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COSTING OF RAINWATER HARVESTING SYSTEM FOR THREE TYPES OF HOUSES IN SEREMBAN

Aida Liyana binti Ismail [1]and Sayed Muhammad Aiman bin Sayed Abul Khair[2]
[1 2] Bachelor Science (Hn) in Architecture, Faculty of Architecture, Planning and Surveying , UiTM Campus Sri Iskandar, 32610, Perak
Email: Aidaliyanaismail@gmail.com [1] , *sayed705@perak.uitm.edu.my* [2]

Abstract:
Water is one of the most precious natural resources that provides moisture to the earth. However, there is still lack of clean water for many of the world's poor. This problem is bound to get worse. Water policies in develop countries listed that RWH as a source of domestic supply. The fourth element of recycling which is rainwater can be used for general cleaning such as flushing, gardening and also washing car thus it can save money on water bills. This research is a study on the cost of Rain Water Harvesting (RWH) system for three types of houses in Seremban using wall mounted technology. The study on the design of RWH applied was done by calculating its cost and measuring the efficiency between the standard RWH which is on ground and wall mounted system. By using literature review, case study and interviews, a conclusion could be made which is that the payback period will decrease when the roof area increases and thus the cost per 1000 liters will also decrease as the rainwater catchment depends on roof area and also the system used.

Keywords: Rainwater Harvesting System; conveyance systems; SPAH

1.0 INTRODUCTION

One of the most precious natural resources is water. It is one of the important elements in our daily life that we should not underestimate. Its role includes domestic uses, industry, landscape decoration, agriculture and many more. Water is the basic thing that we need to stay alive. Rain Water Harvesting (RWH) is defined as the water collected from a surface where rain falls and another system is used for subsequent storage for later. Rain water harvesting as an old tradition adopted in many parts of the world. As technology increases, this tradition is also growing popularity. During the 10th century Asia already had RWH. It is also popular in rural areas of Australia, India, Africa and United States.

More than decades, RWH has led to both the expansions in RWH research worldwide and the formation of national RWH. Water policies in developing countries listed that RWH as a source of domestic supply Moreover, groups and individuals have developed varieties of RWH systems for use (United Nations Environmental Programme, 1997). These technologies have been adapted in arid and semi-arid areas (United Nations Environmental Programme, 1997). Meanwhile, rural and urban areas, RWH can serve as a primary water source. There are some disadvantages of rainwater harvesting for example it is dependable on climatic patterns, storage capacity limitation and contamination from bad collection and storage method but these disadvantages can be avoided with good planning and management. The advantages, flexibility and the many benefits associated with rainwater harvesting cause it to be welcomed and accepted worldwide thus increasingly-promoting an alternative for the water demands of today.

The aim of this study is to identify why Malaysians do not use rainwater and increase their awareness to do so because Malaysia's climate is categorized as equatorial, are being hot and humid throughout the year with an average rainfall of 250 mm per month. This qualitative and quantitative study will explore further the water harvesting system based on Voda for a few types of housing (double storey terrace, cluster and single storey semi-d house) in Seremban area. The study also aims to calculate the cost using water harvesting system for few types of houses in Seremban with the formula for doing so obtained from literature review. In addition, the study hopes to cover aspects of design and how it could

help cut down bills. The efficiency between the standard water harvesting system and the wall-mounted system also investigates the awareness level of using rainwater harvesting among housing area (owners) by giving them a questionnaire.

2.0 LITERATURE REVIEW

RWH is defined here as the collection of water from surfaces on which rain falls, and subsequent storage of this water for later use. The commonly used systems are constructed of these three principle components, the catchment areas, the collection device and the conveyance system. The other will be the filtration, booster pump and many more. Collection surface is limited to the area of roof that is guttered. Supply of rain can be calculated using the equation of SUPPLY = RAINFALL X 'COEFFICIENT' X ROOF AREA. Rainfall = monthly mean/ average rainfall (mm). Runoff coefficient = recommended 0.8-0.85it may be as high as 0.9 or as low as 0.24, depending on the surface material and other factors which may reduce the efficiency (Nissen- Peterson, 1999). Roof area = calculate from roof area. Same unit as rainfall (mm^2)

2.1 Calculation

The literature review is about calculation because it is used to estimate the usage of water for each household.

2.1.1 Water Usage

Based on NAHRIM's findings, the house consist of 2 adults and 4 school going children. The house has 3 bathrooms. The amount of rainwater used for facilities were monitored manually using mechanical water meter install on each facility. Readings were taken and recorded manually. The water used figured obtained is compared with water use figures from literature and specifications of the respective products. Table 1 shows average water use for facilities using rainwater based on twelve months data. Since there was no treatment to the rainwater collected, therefore it is strictly used for toilet flushing and washing clothes.

Table 1 : Rainwater used for various facilities

	AVERAGE DAILY USE (LITRE)	**AVERAGE MONTHLY USE (LITRE)**	**PERCENTAGE (%)**
Washing cloth	300	9000	66
Toilet flushing	90	2700	20
General cleaning (including car and motorcycle washing)	65	1950	14
TOTAL	455	13650	100

From the above, household use for non- portable purpose using rainwater 34% of the total monthly household water use.

2.1.2 Cost

Various subsystem of the rainwater harvesting system includes the installation cost for rainwater harvesting system at a double storey terrace, as shown in Table 2 (year 2001). System included supply and installation and varied accordingly depending to the type of material used. Maintenance including cleaning of the rainwater collection system, electricity, bills and chemicals to prevent mosquito breeding in the storage tank is shown in Table 3. The maintenance cost is believed to be quite small and therefore not included in the subsequent calculations.

Table 2: The system cost

COMPONENTS	**NO.**	**AMOUNT (RM)**
Gutter (uPVC)	-	150.00
Conveyance Systems	-	200.00
Plumbing works	-	400.00
Water tank (top)	1	200.00
Water tank (ground) 2500 litres capacity	2	1000.00
Water pumped	-	750.00
TOTAL		RM 2 700.00

Table 3: Payback period

Old tariff	
System cost	RM 2700.00
Water saving per months	13650 litres x rm 1.05/m³ = RM 14.33
Payback period	RM 2700.00 / (RM 14.33 x 12) = 15.7 years
New tariff	
System cost	RM 2700.00
Water saving per months	13650 litres x rm 1.70/m³ = RM 23.21
Payback period	RM 2700.00 / (RM ~~15.20~~ 23.21 x 12) = 9.7 years

**an increase of 60% water rate (> 35 m³ / month)*

For the new tariff for payback period, the unit cost of water by rainwater harvesting system can be calculated using simple formula below:

$$\text{cost per 1 000 litres} = \frac{\text{cost of the system x 0.10}}{\text{Yield in litres per day x 0.365}}$$

Allowing about 10% of the capital harvesting system can be calculated using simple formula below:
For the double storey terrace

Average yield per day = 298 455 (average daily use)

$$\text{Cost per 1000 litres} = \frac{\text{RM 2700 x 0.10}}{\text{455 x 0.365}}$$

= RM 1.63 compared to water supply department (JBA) rate of RM 1.05* (old tariff) and RM 1.70 ** (new tariff)

** > 35 m³ and above per month*
*** > 40 m³ and above per month*

From the above it can be seen that the unit cost of water from the rainwater harvesting system at RM 2.48 1.63/ m³ is still more cheaply compared to with the piped water cost 1.70/ m³.

3.0 METHODOLOGY

Some articles will be reviewed as reference and also as guidance to complete the research.Any formulas or precedent studi can be achieved by literature reviews that will be used to calculate the water, identify the items or materials, types and also systems used. Case study will be held to get some information for comparison between the standard water harvesting system and new system which is wall mounted (Voda) through websites.From literature reviews, some case studies can be held. Other than that, informal conversation will be held and respondents (in housing area,owner of a house) will answer verbally and spontaneously. The public will tell their experiences or opinion based on water harvesting system. Some printed questions will be given to get some response on their awareness about water harvesting system (rain water collecting).

4.0 ANALYSIS AND FINDINGS

4.1 Comparison between standard system and Voda.

The amount of the system may vary from year to year, the price is dependable on economy and demands. The price is gained from some catalogue and plumbers that used the RWH system.

Table 4: Comparison between standard water harvesting system and wall mounted system

	Standard system	Voda
		
System	Required electric pump Use a lot of space Low aesthetic value (exposed tank , pump and etc) Add filter Capacity : 2500 – 5000 litres	Does not require any electric pump (functioning only by gravitational force) Less space used (wall mounted) Complement the aesthetic appeal (various design and sizes to fit) Built in filter Capacity : 100-3000 litres
Cost	RM 3000-7 000	RM 2000-5000

Based on the comparison, the Voda wall mounted system will be used, for the next calculation because they are of varied prices.

4.2 Data comparison for the system cost for each house by using wall mounted system.

To get the rain water supply is from the equation of SUPPLY = RAINFALL X 'COEFFICIENT' X ROOF AREA. Rainfall = monthly mean/ average rainfall (mm) which 250 mm per months. Runoff coefficient = recommended 0.8-0.85it may be as high as 0.9 or as low as 0.24, depending on the surface material and other factors which may reduce the efficiency (Gould and McPherson, 1987; Nissen-Peterson, 1999) and for 10 to 20 years of housing, recommended number is 0.8. Roof area = calculate from roof area which is gained from roof plan drawing of each house. Unit in mm². And then, the answer is applied to NAHRIM calculation method but for step water usage, changed to water supply. As there is no water meter in each appliance, so the water usage is replaced with water supply, as the result of the calculation, how many a house can save their money and the payback period.

Table 5: Comparison between standard water harvesting system and wall mounted system

Components	Sampling 1 (cluster house)	Sampling 2 (semi–d house)	Sampling 3 (terrace house)
Roof area (m²)	93.50	182.53	86.70
Average daily collect (litres)	662	1293	614
Average monthly collect (litres	19870	38790	184.2
Monthly water used (from public water supply) (litres)	11.5	12.5	91.5
Payback period (years)	8.9	4.6	9.6
Cost per 1000 litres (RM/m³)	1.24	0.64	1.34

4.3 Feedback from questionnaire

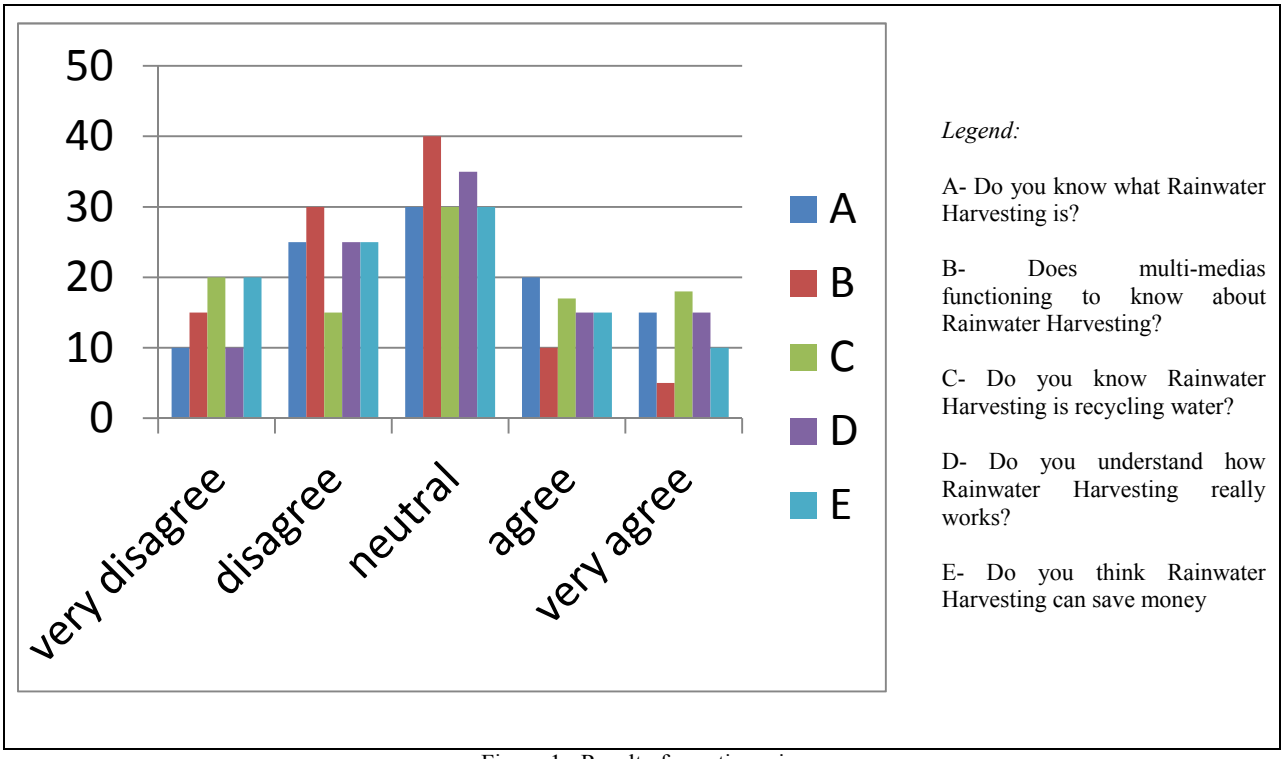

Figure 1 : Result of questionnaire

Most of people that interviewed and given questionnaire answer 3 as in the question is given 1 to 5 options (questionnaire in appendices) for them to analyzed and identify their knowledge about rain water harvesting. As the conclusion, number 3 represent neutral, which means; they don't really care and take note about rainwater harvesting. This is because they are lack of advertisement and exposure about rainwater harvesting and also they always think rainwater harvesting is costly and harm. They don't really study the payback period which actually really pay off their money back then.

5.0 CONCLUSION

Based on the findings, VODA system with wall mounted design is more efficient because no water pump is needed. It is worked by gravitational force. This is because the pump is not environmental friendly and

the main reason the price jack up for installation rain water harvesting system. For standard system, the tank is on ground, so its bulkiness requires large spaces. However, conventional tank has its own advantage which is it stores substantial amount of water and is suitable for very large development. Roof area can calculate rainwater supply and has an impact on the system payback period. This is because in the calculation, all of this is related, so when the roof area increases, the cost per 1000 liters will decrease. Based on questionnaires we can conclude that most people lack information about rainwater harvesting system. This is because the percentage at neutral is the highest and also people that agree with rainwater harvesting system is the lowest count. Last but not least, rainwater harvesting system is a sustainable way to recycle water. It is for long term use because based on findings, it takes years to recover the system installation cost included the materials and components.

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