



KEMENTERIAN PENDIDIKAN TINGGI
JABATAN PENDIDIKAN POLITEKNIK DAN KOLEJ KOMUNITI



LAPORAN PROJEK AKHIR
(STUDY ON THE IMPORTANCE OF “RAINWATER HARVESTING
SYSTEM” STORAGE TANK MANAGEMENT ON EXISTING USERS)

OLEH

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08DPB20F2014

PROGRAM DIPLOMA KEJURUTERAAN PERKHIDMATAN
BANGUNAN
JABATAN KEJURUTERAAN AWAM
POLITEKNIK PREMIER SULTAN SALAHUDDIN ABDUL

SESI 2 2022/2023



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6.6.2023

APPRECIATION

Thank you for everyone because with abundant grace you all has given us the strength to complete this project. First of all, we would like to express our utmost appreciation and gratitude to Mrs. MARIAM BT ABDULLAH as supervisor for all the guidance, advice and advice given throughout the completion of this assignment and report.

In addition, the highest appreciation and thanks are also recorded to him for all encouragement, help and concern during the completion of this report. The guidance, insights and guidance given have greatly helped the success of this report. We greatly appreciate his concern who is ready to share information and expertise, easy to contact and quick in action during supervision sessions throughout this study. The spirit of patience, careful reading, interest in this study as well as convincing feedback from him greatly helped to complete this report.

The highest appreciation is also given to all the Building Services Engineering lecturers who always provided assistance and cooperation throughout our studies at Polytechnic Sultan Salahuddin Abdul Aziz Shah.

Thank you also to my family and friends who have been a source of encouragement and never tired of giving opinions and criticism throughout the course of this project. Not forgotten also to the parties involved such as the developer of kin rimba as well as the Department of Environment in providing cooperation and launching the course of our project in the matter of writing our study. Encouragement and support from all parties is the backbone for us to complete this project successfully. Hopefully this developed project can benefit the public.

Once again we offer a prayer of gratitude to God, so that all the efforts contributed will be blessed. thank you.

ABSTRACT

RWHS stands for "Rainwater Collection and Reuse System" where rainwater is collected from the roof and then channeled to a rainwater storage tank before use (UBBL 1984 Amendment 2011). RWHS is the best management method in effective water management practices in Malaysia. This alternative water supply can help save existing treated water. The RWHS system aims to promote efficient water use because alternative water supply sources are free and safe to use. RWHS used in commercial buildings usually consists of four main elements, namely the catchment area, drainage system, storage tank and rainwater distribution system. A study by NAHRIM (Malaysian National Hydraulic Research Institute) found that the use of RWHS can save the use of public water supply by up to 40 percent per day, thus contributing to saving the use of treated water for the long term. Although the government has implemented a rainwater harvesting system program in most places (Nor Hafizi et. Al, 2018), however, the management of this system needs to be improved among existing users. From the results of initial observations, it was found that the main parts of the rainwater harvesting system that are difficult to maintain are the gutters and storage tanks. Optimal rainwater collection cannot be made if two parts; storage tanks and gutters are not properly maintained. Therefore a study has been carried out to identify the level of maintenance of water storage tanks in the rainwater harvesting system as well as the maintenance of the gutter system of the rainwater harvesting system. The objective of this study is to identify the level of importance of storage tank maintenance and to study how to maintain a more efficient rainwater harvesting system. The data collection process is done through quantitative methods (questionnaires) and qualitative methods (surveys, interviews). The questionnaire was distributed to a developer as a respondent. A survey was conducted for this study in the study area of Ken Rimba, Seksyen 16 Selangor. Interview forms have been distributed to several SPAH users in Selangor residential areas to obtain more authentic data analysis. In conclusion, the respondents' feedback on the use of the rainwater harvesting system is very important to obtain the results of this project in order to achieve the objectives of the study. However, through the research that has been carried out, maintenance in this rainwater harvesting system can be improved in terms of more efficient management from existing users or using stored water carefully in the future.

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CHAPTER 1

(INTRODUCTION)

1.1 INTRODUCTION

The Importance of rainwater harvesting system (RWHS) and storage tank management is also known as the collection system and reunion of rainwater is one of the best management methods in effective water management practicing in Malaysia. Rainwater harvesting (RWH) is the collection and storage of rain, rather than allowing it to run off.

Rainwater is collected from a roof-like surface and redirected to a tank, cistern, deep pit (well, shaft, or borehole), aquifer, or a reservoir with percolation, so that it seeps down and restores the ground water. Dew and fog can also be collected with nets or other tools.

Rainwater harvesting differs from stormwater harvesting as the runoff is typically collected from roofs and other surfaces for storage and subsequent reuse. Its uses include watering gardens, livestock, irrigation, domestic use with proper treatment, and domestic heating. The harvested water can also be committed to longer-term storage.

1.2 Research background

The rainwater harvesting system its evolutionary system and reunion of rainwater, where rainwater is collected from the roof and then channeled to the rain water storage before use (UBBL 1984 Amendment 2011). RWHS is the best management method in effective water management practices in Malaysia. This alternative water supply can help save existing treated water. The RWH system aims to promote efficient water consumption as alternative water supply sources is free and safely used.

The RWH that is used in commercial buildings usually consisting of the top four elements of catchment area, drainage system, storage tank and rainwater distribution system. NAHRIM (Malaysian Hydraulic Research Institute Malaysia) Founding that the use of RWHS is able to save on public water supply to up to 40 percent a day, thus contributing to the savings of the use of the treated water for the long-term.



Figure 1

1.3 PROBLEM STATEMENT

Although the Government has implemented RWHS programs in most places, but the management of the system needs to be improved among existing users. From the initial observation result found that the main part of the RWHS that is difficult to maintain the gutter and savings tank. The optimum rainwater collection cannot be made if these 2 parts are not well maintained.



Figure 2

1.5 Research objective

The objectives of the study at the initial stage of the study are to:

- i) Identify the level of importance of maintenance of tank.
- ii) Reviewed the method of maintenance of more efficient RWHS.

1.6 Scope of the research

The scope of the project study is to the place of use of this RWHS. The scope of the chosen study is to use RWHS in Ken Rimba Seksyen 16 Shah Alam.

- i) Maintenance of RWH Savings Tank.
- ii) Maintenance of Gutter RWH system.



Figure 3



Figure 4

1.7 The importance of the study

- i) The rainwater that falls on your roof and property is essentially free. All it takes is a method to harvest it into a tank or cistern for later use.
- ii) Rainwater harvesting can be a great educational tool to get people to recognize their individual or household water usage. This can get them to start conserving water in other areas around their home.
- iii) For communities that rely on imported water to supply their needs, collecting rainwater that falls naturally in the community can reduce the need for imported water.
- iv) Rainwater harvesting helps utilities reduce peak demands during summer months, saving treated water for more important and appropriate water uses.

1.8 Define the term

A rainwater harvesting system consists of a rainwater catchment surface, conveyance system, and water storage tank(s). A schematic of a typical rainwater catchment system. Rainwater harvesting systems can serve households or communities of various sizes. Household systems generally catch rain from the rooftops of homes and store it in tanks adjacent to the homes. Water is drawn from the tanks by means of taps at the base of the tanks. In some cases rainwater may be reticulated within a house using a pump/pressure system.

The tank may be partly buried and a handpump used to withdraw water. In cases where the majority of homes have thatched roofs, community systems are popular. The roofs of large community buildings, such as churches and schools, are used as catchment surfaces and the water is stored in large tanks adjacent to these buildings. Alternatively, if no suitable catchment surface is available, a separate catchment surface is built adjacent to, or directly over, the water storage tank.

Residents of the community walk to these tanks, draw water from a tap at the base of the tank, and transport it back to their homes for drinking or cooking. In some cases, individual homes with thatched roofs have also built separate catchment surfaces serving household storage tanks.

1.9 Summary

Harvested rainwater can provide a source of alternative water to rural facilities. Alternative waters are sustainable sources of water, not supplied from fresh surface water or groundwater, that offset the demand for freshwater. Rainwater harvesting captures, diverts, and stores rainwater from rooftops for later use. Typical uses of rainwater include landscape irrigation, wash applications, ornamental pond and fountain filling, cooling tower make-up water, and toilet and urinal flushing. With additional filtration and disinfection, harvested rainwater can also be treated to potable standards to supplement municipal potable water supplies to facilities.

CHAPTER 2

(LITERATURE STUDY)

2.1 Introduction

The Maintenance of Gutter RWH system collection is a creative means of sustaining water sources and improving the quality of life. Rainwater harvesting is a technique that aims to collect water running off roofs and other surfaces. Systems vary most greatly in the cross-sectional design of their gutters. This work is a case study of a project-based, service-learning experience, which complemented classroom and laboratory study.

In a previous work, the performance of four gutter cross-section designs based on their ability to intercept and convey water to a collection tank. We showed that, under heavy rainfall conditions, a cross-section that wraps around the ends of the catchment area reduces losses due to water overshooting the gutter. RWHS have students made observation on site. We have to chose study is to use RWH system in ken Rimba sekyen 16 shah alam. The research based on RWH system guntter and function.



Figure 5

2.2 Definition of gutter

Rain water collection systems are used in western countries to collect water from rooftops and release it where the effects will be least harmful. Gutters also help prevent water from seeping into a structure by ensuring the water does not run down the side of the building.

In many developing and some developed countries rain water capture systems are used to collect rain water for potable use. This use of rain water collection inherently requires more reliability as service interruption can immediately effect users. Many parts of the world also lack necessary skills and tools to repair broken or damaged systems causing many to fall into disrepair.

In many parts of the world heavy storms can cause damage to gutter systems and this must be planned for in the initial design. In some areas these heavy storms can also be the only rainfall over long periods of time so the systems need to be able to operate during these periods. The effect of water on the degradation of structural material must also be considered.

2.3 Design Factors

Since gutter systems have differing levels of impact on different areas, the area where system failure would have the most negative effect will be considered. This will guide the design factors toward very conservative estimate including worst case scenario design. A safety factor will also be built into the calculations.

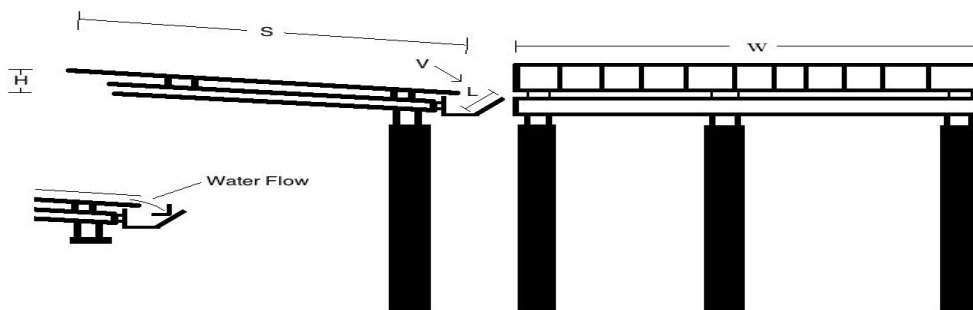


Figure 6

2.4 Cross Section Design

While roughness dictated the materials used, cross-sectional area, a , had a greater impact on the flow capacity of a gutter system, and thus the amount of water that could be collected and stored within the storage tank. Cross-sectional area also directly impacts the performance of using a gutter to collect rooftop runoff. By compiling various data regarding flow rates and capacities of several gutter designs^{2,5}, three gutter designs, V-Shaped, Square, and Trapezoidal, were chosen for further examination. Through the use of a rainwater simulator, we were able to determine the best gutter design for varying rain intensities. Along with V-Shaped, Trapezoidal, and Square gutters, a “wrap” design was implemented during the second round of test trials.

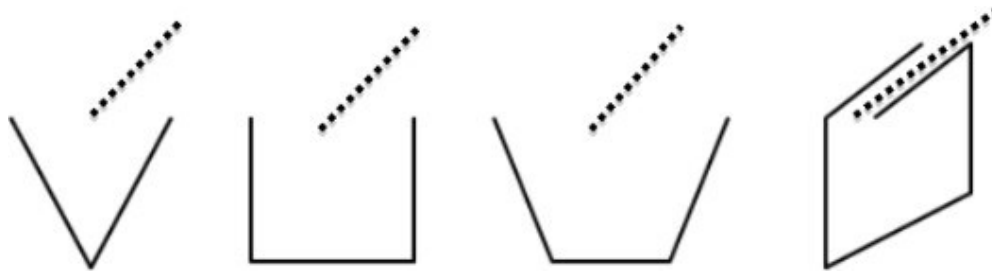


Figure 7

2.5 Water Flow Rate

The water that can flow down from the roof and against the gutter will exert pressure. We can find this pressure knowing the size of the roof and the extremes of local weather. If we assume no friction along the roof, negligible back pressure and no fluid thickness effects, the force exerted against the gutter can be calculated.



Figure 8

2.6 Weight of Gutter With Water

While using heavy duty materials will strengthen the gutter, the extra weight that they add will need to be addressed. Improvised materials also tend to be heavier than the thin sheet aluminum gutters that are found in North American systems. This dictates that we include weight calculations in the design considerations. We will also consider the worst case scenario of the entire gutter being clogged and full of water.

2.7 Required Strength of Gutter

The strength of the gutter must support all the mentioned design factors. We discount the falling rain effects that are explained in the next section and assume the effects will be covered by the included safety factor.

$$F_{\text{total}} = F_{\text{wind}} + F_{\text{water}} + F_{\text{mass}}$$

We can then use this value to approximate the design of the support structure. We use a safety factor of 2 to cover effects not included but not limited to storm surges, material faults, debris build up and calculation error. To gain a better idea of the required strength of the gutter we can use the following formula.

$$m = \frac{F_{\text{Total}}}{g}$$

Where m gives a indicator of the mass that the structure must support in kg. This should be used to ball park the necessary strength. We can approximate that 75kg is approximately equivalent to a large adult male hanging on the gutter.

2.7.1 Falling Rain Effects

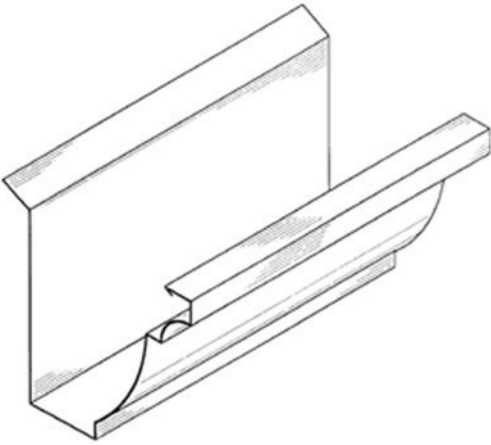
The force due to rain was found to be negligible in the application of rain gutter design. To find the effects of rain falling against the gutter we assume that the dominating effect is the increase of wind density due to the water and air mixture. This force can be found using the new density and the wind effects formula. The terminal velocity of rain drops is known to be 9.12 m/s. If we assume that during a heavy rain storm that all rain droplets reach terminal velocity we can derive a formula that finds the amount of water in a cubic meter of air during a rain storm and use that to find the increased density of the wind.

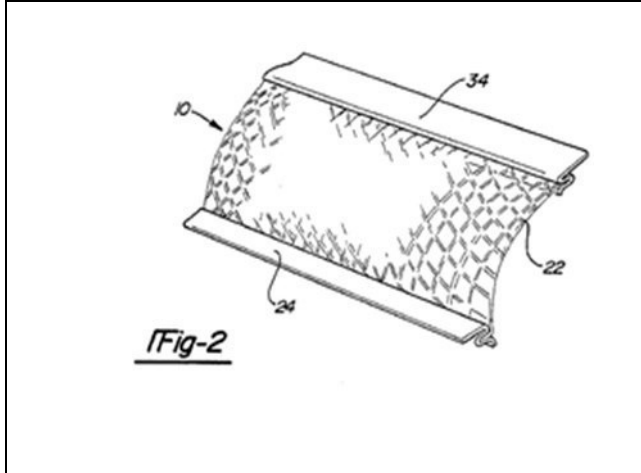
2.7.2 Regional Considerations

The region that that gutter is to be constructed is the major design consideration. The frequency and strength of storms must be considered. Materials that are available in the area must also be considered. When designing systems consult local weather historical data to plan for storm intensities Some areas of the unitedstates including Colorado, rainwater capture is illegal Please consult local laws before building. UPDATE: It is now legal to catch rainwater in Malaysia.

2.8 Current Designs:

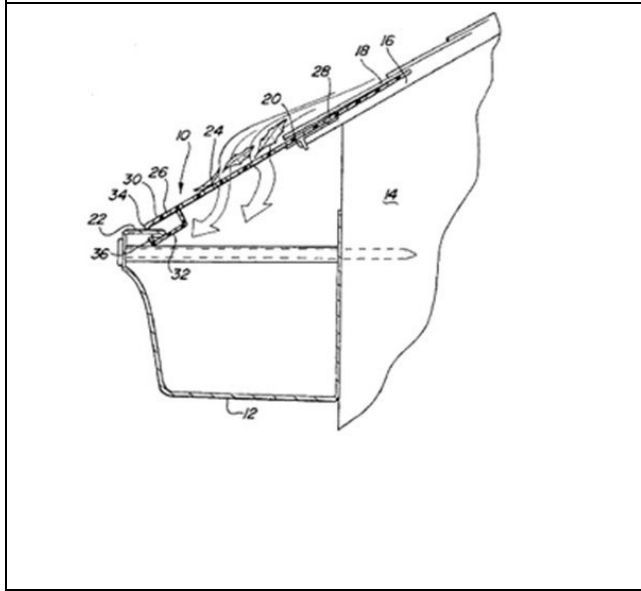
There are many designs available on the market today. The western style designs are usually constructed out of aluminum and are not always designed to withstand tropical storms. Their design features can be by using locally available materials to suit individual applications. Several additional designs have been included to address the possible available materials. The designs below are a combination of US patents and drawings reproduced from Rainwater harvesting . For more information about the patents shown please visit Google Patents and type in the identification number.

DESCRIPTION	Application/Considerations
	<p>Standard western style aluminum gutter.</p> <ul style="list-style-type: none">➤ Where available, can be used in areas where storm intensity is low and replacement parts are accessible.



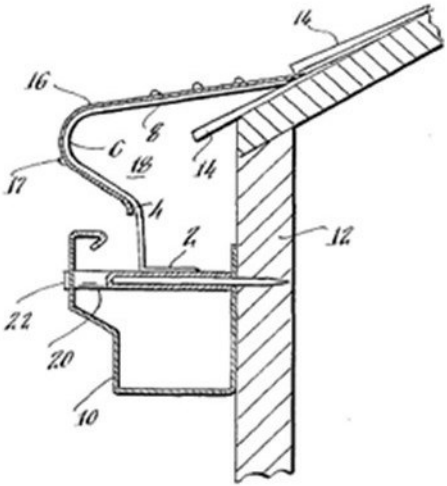
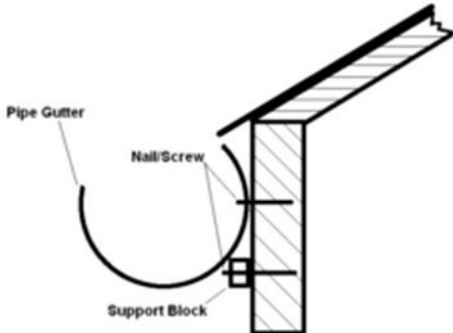
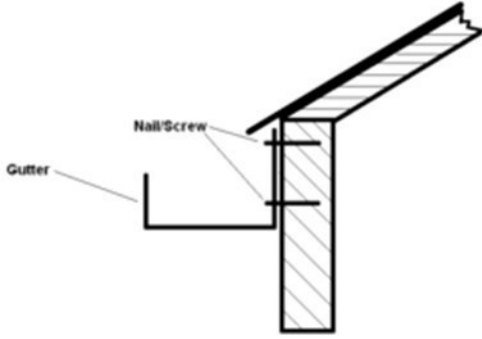
Guard Screen for a Rain Gutter

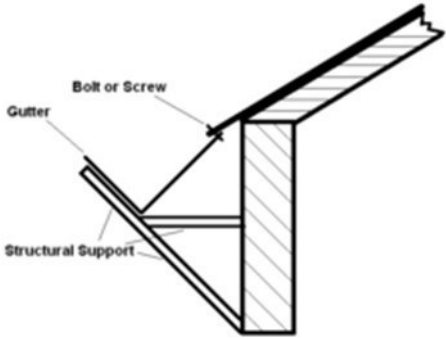
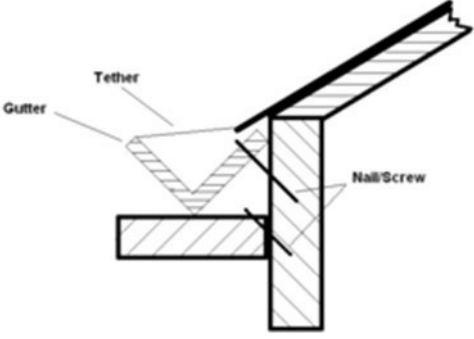
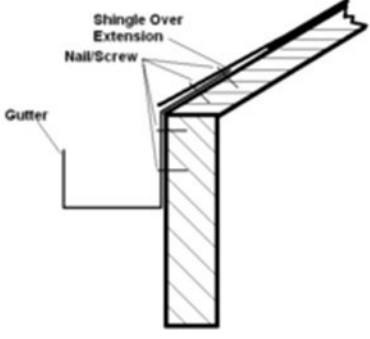
- Gutter screen will prevent debris from collecting. If mesh "holes" are small, feature will prevent some wind forces. Screen material can be made out of many wire mesh materials.



Guard screen for a gutter having flanges for gripping the front lip of a gutter.

- Gutter over will prevent debris from collecting. The rigid cover is perforated so that water can drain in. The cover will also act as a wind break. Cover could be sheet metal with holes of any kind.

 <p>A technical cross-section drawing of a gutter hanger system. It shows a gutter (10) mounted on a wall (12). A hanger (14) is attached to the gutter and passes through the wall. A curved cover (16) is attached to the hanger and the gutter. Other parts are labeled 17, 18, 19, 20, and 22.</p>	<p>Hangers for rain gutter devices</p> <ul style="list-style-type: none"> ➤ The curved nature of the cover prevents debris from entering the gutter while allowing water to run down and around the leading edge. Extreme storms will push water past the gutter preventing unnecessary water pressure but also preventing full capture. The cover will help prevent wind damage.
 <p>A diagram showing a simple gutter design using a PVC pipe. The pipe is cut and bent to form a gutter. It is supported by a support block (10) attached to the wall (12) with a nail or screw. The gutter is labeled 'Pipe Gutter'.</p>	<p>Simple PVC pipe design</p> <ul style="list-style-type: none"> ➤ When PVC (or other types of lightweight pipe) are available they can be cut to catch water. A support block will help keep keep the pipe upright.
 <p>A diagram showing a simple gutter design using a square duct. The duct is cut and bent to form a gutter. It is supported by a nail or screw (10) attached to the wall (12). The gutter is labeled 'Gutter'.</p>	<p>Simple square duct design</p> <ul style="list-style-type: none"> ➤ When square materials (or bendable sheet metal) are available they can be cut and bent to catch water. They should be well fasten along the wall.

 <p>Bolt or Screw Gutter Structural Support</p>	<p>V shaped gutter with support bracket</p> <ul style="list-style-type: none"> ➤ Instructions for fabrication of the V shaped gutter can be found here Rainwater harvesting. The brackets can be constructed out of any available material such as 1" by 1" wood planks.
 <p>Gutter Tether Nail/Screw</p>	<p>V shaped gutter with tether</p> <ul style="list-style-type: none"> ➤ Instructions for fabrication of the V shaped gutter can be found here rainwater harvesting This V shape can also be constructed of plywood fastened together at the seam. The tethers should be made of strong wire and spaced periodically down the roof.
 <p>Shingle Over Extension Nail/Screw Gutter</p>	<p>Gutter with extension under shingles</p> <ul style="list-style-type: none"> ➤ The extension will provide a strong fastening point for the gutter. The extension feature of this design could be combined with other designs to provide superior strength.

2.9.1 Advantages of Rainwater Harvesting

Rainwater Harvesting has proved to be very beneficial in several aspects. Given below are some of the advantages of rainwater harvesting: Rainwater harvesting technology is relatively simple and easy to install and operate. It helps to reduce stormwater runoff, flooding, soil erosion, and pollution of surface water with fertilizers, pesticides. It is an excellent source of water for landscape irrigation with no contaminated water.

- 1) It is cost-friendly.
- 2) It reduces the water bill.
- 3) It decreases the demand for water.
- 4) It reduces the need for imported water.
- 5) It promotes the conservation of both water and energy.
- 6) It helps to improve the quality and quantity of groundwater. 7) It does not require a filtration system for landscape irrigation.

2.9.2 Disadvantages of Rainwater Harvesting

Though there are numerous advantages of rainwater harvesting, it has a few disadvantages too. Here are a few disadvantages of rainwater harvesting:

- i) Unpredictable rainfall, or limited and no rain can limit the supply of rainwater.
- ii) Regular maintenance is required for the rainwater harvesting system.
- iii) Technical skills are required for the installation of a rainwater harvesting system.
- iv) It may attract mosquitoes and other waterborne diseases in case of an improper system.

The limit of storage tanks is the most significant disadvantage of rainwater harvesting.

2.9.3 Skills and material

Rainwater harvesting systems are common but often flawed in design, efficiency and sustainability. This paper investigates the impact of gutter cross-section on the performance and efficiency of rain water harvesting from roof catchments. A novel wrap-gutter design, not normally highlighted in the literature, had the most consistent performance, regardless of rainfall intensity.

Rain Gutter Material Comparison					
					
	Vinyl	Aluminum	Galvanized	Copper	Stainless Steel
Life Expectancy	> 20 years	Lifetime	15~20 years	Lifetime	50 years
Color Available	☑ Yes	☑ Various	☒ No	☒ No	☒ No
Price	💰 Very Low	💰 Low	💰 Lower	💰 Very High	💰 High
Advantages	<ul style="list-style-type: none"> • Not Rust • Ideal for DIY • Quietly Redirects Water 	<ul style="list-style-type: none"> • Not Rust • Various Color to Choose • Can be Customized Seamless Gutter 	<ul style="list-style-type: none"> • Resistant to Rust • Stronger resisting Dents & Damage • Can be Customized Seamless Gutter 	<ul style="list-style-type: none"> • Less Maintenance • Beautiful Material will Last Long • Can be Customized Seamless Gutter 	<ul style="list-style-type: none"> • Resistant to Rust (for Coastal Area) • Very Strong Material • Can be Customized Seamless Gutter
Disadvantages	<ul style="list-style-type: none"> • Easy Crack • Leaks between Sections • Additional Cost for Installation 	<ul style="list-style-type: none"> • Easy Dents & Damage • Expand & Contract with Temperature • Need to be Repainted for Maintenance 	<ul style="list-style-type: none"> • Protective Layer will Wear Off • Hard to inspect the rusted area • Heavier Metal, difficult to install 	<ul style="list-style-type: none"> • Most Expensive Material • Higher Labor Cost for Installation • Fading into Patina Color, will Lose its shine 	<ul style="list-style-type: none"> • Expensive Material • Higher Cost for Installation • Heavier Metal, making installation difficult

Figure 9

Conclusion

Rain gutter systems collect and transport water to desired locations. Their function becomes increasingly more important once they begin to be used for collecting water to be used for drinking. Most of the current systems that exist are designed to withstand western style storms. They are also designed to fit to standard western buildings. Improvisation with an understanding of the fundamental design challenges should lead to better gutter design for critical applications in the developing world.

CHAPTER 3

(METHODOLOGY)

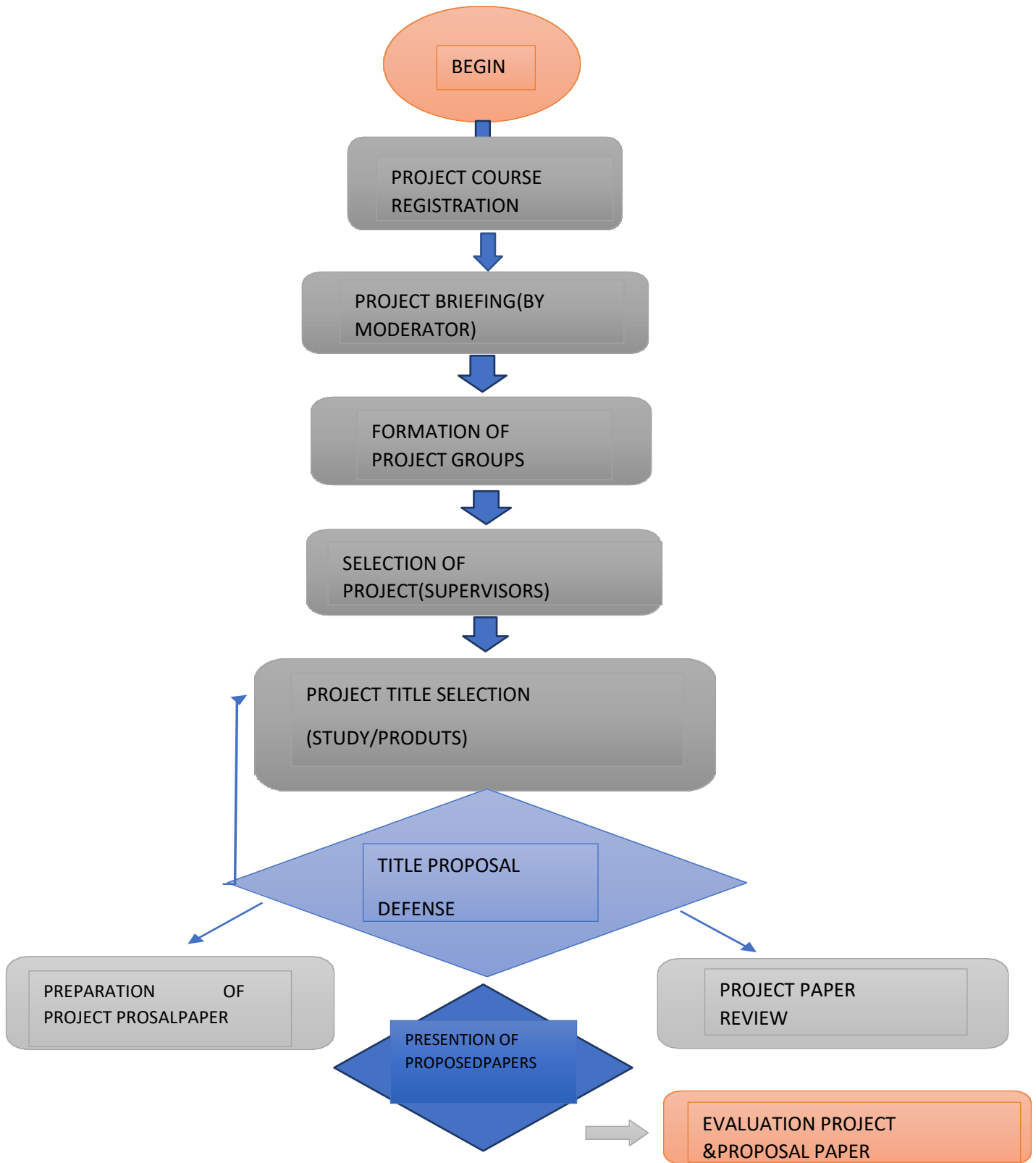
3.1 INTRODUCTION

This chapter will clearly describe some of the features that are related to the methodology that will be used in this study. The key focus in this chapter will be given to the researcher to study the Proper operation and maintenance of rainwaterharvesting systems helps to protect water quality in several ways. Regular inspection and cleaning of catchment, gutters, filters and tanks reduce the likelihood of contamination. Water from other sources should not be mixed with that in the tank. The methodology is a method used to conduct a study on a particular study subject. Therefore, this section will discuss the study design, earlypreparation, early stage of data collection, information collection level and stage analyze data and make suggestions. As the study methodology is a quantitative or qualitative technique, the questionnaire is held online to collect opinions from respondents. Interviews were also held with small traders.

3.2 Research Design

Before this study is conducted, the selection of the study is the first thing. This is because it will be used as a useful answer to the title of thisstudy and answer any questions about the study that will be studied at this time, the study aims to Identify the level of importance of maintenance of tank and reviewed the method of maintenance of more efficient (RWH).

Chart 3.1 the first stage of the implementation of the research project



3.2 Information provision

In this process, the reference reading process, discussion and observations will be done to understand the field of study and data related to the study will be collected to push to achieve the objective of the study. Furthermore, the results of the study are enabled the process to identify the suitability of the selected title with the findings of the study objective.

3.3 Data collection methods

First of all activities will be carried out on data search and collect related information. This method can indirectly identify the problems contained in this study. In addition, this data collection task should be done with the initiative to be able to find outstanding and encouraging research results and at the same time the data has collapsed to be in line with the study title, study objectives and scope of the additional studies, the obtained data should be reviewed by the validity of one by one and should interpret that the extent of these data can help to achieve the objectives of the study required in this study.

In this data collection method, the researcher will hold a discussion with the supervisor, read reference books, from previous studies and surf the internet and most importantly the researcher will distribute questionnaires to respondents, hold interview sessions with respondents, observation methods and methods self observation.

- DISCUSSION WITH THE SUPERVISOR
 - The initial stage is to talk with Project Supervisor for the consent of the suggestion of the proposed titles. The next stage of the planning of the necessary study includes identifying buildings using this rainwater system, after the building is set, the next deal is to discuss the interview session with the relevant officer for the permission to conduct a study and the truth to distribute Form to existing occupants.

- Browsing the internet

-A variety of information will be collected from well-known websites such as Wikipedia, Mendeley, Yahoo and others related to this research project. By browsing the internet, a lot of information can be collected. This is because, in this modern age, everything is at the fingertips only and can save time and it is very easy to get information. However, the information obtained from the internet should be filtered in terms of making a comparison with one's own opinion so that the information obtained is more accurate.

3.3.1 STUDY INSTRUMENTS

Quantitative and qualitative research methods to determine the problem statement are encouraged in this study. In that, quantitative and qualitative data will be collected in the form of questionnaires will be distributed to respondents, make interviews, make observations and document analysis.

3.4 Questionnaire

Data analysis means a method that shows and controls data and statistical procedures. In this, there are two ways to analyze data, namely descriptive analysis and statistical analysis. Next, in descriptive analysis it can conclude information numerically with the presence of research variables. As for example, by using tables, graphs or diagrams. In addition, statistical analysis can produce conclusions or be able to find out what is happening to the population by using information collected from the sample. As additional information, the researcher will use both of these analyzes in the study this.

BAHAGIAN A: MENGENALPASTI PENYELENGGARAAN SISTEM TALANG AIR/GUTTER DALAM SISTEM PENUAIAN AIR HUJAN (SPAHS)

A. Maklumat Diri Responden

a) Nama

b) ALAMAT : LEGIAN RESIDENCE

1) Adakah syarikat dibawah kendalian tuan/puan menggunakan SPAHS sistem?

Ya

Tidak

2) Apakah kaedah pembersihan gutter SPAHS yang digunakan oleh syarikat tuan/puan?

Membayar technician profesional

Membersihkan sendiri

Lain-lain _____

3) Apakah yang dilakukan oleh pihak tuan/ puan, jika gutter SPAHS bocor?

Menukar gutter baru

Membayar technician profesional

4) Berapakah kos yang dikeluarkan oleh pihak pemaju untuk penyelenggaraan gutter SPAH?

- o RM100
- o RM200
- o RM300
- o Lain-lain _____

5) Adakah pemilik rumah boleh membersihkan sendiri gutter tersebut?

- o Boleh
- o Tidak boleh

The data analysis method of this study will use the questionnaire method. Therefore, the data we obtain from this method is online as a result of findings and references. This is said to be so because, this questionnaire method is very compatible with the data collection methods so that it is easy to evaluate the respondents' answers later. Therefore, in this study will contain direct questions and at the same time not too many questions will be answered by the respondents. In addition, this can build a questionnaire that the respondents are able to answer and will be compared from each other's opinions.

3.5 INTERVIEW

Most RWHS have a to-do list of household chores that seems to grow longer each year. For many people, gutter cleaning is one of those chores that gets pushed down the list until the last possible moment, likely because it's a dirty, unwieldy job that you usually have to do while standing on a ladder.

BAHAGIAN B : MENGAJI PENYELENGGARAAN SISTEM TALANG AIR/ GUTTER DALAM SISTEM PENUAIAN AIR HUJAN (SPAHS)

- 1) Bagaimana gutter dibersihkan?
- 2) Apa akan terjadi bila gutter tidak dibersihkan dalam tempoh tertentu?
- 3) Apakah kaedah pembersihan gutter yang digunakan sekarang?
- 4) Apakah peralatan yang digunakan untuk membersihkan gutter?
- 5) Adakah pemaju mengupah pekerja untuk membersihkan gutter?
- 6) Adakah pemilik rumah boleh membersihkan sendiri gutter tersebut?
- 7) Apakah cara pemilik rumah untuk memastikan gutter sentiasa bersih?
- 8) Apakah ciri-ciri keselamatan yang diambil oleh pekerja semasa proses pembersihan gutter dijalankan?
- 9) Bagaimana cara penyelenggaraan gutter dilakukan?
- 10) Bagaimana pemilik SPAHS membuat aduan kerosakan kepada pemaju?
- 11) Apakah jenis bahan gutter yang digunakan oleh pemaju?

3.6 SUMMARY

Each study conducted has its own research methodology according to the type of study conducted. In addition, the research methodology used is in line with the objective of our project title. It is a very important thing in doing research to get authentic and quality information. With a research methodology, the research we will do will be more organized and will get better research results. Research methodology can also be considered as preliminary planning towards the formation of a study that will lead either to success or otherwise.

The results that will be obtained also depend on the selection of research methodology. After researching all aspects related to the research topic, we can determine and choose the research methodology that suits the research topic that has been chosen. This study has fulfilled the objectives of the study and has answered all the questions of this study. In addition, this study aims to Identify the level of importance of maintenance of tank and Reviewed the method of maintenance of more efficient RWH. Community based harvesting structure construction and maintenance and improvement of existing RWH systems.

CHAPTER 4

(FINDING AND DISCUSSIONS)

4.1 INTRODUCTION

Rainwater harvesting is a sustainable practice that involves collecting and storing rainwater for various purposes, such as irrigation, household use, and groundwater recharge. The finding and discussion stages in the context of rainwater harvesting system research are essential for analyzing and interpreting data related to the effectiveness, benefits, limitations, and potential applications of such systems.

During the finding stage, researchers gather data through field studies, monitoring systems, or simulations to assess the performance and efficiency of rainwater harvesting systems. They collect information on rainfall patterns, water collection methods, storage capacities, water quality, and system maintenance. The collected data is then analyzed to identify key findings and trends related to the performance of the rainwater harvesting system.

The discussion stage involves a comprehensive analysis and interpretation of the findings. Researchers critically evaluate the effectiveness of the system in terms of water availability, quality, and cost-effectiveness. They compare their findings with existing studies and established guidelines or standards for rainwater harvesting systems. This comparison helps researchers assess the reliability and applicability of their results.

4.2 DESCRIPTIVE DATA

- Overview of the study area:

When conducting a study on rainwater harvesting systems in private residences, the focus shifts to the specific area where private households implement and utilize these systems. The study area overview provides important insights into the residential context, including factors such as location, building types, water usage patterns, and the potential benefits and challenges associated with implementing rainwater harvesting systems at the household level.



Research area ken rimba



Figure 10

- Permission from a private residence:

When conducting a study on rainwater harvesting systems in private residences, it is crucial to consider both the characteristics of the study area and the necessary permissions from the homeowners and residents management. This overview encompasses the geographical context, residential features, water usage patterns, and the process of obtaining consent to conduct the study in private residences.



Figure 11

Developer office schedule in Ken

Rimba, section 16, Selangor

- INTERVIEW SCRIPTS FOR DEVELOPERS AND USERS

BAHAGIAN A: MENGENALPASTI PENYELENGGARAAN SISTEM TALANG AIR/GUTTER DALAM SISTEM PENUAIAN AIR HUJAN (SPAHS)

A. Maklumat Diri Responden

a) Nama

b) ALAMAT : LEGIAN RESIDENCE

1) Adakah syarikat dibawah kendalian tuan/puan menggunakan SPAHS sistem?

Ya

Tidak

2) Apakah kaedah pembersihan gutter SPAHS yang digunakan oleh syarikat tuan/puan?

Membayar technician profesional

Membersihkan sendiri

Lain-lain_____

3) Apakah yang dilakukan oleh pihak tuan/ puan, jika gutter SPAHS bocor?

Menukar gutter baru

Membayar technician profesional

4) Berapakah kos yang dikeluarkan oleh pihak pemaju untuk penyelenggaraan gutter SPAHS?

RM100

RM200

RM300

Lain-lain_____

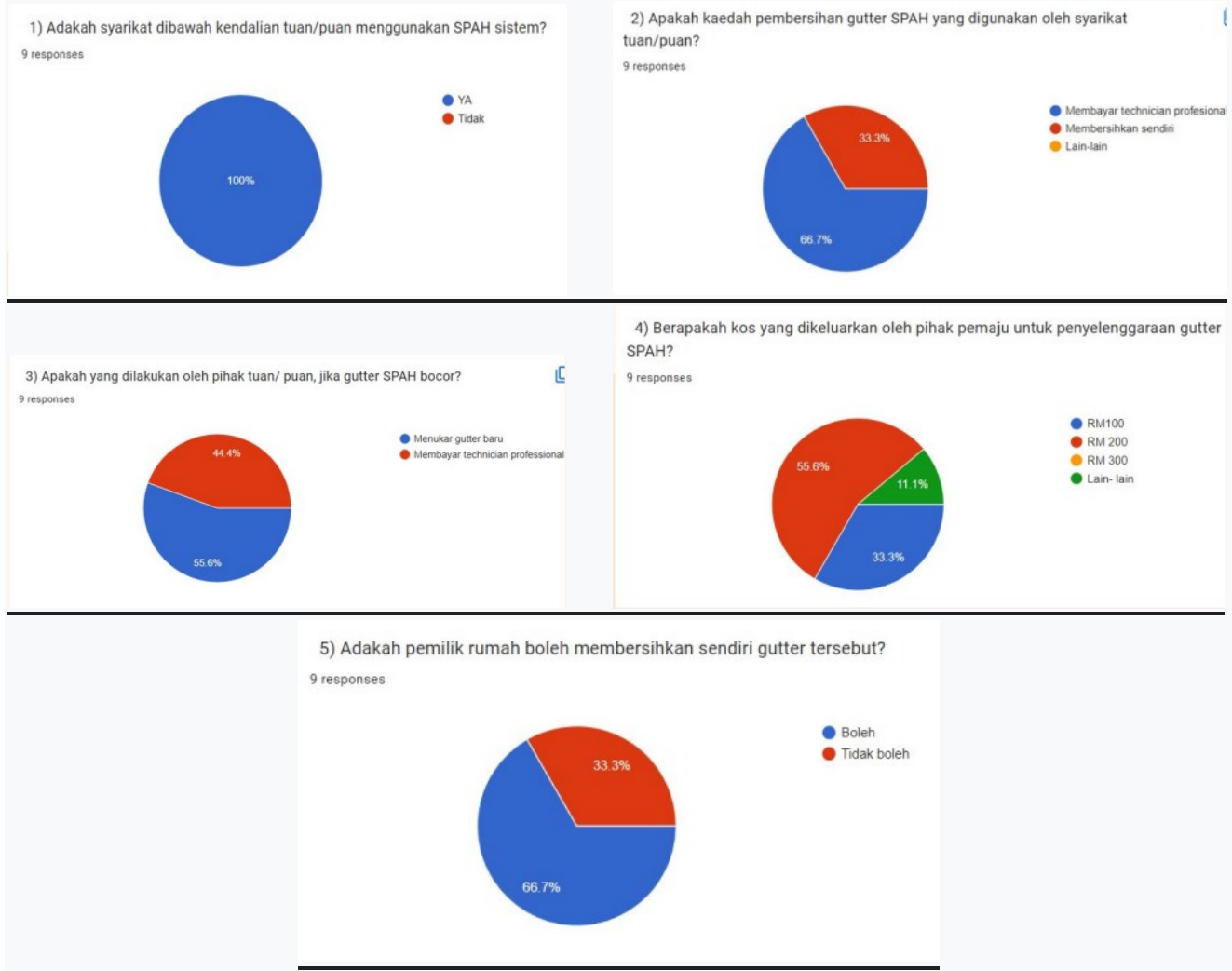
5) Adakah pemilik rumah boleh membersihkan sendiri gutter tersebut?

- o Boleh
- o Tidak boleh

BAHAGIAN B : MENGENAL PENYELENGGARAAN SISTEM TALANG AIR/
GUTTER DALAM SISTEM PENUAIAN AIR HUJAN (SPAHS)

- 1) Bagaimana gutter dibersihkan?
- 2) Apa akan terjadi bila gutter tidak dibersihkan dalam tempoh tertentu?
- 3) Apakah kaedah pembersihan gutter yang digunakan sekarang?
- 4) Apakah peralatan yang digunakan untuk membersihkan gutter?
- 5) Adakah pemaju mengupah pekerja untuk membersihkan gutter?
- 6) Adakah pemilik rumah boleh membersihkan sendiri gutter tersebut?
- 7) Apakah cara pemilik rumah untuk memastikan gutter sentiasa bersih?
- 8) Apakah ciri-ciri keselamatan yang diambil oleh pekerja semasa proses pembersihan gutter dijalankan?
- 9) Bagaimana cara penyelenggaraan gutter dilakukan?
- 10) Bagaimana pemilik SPAHS membuat aduan kerosakan kepada pemaju?
- 11) Apakah jenis bahan gutter yang digunakan oleh pemaju?

Survey results: section A



TITLE	STUDY OBJECTIVES
NUMBER OF QUESTIONS	9 RESPONDENTS
SUCCESSFUL RESEARCH COLLECTED	TARGET GROUP OF EXISTING USERS
TIME PERIOD	19 MARCH 2023 - 11 MAY 2023

Survey results: section B

TITLE	STUDY OBJECTIVES
NUMBER OF QUESTIONS	2 RESPONDENTS
SUCCESSFUL RESEARCH COLLECTED	TARGET GROUP OF EXISTING USERS
TIME PERIOD	19 MARCH 2023 - 11 MAY 2023

1 Developer information

- i) Name: EN. AKMAL
- ii) Address: ken rimba
- iii) Position: site supervisor

BAHAGIAN B : MENGENAL PENYELENGGARAAN SISTEM TALANG AIR/ GUTTER
DALAM SISTEM PENUAIAN AIR HUJAN (SPA)

1) Bagaimana gutter dibersihkan?

- Pembersihan gutter dengan hos.
- Pembersihan bumbung dan gutter dengan peniup daun.
- Membersihkan gutter dengan Power Washer.

2) Apa akan terjadi bila gutter tidak dibersihkan dalam tempoh tertentu?

- Kerosakan air: Apabila gutter tersumbat, air akan melimpah dan melimpah ke tepi gutter. Air ini boleh

meresap ke dalam asas atau dinding rumah anda, menyebabkan kerosakan air.

- Kerosakan pada gutter: Pengumpulan serpihan boleh menyebabkan longkang menjadi berat, menyebabkan longkang atau tertanggal daripada garis bumbung. Ini mungkin mahal untuk dibaiki atau diganti.

3) Apakah kaedah pembersihan gutter yang digunakan sekarang?

-Pembersihan tangan: Kaedah ini melibatkan membuang serpihan secara fizikal dari longkang menggunakan sarung tangan, sudu dan baldi. Ini adalah kaedah yang mudah dan berkesan tetapi boleh

memakan masa dan mungkin memerlukan menaiki tangga.

-Power washing: Air tekanan tinggi digunakan untuk membuang serpihan dan membersihkan gutter.

Kaedah ini cepat dan berkesan, tetapi ia juga boleh menjadi tidak kemas dan mungkin memerlukan peralatan khas.

4) Apakah peralatan yang digunakan untuk membersihkan gutter?

- Tangga, sarung tangan, senduk gutter, baldi dan garden hose.

5) Adakah pemaju mengupah pekerja untuk membersihkan gutter?

- kadang-kadang saya perlu membersihkan gutter.

6) Bagaimana cara penyelenggaraan gutter dilakukan?

-Pembersihan biasa: Adalah penting untuk membersihkan gutter sekurang-kurangnya dua kali setahun,

atau lebih kerap jika perlu, untuk mengeluarkan sebarang serpihan yang mungkin terkumpul. Ini akan

membantu mengelakkan tersumbat dan kerosakan air.

-Semak kerosakan: Periksa gutter dengan kerap untuk sebarang tanda kerosakan, seperti retak, lubang

atau karat. Baiki sebarang kerosakan secepat mungkin untuk mengelakkannya daripada menjadi lebih

teruk.

7) Apakah cara pemilik rumah untuk memastikan gutter sentiasa bersih?

-Ya, terdapat beberapa cara untuk pemilik rumah memastikan gutter mereka bersih dan mengelakkan

tersumbat.

i) Potong pokok berdekatan: Potong mana-mana pokok atau dahan berhampiran gutter untuk mengelakkan daun dan serpihan lain jatuh ke atas bumbung dan gutter.

ii) Siram air: Selepas membersihkan gutter, siram dengan air menggunakan hos untuk memastikan tiada

baki tersumbat. Ini juga akan membantu mengenal pasti sebarang kebocoran atau kerosakan pada gutter.

8) Apakah ciri-ciri keselamatan yang diambil oleh pekerja semasa proses pembersihan gutter\diadakan?

- Pembersihan gutter boleh menjadi tugas yang berbahaya, jadi penting bagi pekerja untuk mengambil

langkah berjaga-jaga keselamatan yang sesuai untuk mengelakkan kemalangan dan kecederaan.

Berikut

ialah beberapa ciri keselamatan yang mungkin diambil oleh pekerja semasa proses pembersihan gutter.

i) Gunakan tangga yang stabil

ii) Pakai alat pelindung

iii) Use proper tools

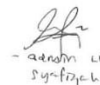
iv) safety helmet

Developer 2 information

i) Name: PN. SYAFIZAH

ii) Address: ken rimba

Position: developer


- arnab LF40 -
Syafizah 8/5/2023

**BAHAGIAN B : MENGAJAI PENYELENGGARAAN SISTEM TALANG AIR/ GUTTER
DALAM SISTEM PENUAIAN AIR HUJAN (SPA)**

- 1) Bagaimana gutter dibersihkan?
- 2) Apa akan terjadi bila gutter tidak dibersihkan dalam tempoh tertentu?
- 3) Apakah kaedah pembersihan gutter yang digunakan sekarang?
- 4) Apakah peralatan yang digunakan untuk membersihkan gutter?
- 5) Adakah pemaju mengupah pekerja untuk membersihkan gutter?
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- 9) Bagaimana cara penyelenggaraan gutter dilakukan?
- 10) Bagaimana pemilik SPAH membuat aduan kerosakan kepada pemaju?
- 11) Apakah jenis bahan gutter yang digunakan oleh pemaju?

1. The owner clean themselves as the gutter is not in common area as management just manage common area only.

2. ~~The water will stagnate.~~
2. water stagnant will happen due to clogged gutter. This will leads to

3. owner clean themselves

4. owner clean themselves

5. No, the service of cleaning fee fully covered by owner of the unit.

6. Yes. The owner only can clean the gutter.

7. Yes. To prevent from

8. Should wear glove & use any chemical to clean the gutter.
aware of the height of gutter.

9. Usually the owner should clean debris that has in gutter to avoid any clog or water stagnant. Also to avoid any weed growth.

10. self repair.

11. PVC




Figure 12

iii) EVIDENCE OF INTERVIEW

Interviewed the developer, but there is no and instead we interviewed the site supervisor to find out as well gain insight into maintenance storage tank and gutter system. This is because, to get more accurate and authentic evidence.

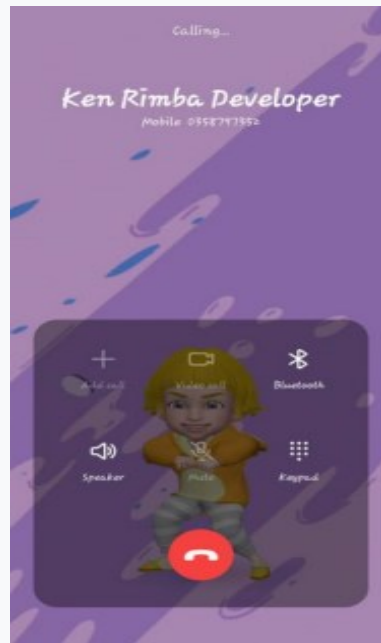


Figure 13

4.3 OBSERVATION RESULTS



Figure 14

The technician checks the condition of the storage tank(s), looking for cracks, leaks, or signs of deterioration. If any issues are identified, repairs or replacements may be necessary. The tank's overflow system is also examined to ensure it is functioning properly.



Figure 15

If the rainwater harvesting system includes a pump and control system, the technician tests their operation. They check the pump for proper functioning, inspect electrical connections, and ensure that the control settings are adjusted correctly. Any necessary repairs or adjustments are made.



Figure 16

The rainwater harvesting system has filters, the technician inspects and cleans or replaces them as needed. Filters help remove debris, sediment, and contaminants from the collected rainwater, ensuring its quality. The technician follows the manufacturer's recommendations for cleaning or replacing the filters.



Figure 17

Show the technician install the first flush diverter to divert early rainwater flow, which may contain material dirty, away from the tank. Next, install a waterproof mesh screen mosquitoes above the inlet for avoid insects, leaves, and debris from entering the tank.



Figure 18

The technician cleans out the gutters and downspouts, removing any debris or accumulated leaves that may obstruct the flow of rainwater. They may use a brush or a high-pressure water jet to thoroughly clean the system components.



Figure 19

Throughout the maintenance process, the technician documents their findings, noting any repairs made, replacements required, or recommendations for future system improvements. This documentation serves as a reference for the homeowner or property manager and helps ensure ongoing maintenance and system performance.

4.4 CONCLUSION

In conclusion, when conducting a study on rainwater harvesting systems in private residence KEN RIMBA, it is essential to provide an overview of the study area and obtain permission from the homeowners or residents. The study area overview should include the geographical context, residential features, water usage patterns, and relevant factors that influence the implementation of rainwater harvesting systems. Understanding the location, residential types, and water consumption patterns helps assess the feasibility and benefits of rainwater harvesting systems in meeting household water needs.

Obtaining permission from private residences is a crucial step in conducting research ethically. Researchers should clearly communicate the study objectives, data collection methods, and any potential benefits or risks associated with participation. Respecting privacy, protecting personal information, and ensuring confidentiality of the collected data are paramount. Collaboration and engagement with homeowners or residents foster trust and enable a cooperative relationship, which enhances the research process and promotes accurate data collection.

CHAPTER 5

(RECOMMENDATIONS AND CONCLUSION)

5.1 Identification

This study aims to investigate the significance of effective storage tank management in rainwater harvesting systems for existing users. Rainwater harvesting is a sustainable water management practice that involves collecting and storing rainwater for various uses, such as irrigation, domestic water supply, and groundwater recharge. However, the efficient management of storage tanks plays a crucial role in maximizing the benefits of rainwater harvesting systems. This study examines the impact of storage tank management on the performance and effectiveness of rainwater harvesting systems, focusing on existing users. The research evaluates key factors such as maintenance, water quality, capacity utilization, and user behavior to identify the importance of proper storage tank management in achieving optimal results.

5.2 Discussion

The study on the importance of rainwater harvesting system storage tank management on existing users highlights the crucial role that effective management plays in maximizing the benefits of rainwater harvesting systems. By examining factors such as maintenance, water quality, capacity utilization, and user behavior, the study provides valuable insights into optimizing storage tank management practices.

One of the key findings of the study is the significance of regular maintenance activities for storage tanks. Proper cleaning, inspection, and repair of storage tanks ensure their longevity and efficient functioning. Neglecting maintenance can lead to issues such as blockages, leaks, and contamination, which can negatively impact the overall performance of the rainwater harvesting system. Therefore, the study emphasizes the importance of implementing a proactive maintenance schedule to ensure the smooth operation of storage tanks.

5.3 RECOMMENDATIONS

Based on the study on the importance of rainwater harvesting system storage tank management on existing users, the following recommendations are provided to enhance storage tank management practices:

1. **Establish a Regular Maintenance Schedule:** Encourage existing users to develop a routine maintenance schedule for storage tanks. This should include activities such as cleaning, inspection, and repair. Regular maintenance helps prevent blockages, leaks, and contamination, ensuring the long-term functionality of the storage tanks.
2. **Promote Water Quality Testing:** Raise awareness among users about the importance of water quality testing. Encourage them to regularly test the harvested rainwater for contaminants and implement appropriate treatment measures when necessary. Provide educational resources on proper testing techniques and guidelines for maintaining good water quality.
3. **Provide User Education and Awareness:** Conduct awareness campaigns and educational programs to inform existing users about the significance of storage tank management. Offer guidelines and training materials that cover maintenance practices, water quality preservation, and responsible behavior. Empower users with the knowledge and skills to effectively manage their storage tanks.
4. **Implement Capacity Monitoring and Planning:** Encourage users to monitor their storage tank capacity and plan water usage accordingly. This helps optimize the utilization of collected rainwater and ensures that users have sufficient water available for their needs. Provide guidance on effective capacity management and planning strategies.
5. **Foster Community Engagement:** Facilitate community-based initiatives where existing users can share their experiences, challenges, and best practices related to storage tank management. Foster collaboration and knowledge exchange among users to promote effective management techniques. Support the formation of user groups or forums to encourage ongoing discussions and mutual support.
6. **Develop User-Friendly Maintenance Tools:** Create user-friendly tools, such as checklists or mobile applications, that guide users through maintenance activities and help track their progress. These tools can simplify the management process, ensuring that users can easily adhere to recommended maintenance practices.
7. **Monitor and Evaluate System Performance:** Continuously monitor the performance of rainwater harvesting systems, including storage tanks, to assess their effectiveness. Collect data on water availability, water quality, and user satisfaction to identify areas for improvement. Use this information to refine storage tank management strategies and adapt to changing user needs.
8. **Support Research and Innovation:** Encourage further research and innovation in the field of rainwater harvesting system storage tank management. Promote studies that investigate new technologies, materials, and approaches to enhance storage tank performance and longevity. Support initiatives that aim to develop cost-effective and sustainable solutions for storage tank management.

By implementing these recommendations, existing users can improve the management of their rainwater harvesting system storage tanks, leading to enhanced performance, increased water availability, and better utilization of rainwater resources.

5.4 conclusion

In conclusion, the study emphasizes the significance of proper storage tank management for users of rainwater harvesting systems. Active management practices improve storage capacity, water availability, reliability, and quality, ensuring a sustainable and dependable water supply. Additionally, such management practices contribute to the longevity of the system and have positive environmental impacts. These findings highlight the importance of educating existing users about the benefits of effective storage tank management and promoting responsible maintenance and care of rainwater harvesting systems.

5.5 SUMMARY

1. **Water Availability and Reliability:** Proper storage tank management ensures an adequate and reliable supply of rainwater for various purposes, such as irrigation, domestic use, or industrial processes. Neglecting tank maintenance and optimization can lead to reduced water availability and compromise the system's reliability.
2. **Water Quality:** Storage tank management significantly influences the quality of harvested rainwater. Regular cleaning, maintenance, and appropriate filtration techniques are essential to prevent contamination and ensure safe water for intended uses.
3. **System Efficiency:** Well-maintained storage tanks contribute to optimizing the overall efficiency of rainwater harvesting systems. This includes minimizing losses due to evaporation, leakage, and overflow, as well as maximizing the utilization of collected rainwater.
4. **Longevity and Durability:** Adequate tank management practices extend the lifespan of storage tanks, reducing the need for frequent replacements and associated costs. Proper maintenance helps prevent corrosion, degradation, and other damage to the tank structure.
5. **Environmental Impact:** Rainwater harvesting systems with well-managed storage tanks contribute to reducing reliance on other water sources, such as groundwater or municipal supply, resulting in lower water consumption and reduced strain on natural resources.

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