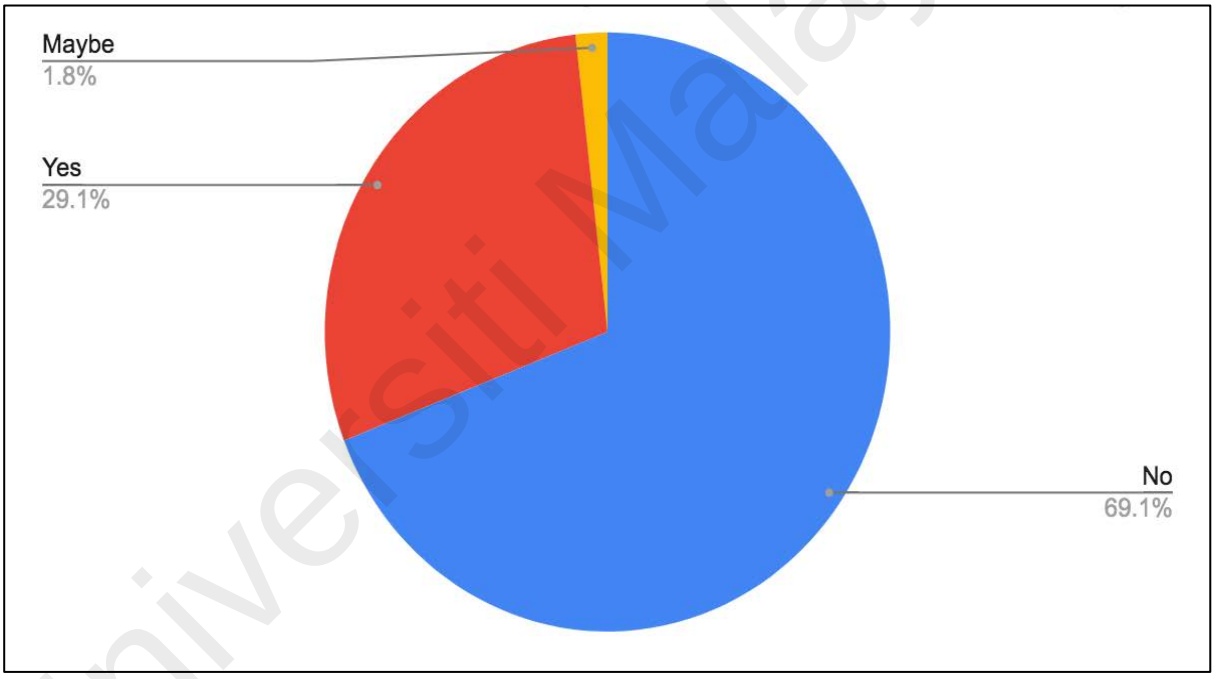


Figure 4. 28 Waste management practice by the respondents

4.6 Design of the house

In this section of report, the design of the house will be examined. The type of roof shingles installed plays an important factor in energy usage. This is because asphalt and concrete shingles absorbs heats from the sun ray instead of reflecting them away. The absorbed heat is then transferred thorough the artic space and significantly increase the temperature of the house which leads to increase in usage of air condition to regulate the

temperature. As for the metal roofing, it naturally able to reflect heat than absorbing, this leads to much cooler house during the summer. Concrete shingles is preferred over metal roof is due to the price. On average concrete roof shingles cost RM 2.30 per piece (1.375 ft X1.083ft) where else metal roof costs RM 290 per piece (6ft X 2.5 ft) (Lau Tat Hardware, 2022). To cover one piece of metal roof (6ft X 2.5ft), it requires 8 concrete shingles and only costs RM 18.40. This causes the developer/houseowner to opt for concrete singles than metal roof due to pricing. Based on respondents, 79.2% has concrete roof shingles installed, 9.4% installed asphalt roof shingles and 11.3% has installed metal roof. Based on the group of respondents that chose metal roof, 50% of them turn on fan and open the window to keep their home cool day and night. As for the group that uses concrete roof shingles 69% uses fan and air conditioner to keep their home cool at day and night. Figure 4.28 shows the type of roof installed and ways to cool their home at day and night.

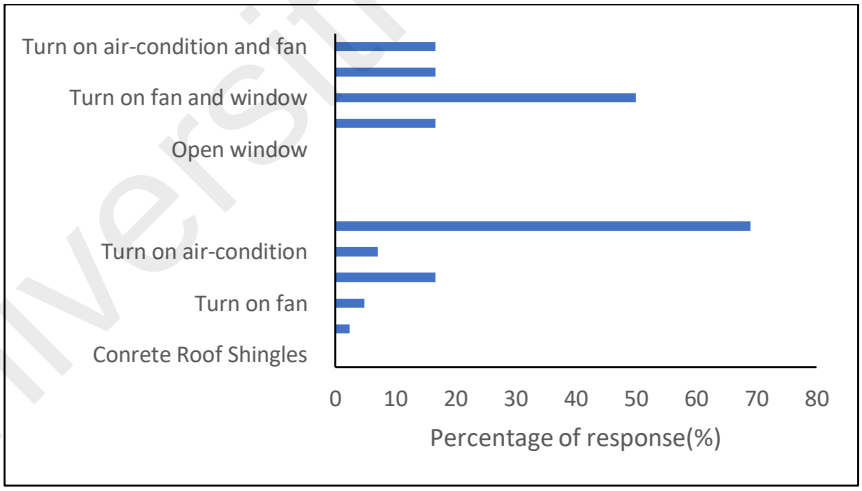


Figure 4. 29 Type of roof installed and ways to cool their home at day and night.

The roof skylight system is system which is enable natural light from the sun to pass through roofs. According a study conducted by Karam et.al on impact of environmental loads penetrate a passive skylight roofing system in 2014, stated that due do Malaysian climate which is sunny all year round, which makes ideal place to make skylight system. Besides that, the author also stated, installing skylight also reduces the

artificial lighting time with proper integrated by using glare protection, proper use of reflective surface and shading. Window glare or glare protection helps to minimize heat loss, air leakage which leads to reduce in heat transfer and cuts down on energy consumption(Rafik Belarbi et.al, 2011).Figure 4.29 summarise the installation of skylight, number of windows present and type of glazing window.

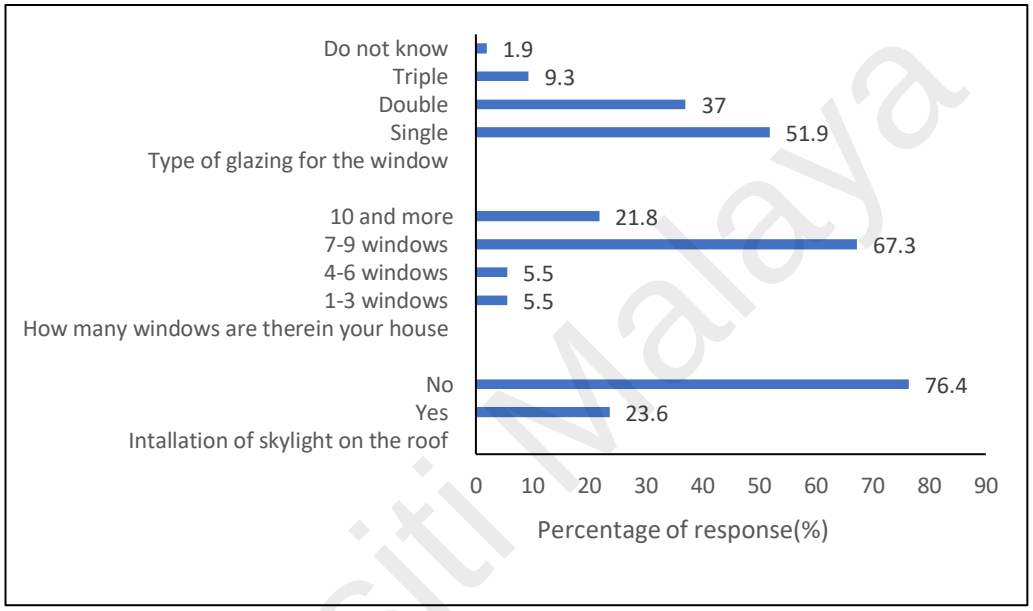


Figure 4. 30 Summary of installation of skylight, number of windows installed and type of glazing window

Based on figure 4.29, around 51.9% of the respondents has installed single glazing window, 37% person double glazing window, 9.3% triple glazing window. Double glazed windows uses two piece of glass and separated by vacuum. The vacuum layer in between acts an insulative barrier which stops heat transferring from one side to the other. As for single glazed window, it allows heat energy transfer from the sun transfer through the glass without any insulative barrier which leads to increase in temperature.

4.6 Overall Evaluation of Taman Templer Park Suasana

In this section of report, the overall evaluation will be conducted to determine the type of sustainable approach taken by the developer. Figure 4.30 summarise the findings.

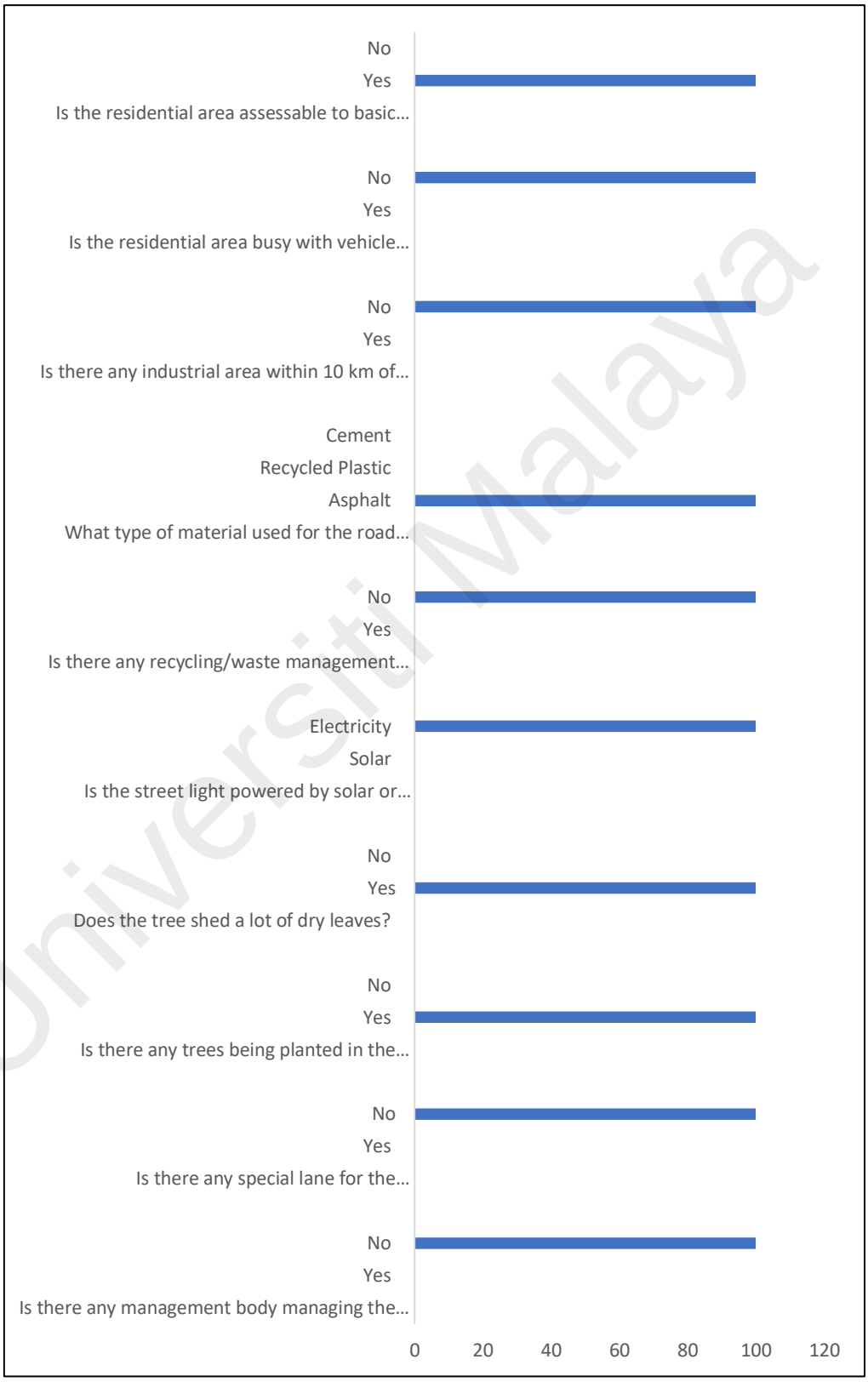


Figure 4. 31 Overall summary of Templer Park Suasana Rawang

4.7 Proposed Cleaner Production Options In Greening Residential Area In Planning Stage

Based on the analysis of the respondents and the overall evaluation of Templer Park Suasana. There are several CP options that can be introduced in building a residential area. The implementation of CP strategies can be categorised into following:

1. Design of the House
2. Material Used For construction
3. Energy Conservation
4. Water Conservation
5. Waste Management
6. Outdoor Design

4.7.1 Design of the house

Design of the house plays a huge factor in sustainable development. According to sensible house 2022, square shaped house is the most sustainable design compared with rectangular or complex shaped house ("Green Principles for Residential Design | WBDG - Whole Building Design Guide", 2016). This is because square shape house requires less material to be constructed in relation to floor area. Besides that, in 2020 the average household size in Malaysia is 3.8 person reported by statista, based on the findings the most suitable size in building a house would be from 1000-2000 square feet which can accommodate 3-4 person (Mesthrige Jayantha & Lau, 2008)

Based on the analysis conducted in section 4.3.1, most of the respondents have installed 3-4 air conditioning system to regulate their house temperature. This causes an increase energy usage as air-conditioner is the largest consumer of electricity. To overcome this problem all newly constructed house must have an effective air ventilation. To archive good ventilation system, the house must consist of ventilated skylight which

enables natural lighting and promote better air ventilation which helps in keeping the home more energy-efficien (Dyson Energy Service,2022). The type of windows that should be installed are double glazed windows. Double glazed windows uses two piece of glass and separated by vacuum. The vacuum layer in between acts an insulative barrier which stops heat transferring from one side to the other which helps in reducing energy consumption (Mehdizadeh-Rad et al., 2022,).Figure 4.32 shows the proposed designed of the house with ventilated skylight.

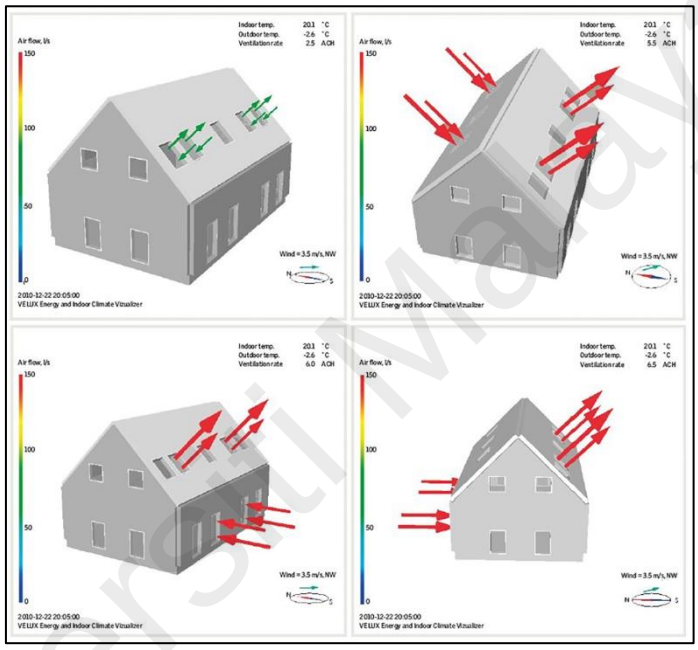


Figure 4. 32 Example design of a house with ventilated skylight

4.7.2 Material used for the construction

The most commonly used material in building a house is steel, concrete and bricks. This causes increase in material extraction from the ground and increases the carbon footprint due to transforming the raw material into finished products. As for steel, it releases 3 billion metric tons of carbon dioxide each year which contributes to biggest climate impact(c&en, 2021).Steel in constructing primarily used for building columns, beams and wall. Bamboo can be used an alternative to steel. Not only bamboo is 3 times cheaper than steel but it has greater tensile strength. In 2017, P R Himasree conducted a

study on “bamboo as a substitute for steel in reinforced concrete wall”. The findings from the study was bamboo reinforced concrete wall can carry loads as high 850kN and effectively replace steel reinforced wall. Figure 4.33 shows the example of bamboo usage as replacement of steel.

Figure 4. 33 Usage of bamboo in construction

As for the cement usage, the developer can opt in using green cements. Green cements minimizes the carbon footprint of cement production which based on technologic advance. This includes new cement formulation, geopolymers and low carbon production method. The major raw material in green cement is discarded industrial wastes such as blast furnace slag and fly ash. It is an environmentally friendly product (The Constructors, 2022). Example of green cements are Ekkomaxx cement, Magnesium Oxychloride cement, Ferrocrete and Calcium Sulfoaluminate cement.

In construction of the wall, bricks are the most common material used in constructing them. Most of the bricks are made out from concrete. In 2013 Yoshioka et al., came up with “new ecological concrete that reduce carbon dioxide emission below

zero levels". Using special admixture (the γ phase of dicalcium silicate: -2CaO.SiO2) instead of cement, this material has very low level of CO2 emission and hardens the concrete by capturing the CO2. Figure 4.34 shows the difference between ordinary concrete and the new ecological concrete.

Table 4. 3 Difference between ordinary concrete and ecological concrete (Yoshioka et al.,2013)

	Ordinary Concrete	**The new ecological concrete CO2-SUICOM**
Concrete materials	Water + cement + aggregate	Water + cement + aggregate + special admixture + coal-ash
Curing method	Water curing or air curing	Curing by CO2 contained in gas emitted from thermal power station
Hardening reaction	Hydration reaction between water and cement	Carbonation reaction of CO2 and special admixture in addition to hydration reaction between water and cement

Using the ecological concrete, the developer able to produce new sustainable bricks in constructing new residential area.

4.7.3 Energy Conservation

Since the primary source of energy generation in Malaysia heavily dependent on combustion of coal and natural gas. It causes large amount carbon dioxide released into the environment. As for the residential area, the average operation lifespan of a house is 90 to infinite period of years and with increase in population growth, the demand for new residential area will increases as well which leads to increase energy generation. So it is important to manage the energy usage. One of the ways in reducing energy usage would be by installing solar panel. Solar Panel system works by absorbing sun's energy using

photovoltaic cell and converts it to electricity. Not only generating electricity, usage of solar panel can be used in heating up waters for daily usage. In Malaysia, with average daily solar radiation of 4500 kWh m–2 and abundant sunshine for about 12 hours a day. Installing three 450 watt solar panel on the roof will produce 32,400 kwh per year. This would result in reduce electricity consumption(Nicholas Tan et al., 2017)

Besides that, installing LED bulb as lighting system would reduce in energy usage. On average 60 watt LED light bulb only uses 0.01 kWh of electricity(Akhtar Zeb et al., 2016). During the analysis conducted, most of the respondents does not have single control switch for tuning on/off lighting appliance. One of ways is by installing smart lighting system which has photosensitive and motion sensor. This installation enables automated switching on/off the lights. Moreover, in section 4.5 most of the respondents stated that a monitoring device installed would help them in monitoring their energy usage. In 2021, R S Hariharan et al., has come up with an monitoring system that uses Internet of Things(IoT) which connects ACS712 current sensor to measure current flowing through an appliance.This provides real time monitoring on the energy usage of different type of appliance using mobile app. With this technology, it helps the users to monitor their energy usage and create awareness on energy conservation .

4.7.4 Water Conservation

Water conservation is an important element because conserving water saves energy. Energy is primarily used in wastewater treatment facilitates, where raw water is filtered and treated to produce clean supply of water. So reduce in water usage would reduce in possessing of clean water supply and also reduces in carbon footprint(The Wild Life Trust,2022) . Installing rainwater harvesting system, would help in water

conservation. Rainwater harvesting is method collecting the run off from a structure. In Malaysia, the average annual rainfall is 2000mm to 2500mm equivalent to 2000 to 2500 litres of water per square meter(Malaysia Information, 2022). It will be an suitable approach for water conservation. The rainwater harvesting system can be installed at edge of the roof and collected in a tank. On estimation in year using rainwater harvesting method around 230000 litres of can be harvested based on 92.03 square meter of exposure. This water can be used to perform daily activities such as watering plants, washing dishes or even filter the water for shower usage and washing clothes. Figure 4.35 shows the example of installation and its usage.

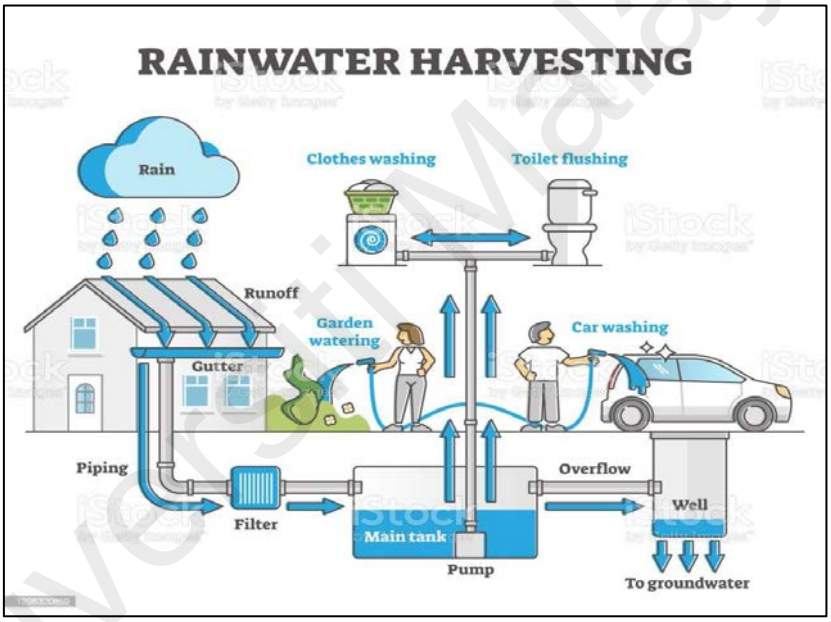


Figure 4. 34 Installation of rainwater harvesting system(Istock,2022)

Another method in conserving the water usage, is by installing dual-flush toilet bowl. Dual flush toilet bowl system has two option for flushing, high volume flush for solid waste and low volume flush for liquid waste. Dual flush system typically uses 4-6 litre of water where gravity and pressure assisted toilet bowl consumes which only has one flushing system and consumes 13 litres of water(Save Water,2022). Based on the respondents analysis, most of them has installed dual-flush toilet bowl system.

Hand wash sink attached to toilet bowl shown in figure 4.19 is an efficient and innovative way to save water. The used waste water from the hand wash sink is channelled to toilet bowl tanked and can be used to flush. By using this type of integrated system, the user able to save few litres of water in their daily life. Based on the responses from the respondents, 9.1% has installed hand wash sink which connects to their toilet bowl system. This is a good approach taken by them in conserving water. Besides that, type of tap installed plays an important role in water usage. According to Alyssa Harmon 2016 conducted a study on manual water tap and automated water tap. Based on the authors finding, automated water tap has reduction of water usage up to 54% compared with manual water tap.

4.7.5 Waste Management

Based on the overall analysis conducted in Templer Park Suasana, the residential area does not consist of recycling/waste management facilities. This has resulted the respondents not to manage their waste efficiently. Waste management is important because it reduces the effect of waste on the environment. It is important to have a waste management/recycling facilities available in a residential area. This would help in reuse or recycle resource, manage disposal of hazardous substance and avoid mismanagement of waste which leads to water contamination, soil erosion and air contamination (Waste Management,2022)

4.7.6 Outdoor Design and Facilities of Residential Area

Quality housing can be highlighted as an important factor in creating sustainable living environment. Location of building the residential area should be 10km radius away from any industrial areas. Building a residential area nearby industry area decreases the quality of life. This is due to pollutants emitted from the industrial area have significant

impact towards human health. Based on the overall analysis, Templer Park Suasana residential area has no industrial area within the 2km radius (Sahabat Alam Malaysia, 2022). Besides that, having a good landscape in a residential area acts an environmental cleaner as they capture smoke,dust and other impurities leaving clean cool fresh air to breath.Thus, it is important to have trees planted in the residential area. Choosing the right type of tree being planted is important so that no secondary waste being created such sheading of dry leaves. The suitable tree that can be planted is pine trees (Bai et al., 2015).

Moving on, in the process of greening the residential area certain facilities should be available. Type of facilities that should be available in developing a residential area are accessible to public transport, accessible to basic needs(restaurants, clinic and mini mart) within reasonable distance and special pathway for pedestrian/cyclist. This would encourage the residents to use nearby facilities by just walking/cycling reduce the usage of private transportation. Reduce in the usage of private transportation contributes less carbon emission to the environment (Wang et al., 2021)

Lastly, the developers must establish maintenance management in greening residential area. From section 4.5, 49.1% of respondents only conduct maintenance inspection when something is broken/faulty/not performing well and 20% of them has never conducted maintenance in their property. Maintenance of a house is an important thing that every houseowner should conduct to ensure the property is in full functional and operating in its best condition. With maintenance management being established in a residential area, this would help in reducing the energy, water usage and promote sustainable living environment (Sia et al., 2018).

Based on analysis from respondents responses via questionnaire and overall overview of residential area. A cleaner production strategies options was proposed in greening the residential area with estimated reduction of carbon footprints in terms of energy and water conservation are tabulated in table 4.4 and a checklist was created table 4.5 for new developers in greening residential area using cleaner production strategies in planning stage

Table 4. 4 Cp options and Overall Carbon Footprints Reductions

Cp Options	Carbon Footprint Reduction per Year (kg of CO_2)
Energy Conservation	
a) Installation of three 450 watt Solar Panel	22485.6
b) Installation of Led bulb (per bulb)	8.328
c) Integrated lighting system with smart lighting system	-
d) Integrate smart monitoring sensors into power supply	-
Water Conservation	
a) Rainwater harvesting system	963.7
b) Dual flush toilet system	16.76
c) Installation of hand wash sink together with dual flush toilet bowl	-
d) Automated tap water	-

Table 4. 5 Checklist for new construction of residential area

Construction of residential area checklist in planning stage	**Please Tick**
1.Design of the house	
a. Square shape	
b. 1000-2000 Square feet size for 3-4 person	
c. Ventilated Skylight	
d. Double Glazed window	
2.Type of Material need used for constructing the house	
a. Bamboo, replacement for steel	
b. Green cements	
c. Ecological Concrete for producing bricks	
3.Energy Conservation	
a. Install 3 solar panel with 450 watt output power	
b. Install LED bulbs for lighting system	
c. Integrate the lighting system with smart lighting system	
d. Integrate smart monitoring sensors into power supply	
4.Water Conservation	
a. Install rainwater harvesting system on the roof outlet and connect it with a storage tank	
b. Install Dual-Flush toilet bowl	
c. Install Hand wash sink together with dual flush toilet bowl	
d. Install automated water tap in toilets	
5.Waste Management	
a. Construct a waste management/recycling facilities	

Table 4.5 Continue

6.Outdoor Design and Facilities of Residential Area	
a. The residential should be constructed 10km radius away from industrial area	
b. Easy access to public transport	
c. Easy access to nearby amenities	
d. Pathway for cyclist/pedestrian	
e. Solar powered street lights	
f. Plantation of trees such as pine trees	
g. Establishing maintenance management	

4.8 Summary of Findings

In summary, based on the analysis findings, there has been some sustainable approach taken by the respondents in Templer Park Suasana residents. There has been a small group of respondents uses cleaner production strategies in energy conservation. In terms of energy conservation, the respondents has implemented changes in technology. Example of changes in technology that has been opted by the respondents are usage of LED bulbs for lighting appliance, usage of solar panels for heating water, powering up small electric appliance and lighting appliances. Moreover, majority of the respondents has installed electrical appliances with energy efficiency rating.

Besides that, there have been few respondents who has changes in operating changes in terms of water conservation. The operation changes that have been practised by the respondents are usage of dual-flush toilet bowl, using harvested rainwater to water the plants and washing the vehicles. As for the waste management, most of the respondents does not practice a good waste management only a small group of respondents practices proper waste management. The approach used by the small group of respondents are end of pipe sustainable approach such as sorting out their trash for recycling.

This case study analysis, has shown there is options for cleaner production strategies that can be implemented. 23 Cleaner Production option checklist was created based on the analysis of case study which compromise from designing the house, material used for construction, energy conservation, water conservation, waste management and outdoor plan and facilities. This checklist can be used as a guideline for future development of residential area.

CHAPTER 5 : CONCLUSION

5.1 Conclusion

With the rapid growth of worldwide population in the last few decades it has resulted in unparalleled requirement for housing construction. Increase in the number of houses requires higher amount of generation of electricity. Generation of electricity in Malaysia is generated by combustion of fossil fuel, through this combustion process large amount of greenhouses gases being released into the atmosphere. This process contributes to increase in global warming rate. Besides that, the operation phase of a house in Malaysia is around 60-90 years. It is important to have a sustainable approach in building a house which covers the energy usage, water usage and waste management

Research Objective 1: To determine the current sustainable approach from building the current case study residential area.

From the research analysis and overall observation. There were minimal sustainable approach taken by the developer when constructing the residential area. In terms of energy usage and water usage there was no sign of sustainable approach used in terms of energy and water conservation. This is because the residential area was build in early 2000's were sustainable building was not a major concern in Malaysia.

Research Objective 2: To investigate opportunities of cleaner production in the planning stage of building residential area.

Through this study, it is concluded it is possible to implement cleaner production strategies as sustainable approach in greening the residential area in planning phase. As small group of respondents have been practicing certain type of cleaner production

strategies such as change in technology, change in operation and change in maintenance. Based on that a total of 23 cleaner production options has been identified that compromise from designing the house, material used for construction, energy conservation, water conservation, waste management and outdoor plan and facilities. This cleaner production options can be used as a guideline for future development of residential area.

Research Objective 3: To improve the usage of energy and water usage and reduce environmental damages in the long operational life span of residential area using cleaner production.

As 23 cleaner production options that has been proposed, it will help to reduce in energy and water usage throughout the operational life span of a residential area. Usage of solar panel to generate electricity, would reduce the dependency of fossil fuel in generation of electricity. Besides that, change in material used would help in reducing energy usage. Such as using LED bulb instead of CFB, which requires low amount of energy to operate. Besides that, in term of water usage, installation of rain water harvesting would help in reducing the amount of water usage by a house. Reduce in water usage, will results in low energy usage and carbon emission from water treatment facility. Finally with cleaner production options it helps in reducing the amount greenhouse gases being emitted into the atmosphere which helps in decreasing the global warming

5.2 Recommendation for Future Studies

As for this analysis, the case study was only conducted in one residential area. In the future, number of residential area analysis should be increased with different type of houses. Such as single story, triple story, bungalows and green building index rated residential area. Based on the analysis, it would provide more information towards different type sustainable approach being practised. The analysed information can be used in creating a better framework/checklist in developing new residential areas.

Besides that, with the current proposed checklist, a house model should be constructed to determine the effectiveness of proposed cleaner production options in terms of energy usage, water usage, waste management and outdoor quality. Carbon footprints should be calculated for the model house and compare with the current residential area.

Moving on, the government must impose new frameworks with stronger enforcement of rule and regulations towards developers to ensure wider compliance with green technology in building houses. Besides that, the government should educate the publics on the benefits of owning a green residential area. Finally, the government should provide tax relief towards green building owners.

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