

## Implementation of Rainwater Harvesting System in Development Project Among Local Authorities in Malaysia

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**Abstract:** Rainwater harvesting system (RHS) is an emerging technology in the world. Several studies have shown that rainwater harvesting system indicates many benefits to environment societies, government and others. However, RHS is an adoption at an early stage. The purpose of this study was to determine the characteristics of RHS implementation among local authorities in Malaysia and summarize the standard and guidelines for RHS in any development project in Malaysia. The study method by used are by a research approach and systematic review. Both implementations method will be focussing in achieve the objective of this study. Therefore, the data collected will be referred the objectives of this study and result of the data analysis will be as an orientation for development RHS in Malaysia. 10 local authorities in Malaysia had been selected for this study purpose. It can conclude that each local authority had their own guidelines in implementation RHS in Malaysia. All those guidelines had been discovered that can give impact to the future trends of implementation of RHS in Malaysia. Especially, the uses of RHS in residential development as a must for future in reducing the uses of treated water supply. Hence, the findings provide additional knowledge on the implementing RHS in Malaysia.

**Keywords:** Rainwater Harvesting System, Local Authorities,

### 1. Introduction

Water is a source of living things. Water can be categorized under physiological needs which are the most important basic needs of human in daily life Rainwater is form from hydrologic cycle. This cycle will never be ending cycle which is the cycle of rainwater from atmosphere and back to ground

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surface as runoff water. Malaysia one of country are located at line equatorial doldrum which is the characteristics of its climate are hot and humid along a year. In Malaysia, water demand will be expected to increase about 51% in 2020, due to growing population and industrialisation [2]. Based on the data from National Water Service Commission (SPAN), each person in Malaysia utilizes around 201 litres of water per day [3]. Therefore, to meet water demand in Malaysia, another alternative solution is by using rainwater to support the water supply in Malaysia. RHS can be used as portable and non-portable water requirement such as laundries, water drinking and irrigation of landscape.

The implementation RHS are towards to sustainable water use. Rainwater is as support source of clean water instead of by using only groundwater source. In Tokyo, rainwater harvesting system are implement for miscellaneous purpose such as toilet flushing and water cooling while educate their society in sustainable water used. This is because the uses of rainwater can be categorized as environmental education among their society [7]

## 2. Literature review

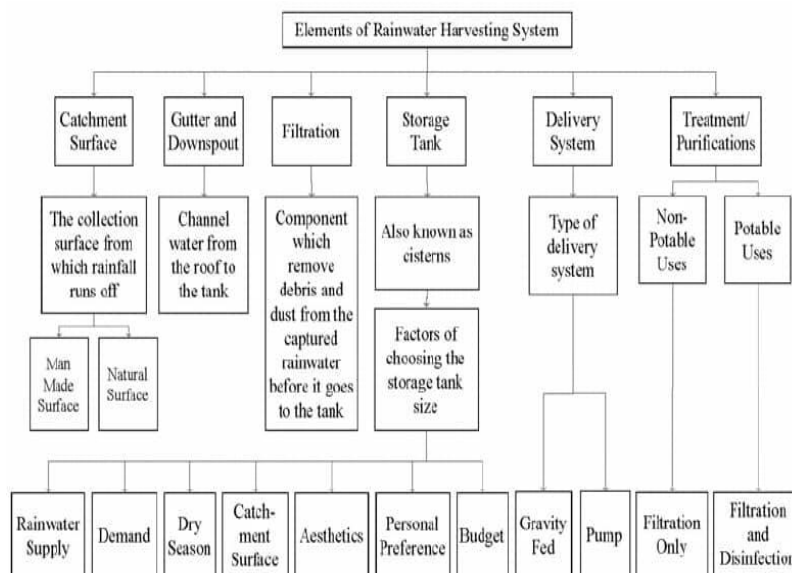
### 2.1 Definition

There is various definition rainwater harvesting system based on number of previous research studies. RHS will be involve in capturing rainwater before it becomes surface water and minimize pollution and capturing potential energy [1]. According to Swati Ogale, RHS is technology that collect and stores rainwater for human use [13].

RHS also can defined as composed of collecting surfaces, filters, a water tank and a network of pipelines for bringing rainwater for bringing rainwater from the collecting surfaces to the water tank and delivering it to the application points [17].

### 2.2 Component in Rainwater Harvesting System

RHS have 6 component which is catchment surface, gutter and downspout, filtration, storage tank, delivery system and treatment



**Figure 1: Elements of Rainwater Harvesting System**

### 2.3 Implementation of rainwater harvesting in Malaysia

In Malaysia, Ministry of Housing and Local Government (MHLG) was introduced the Guidelines for Installing A Rainwater Collection and Utilization System 1999. This was a first step

introduce of RHS in Malaysia [5]. The purpose of this guidelines is to decrease dependence on treated water and provide convenient during emergency on water shortage. It also focusses on the construction “mini dams” or rainwater tanks in urban areas because to reducing in builds bigger dams upstream [18]. The conclusion in RHS is not only conserve treated water but can prevent from flash flood.

However, the main objective of this guideline is as manual and reference for user to implement RHS in building such as houses, office, and other buildings.[14]. Next, several policies and guideline are formulated by various agencies. The main reason of the policies and guideline are to improved implementation RHS in Malaysia [18]. Table 1 shows policies and guideline rainwater harvesting system under Malaysian government.

**Table 1: Policies and Guideline Rainwater Harvesting System Malaysia**

<b>Guidelines</b>	<b>Department/Agencies</b>	<b>Year</b>
Guidelines for installing a Rainwater Collection and Utilization System	Ministry of Housing and Local Government Department	1999
RWHS: Guidebook on Planning and Design	Department of Irrigation and Drainage Malaysia (DID Malaysia)	2009
Guideline on Eco-Efficiency in Water Infrastructure for public Buildings in Malaysia	National Hydraulic Research Institute of Malaysia	2011
Urban Stormwater Management Manual for Malaysia, MSMA 2nd Edition	Department of Irrigation and Drainage Malaysia (DID Malaysia)	2012
Panduan Pelaksanaan Inisiatif Pembangunan Kejiranan Hijau— Sistem Pengumpulan dan Penggunaan Semula Air Hujan	Malaysia Federal Town and Country Planning Department	2012
Garis Panduan Perancangan Kejiranan Hijau	Department Federal Town and Country Planning Department	2012
Garis Panduan Sistem Pengumpulan dan Penggunaan Air Hujan	Federal Town and Country Planning Department, Ministry of Urban Wellbeing, Housing and Local Government	2013
Urban Stormwater Management— Part 6: RWHS, MS2526-6:2014	Department of Standards Malaysia	2014

### 3. Benefit Rainwater Harvesting System

In general, implementation of rainwater harvesting system give benefit in term of environment and social.

In term of environment, rainwater harvesting system are as an alternative water supply in futures. Rainwater can support existing water supply for potable used and non-potable used [9]. Furthermore, rainwater harvesting system are collection of rainwater. Despite of that, rainwater harvesting system are one of method to reduce flood volume in certain residential urban area [6].

RHS can be reclaimed for sustainable water used because of not only depend on fresh water [7]. In Malaysia, RHS as one of element in Green Building Index (GBI) under category of water efficiency in order to promote sustainable built environment. It carries 10% of total score for non-residential building and 12% for residential building [8]

In term of social, RHS can reduce burden societies in paying bill of water. The uses of RHS as non-potable system such as washing laundries, toilet flushing can cause reducing in using pipes water supply [9].

In conclusion, with implementation of RHS, it can improve as an alternative water supply and can be reclaim for sustainable used. Last but not least, RHS can reduce cost in bill of water.

#### **4. Challenges of Implementation of Rainwater Harvesting Systems**

In order to implement RHS. There is a lot challenges that need to be recognized and overcome in implement RHS. Cooperation between societies and government are needed in order to implement RHS because without cooperation from both parties the objective is to use RHS as an alternative water supply in the future cannot be obtain [5]

There are challenges that are caused by cost. Cost is major problem when implement RHS because the cost is higher than others water supply. Initial and maintenance cost is are still arguable with still think of how this system can be afford for all societies especially people with low-income category. This limitation can cause the low awareness of the community because of national income in among societies [10]. However, the cost estimation of implement rainwater harvesting system are around RM 1630.80 into RM 12231.00 depends on the material selection and system used [11]

In term of government, there is several guidelines and policy in implement rainwater harvesting since 1999 have been in issued by Ministry of Housing and Local Government. However, RHS does not yet gain popularity in public [11]. Limitation of implement RHS are only focus on largest building for example office, schools, or bungalows. Otherwise, there is lack of government support in implement RHS because in term of economic issue provision of subsidies and tax rebate to who are involved in implement RHS need to be discuss more in the future [21]

Besides that, there is lack of awareness of public in implementation of RHS. Government and private agencies should be cooperation together in order to give campaign through education about important and benefit of RHS [18]. Main reason of insufficient in implement RHS because of low water tariff [10]. At the moment, water tariff in Malaysia are between RM 0.80 to RM 3.00 [19]. From that, public feel more comfortable with current water supply and take no notice of existence of RHS

In a nutshell, the challenges that had been faced in implement RHS were lack of cooperation between societies and government because of societies cannot adapt the complexity of RHS and lack of government support.

#### **5. Methods**

Study design is an observation and description type where selection of techniques or methods are used to gain any related data and achieve the objective of this study. The technique selection which accurate and timely can lead the accomplishment of objectives of the research.

In this study, two types of methodologies were adopted, which are the research approach and systematic review. Both implementations will be focusing in achieve the objective of this study. Therefore, the data collected will be referred the objectives of this study and result of the data analysis will be as an orientation for development in RHS in Malaysia.

#### **6. Characteristics in development of implementation rainwater harvesting system**

##### **6.1 Residential**

The development of RHS in residential area by local authorities are increases since RHS was introduced among society in Malaysia. The implementation of RHS in development of residential sector are not only focusing in landed house but this system also can be implemented at multi-storey housing such as apartment. Among local authorities in Malaysia one example of this system had been implement

throughout in past decade is Majlis Perbandaran Sandakan (MPS) was enforced implementation of RHS since 2001

Generally, developer can provide rainwater tanks with their own design. Mostly developer provide *polyethylene* water tanks at residential area which is this system are very friendly user with equipped by gutter at roof area and rainwater will supply into water tank by rainwater down pipe. Other than polyethylene, developer can provide rainwater tanks with pump function

Moreover, type of rainwater tanks can be implemented in concrete type with the same capacity as polyethylene which is 1818 litre. This type is stronger and more stable compared to other type of rainwater tanks. In addition, the location of concrete type is permanent and cannot be move to other location. Usually, this rainwater is installed at in front of house

Furthermore, rainwater tanks also can be implemented underground of house area. Similar from polyethylene and concrete type the capacity of underground also 1818 litre. Underground rainwater needs water pump technique to supply water into user.

## 6.2 Public Buildings

Implementation RHS in development of public building are increases since RHS was introduced in 1999. Mostly implementation RHS of public buildings development such as city hall, are supported by government in terms of financial [4]

The development of RHS in public buildings are introduced by Dewan Bandaraya Kuching Utara (DBKU). DBKU takes another initiative to implement RHS at their own building in administration buildings. Four rainwater tanks had been implemented with size of capacity 909 litre and located at the end of building. This rainwater tanks are equipped with gutter and rainwater will supply by rainwater down pipe

The main purpose of implementation RHS in public building sector at Dewan Bandaraya Kuching Utara are cleaning works for example floor cleaning, watering plants and other. This system had been reducing the utilization of public water supply. Hence, this will reduce tariff water bill.

## 6.3 Agriculture

Characteristics of RHS in agriculture slightly different from residential or public buildings. Element of RHS in agriculture does not have treatment or purification stage This is because the use of rainwater harvesting is only for non-potable used which is for plants only. Generally, the rainwater will undergo filtration stage only.

According to Majlis Perbandaran Ampang Jaya (MPAJ), RHS in agriculture can be implement at or nearby store at garden area for plants uses only. MPAJ state that RHS in agriculture must have signage “Not for Drinking Purpose” at area of storage rainwater [12].

## 6.4 Landscape

RHS also can be used in landscape area. In landscape area the system used different compared to residential and agriculture. Local authorities made another alternative solution instead of using treated water supply for landscape use. Therefore, a few locations were made as a pilot testing for RHS in landscape development.

Generally, it used in-situ topographic technique which is rainwater from upstream into downstream by gravity force. Rainwater will be flow into water reservoir (wet pond, dry pond) by swale. Usually, this water reservoir can be transforming into recreation park or fishing activities. In green technology era, rainwater from water reservoir can be as watering plant around the landscape area

Other than that, RHS for landscape can be used without filter or treatment technique. According to Federal Department of Town and Country Planning Peninsular (PLAN), RHS for landscape have three system for catchment of rainwater [16]. Firstly, rainwater from roof can be directly into landscape or plants area and the rest of rainwater will flow in French drain. Secondly, rainwater flow into water reservoir at landscape area and can be used when needed. Thirdly, rainwater flow into landscape area and stored in Bermed landscape

Furthermore, one example in development of RHS by landscape sector area is Majlis Bandaraya Johor Bahru. The developer of Bandar Setia Tropika, Johor Bahru had been implemented RHS for landscape purpose. This system is work by water reservoir which is the water is pump out and reused for watering plant at landscape area [15].

## 7. Guidelines in Implementation Rainwater Harvesting System by Local Authorities

Local authorities in Malaysia are under state government jurisdiction which is their responsibility is under “Jabatan Kerajaan Tempatan” (JKT) and Kementerian Perumahan dan Kerajaan Tempatan (KPKT) [14]. It is including in policy and legislation, give advices including technical advices and distribution of allocation from federal government.

RHS is one of initiatives of KPKT to implement this system due to water crisis in [10]. From that, implementations of RHS are increasing until now. Furthermore, RHS is under of urban planning department in local authorities. Hence, every local authority in Malaysia has their guidelines in installing RHS. The summarization of guidelines in implementation RHS by local authorities are shown in Table 2.

**Table 2: Guidelines in implementation rainwater harvesting system by Local Authorities**

Guidelines in implementation rainwater harvesting system	Local Authorities
i. Location of rainwater tanks are shows in plan	Majlis Daerah Hulu Selangor (MDHS)
ii. Element RHS as example tanks, water pump and other are must shows in plan clearly	
iii. Bungalow residential must install rainwater harvesting system	
iv. Twin house (Semi-D) with area of roof is same and exceed 100m <sup>2</sup> can implement RHS.	
v. All category building can implement rainwater harvesting system with area of roof is same or exceed 100m <sup>2</sup> .	
vi. All building roof must be built so that water can be supply efficiently from gutter into rainwater tanks	
vii. Rainwater cannot be entering into public water supply tanks but public water supply tanks can enter rainwater tanks equipped with retention valve in one-way	

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backflow or end at least at 225 above overflow level in rainwater tanks.	
<ul style="list-style-type: none"> <li>i. Scale of details RHS plan with minimum 1:50 ratio.</li> <li>ii. All category of building type can implement rainwater harvesting system with area of roof same or exceed 100m<sup>2</sup>.</li> <li>iii. At the RHS area have precaution measures of breeding of aedes mosquito.</li> <li>iv. Area of roof must write in the plan</li> <li>v. Rainwater tanks are not mix with water supply.</li> <li>vi. Rainwater flow are marks with purple colour</li> <li>vii. Signage of not for drinking used if the RHS are for non-potable use.</li> <li>viii. Pipe of rainwater are marks with green colour.</li> </ul>	Majlis Perbandaran Klang (MPK)
<ul style="list-style-type: none"> <li>i. RHS can be install if the roof area of building same or more than 100m<sup>2</sup></li> </ul>	Majlis Bandaraya Ipoh (MBI)
<ul style="list-style-type: none"> <li>i. Location of rainwater tanks are shows in plan</li> <li>ii. Element RHS as example tanks, water pump and other are must shows in plan clearly</li> <li>iii. Bungalow residential must install rainwater harvesting system</li> <li>iv. Twin house (Semi-D) with area of roof is same and exceed 100m<sup>2</sup> can implement RHS.</li> <li>v. All category building can implement rainwater harvesting system with area of roof is same or exceed 100m<sup>2</sup>.</li> <li>vi. All building roof must be built so that water can be supply efficiently from gutter into rainwater tanks</li> <li>vii. Rainwater cannot be entering into public water supply tanks but public water supply tanks can enter rainwater tanks equipped with retention valve in one-way backflow or end at least at 225 above overflow level in rainwater tanks.</li> </ul>	Majlis Perbandaran Selayang (MPS)

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<ul style="list-style-type: none"> <li>i. Plan of rainwater harvesting system are shown clearly</li> <li>ii. Guidelines of rainwater harvesting system are followed by KPKT.</li> <li>iii. Element of RHS must be followed my Undang-undang Kecil Bangunan Seragam 1984 (UKBS 1984)</li> <li>iv. Rainwater harvesting must in maximum uses in all type of building.</li> </ul>	<p>Majlis Daerah Tangkak (MDTangkak)</p>
<ul style="list-style-type: none"> <li>i. Refer of Guideline for Installing A Rainwater Collection and Utilization System</li> </ul>	<p>Majlis Bandaraya Pasir Gudang (MBPG)</p>
<ul style="list-style-type: none"> <li>i. Rainwater harvesting system are provided and must show in plan of building.</li> </ul>	<p>Majlis Bandaraya Johor Bahru (MJB)</p>
<ul style="list-style-type: none"> <li>i. Bungalow residential system and Twin house (Semi-D) with area of roof is same and exceed 100m<sup>2</sup> can implement RHS.</li> <li>ii. All category building can implement rainwater harvesting system with area of roof is same or exceed 100m<sup>2</sup></li> <li>iii. The minimum size of water tanks is 1365 litre.</li> <li>iv. Location of rainwater tanks are provided in plan.</li> <li>v. Element RHS as example tanks, water pump and other are must shows in plan clearly</li> <li>vi. Rainwater cannot be entering into public water supply</li> <li>vii. Outlet pipe must have sign “Not for Drinking”</li> <li>viii. The water though must have suitable angle to avoids stagnant water.</li> <li>ix. Rainwater downpipe that continued with RHS must use green colour pipe.</li> </ul>	<p>Majlis Bandaraya Seremban (MBS)</p>
<ul style="list-style-type: none"> <li>i. Bungalow residential system and Twin house (Semi-D) with area of roof is same and exceed 100m<sup>2</sup> can implement RHS.</li> <li>ii. All category building can implement rainwater harvesting system with area of roof is same or exceed 100m<sup>2</sup></li> </ul>	<p>Majlis Perbandaran Port Dickson (MPPD)</p>



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- iii. The minimum size of water tanks is 1365 litre.
  - iv. Location of rainwater tanks are provided in plan.
  - v. Element RHS as example tanks, water pump and other are must shows in plan clearly
  - vi. Rainwater cannot be entering into public water supply
  - vii. Outlet pipe must have sign “Not for Drinking”
  - viii. The water though must have suitable angle to avoids stagnant water.
  - ix. Rainwater downpipe that continued with RHS must use green colour pipe.
    - i. Building plan must comply with Guideline for Installing A Rainwater Collection and Utilization System
- Majlis Daerah Jelebu (MDJelebu)
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## 8. Conclusion

Each developments sector had their own characteristics in implementation RHS such as residential, public buildings, agriculture and landscape. The characteristic every development is different. This is because the purpose of implementation RHS in every development are based on their function.

The purpose of implementation RHS in development of residential and public buildings such as public city hall are for cleaning used such as cleaning floor, washing car and others. Then, agriculture and landscape have slightly different in characteristics in RHS which is element of this system in agriculture does not have treatment or purification stage while landscape sector by using situ topographic technique.

Guidelines in RHS system by Local Authorities were summarized by the writer. From the table it can conclude that each local authority had their own guidelines in implementation RHS in Malaysia. Now, every new project of residential, commercial building, agriculture and landscape development still as an optional for implementation RHS but the uses of this system are increase by time.

In a conclusion, this study about the implementation of RHS will provide the characteristics and guideline in implementation of RHS in any development project in Malaysia for future. Then, this study also will provide some contribution in addition of the knowledge of this subject to the human beings in worldwide. In a nutshell, all the parties such as governments, providers, and consumers should give an effort in order to improve and make RHS are fully implemented in Malaysia.

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