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PEOPLES' PERCEPTION OF RAINWATER HARVESTING TO MEET NON-POTABLE WATER DEMAND AT KUET, KHULNA

Mashiat Noor -E- Zakir*[1] and Khondaker Mohammed Mohiuddin Ekram[2]

[1]Graduate Student, Department of Urban and Regional Planning, Khulna University of Engineering & Technology, Khulna, Bangladesh, E-mail: mashiatkuet@gmail.com
[2]Lecturer, Department of Urban and Regional Planning, Khulna University of Engineering & Technology, Khulna, Bangladesh, E-mail: mohiuddinekram@urp.kuet.ac.bd

***Corresponding Author**

ABSTRACT

Water scarcity is becoming one of the biggest challenges of the future. Bangladesh is also facing acute water shortage even though frequency of rainfall event is quite high here. Coastal regions of Bangladesh such as Khulna faces lack of fresh water due to presence of salinity. KUET is a residential accommodation providing university without any municipal water supply connection. Therefore, the university authority extracts and treats groundwater before supplying it to its beneficiaries. Rain water harvesting is an alternative way of water sources in order to meet non-potable water demand. Also, it acts as a backup for the emergency purpose. The rain water which is being wasted in every rainfall event can be collected and reused for many purposes. By practicing rainwater harvesting, the need for water for the everyday purpose could be fulfilled at a certain rate.In this study, the perception of the people about rainwater harvesting was assessed at KUET campus. Mainly data were collected against various parameters including practice of rainwater harvesting at home, acceptance of rainwater harvesting to meet non-potable water demand, water savings and safety of rainwater, particular use of harvested rainwater at home, rainwater as an auxiliary water source at KUET, expected contribution to install rainwater harvesting at KUET etc. Sample size of the study area was determined as 198 (including students, faculties and staffs). After analyzing collected data, it was found that, a large portion of respondents practice rainwater harvesting at house and they also think harvested rainwater can be used as non-potable consumption without any treatment. It was also found that people were more likely to use rainwater for washing purposes. Besides, respondents were found to have interest in contribution of certain amount of money to install rainwater harvesting system at university campus.

Keywords: *KUET, Non-potable, Perception, Rainwater harvesting, Water demand.*

1. INTRODUCTION

The demand of water is increasing day by day with increase of rapid urbanization. Though Bangladesh is blessed with plenty amount of rainfall with an average of at least 2425 mm in most parts of the country per year (Quadir & Saha, 2016), it is also facing water shortage problem.In Bangladesh, both in rural and urban area people often do not get the available amount of water. In the urban area, especially female from lower income group have to collect water from a particular water source as they do not get all time water connection from municipal water supply authority. Municipal authorities are trying to fulfil water demand of people as per their requirement but as water is a limited resource there is a gap between water demand and supply. In rural areas particularly in the coastal region such as Khulna, amount of salinity in water is increasing (Ahmed, Kadir, & Ahmed, 2014). Moreover, supply water of Khulna WASA is not enough to fulfill daily water demand. In Khulna only 20 percent of urban area has been covered by public water supply system (Islam, Arif, & Noman, 2015). Khulna city dwellers are facing the need of fresh water. Some of the city dwellers have already arranged to lift water by using bore wells, pumps etc. but the ground water level is depleting and so wells and pumps could not work well.

KUET is one of the public engineering university of Bangladesh which is situated in Khulna region. Being located in the coastal region, university also faces problems to manage safe and fresh water to meet non-potable water demand of the university beneficiaries. Moreover,the university doesnot have any municipal water supply connection.At present, the university have their own arrangement where water is being extracted from ponds and after that it goes to university's treatment plant before being supplied to its beneficiaries. This involves a huge amount of financial cost to university authority as well as the ground water level is also depleting day by day due to continuous water extraction. In this situation, rainwater harvesting is the most effective system along with existing water supply system to meet the non-potable water demand of the university effectually. Rain Water Harvesting(RWH) is an substitute and effective way to meet water demand especially for non-potable uses. The rain water which is being wasted can be collected and reused for many purposes. Also, Rain Water Harvesting System(RWHS) is economically cheaper in construction compared to other sources, i.e. well, canal, dam, diversion, etc. (Jyotiba & Regulwar, 2013). By using rainwater, water demand can be minimized to some certain level. In large institutions like university where water demand is at large scale, rainwater can act as a supporting source for supplying water in order to reduce ground water extraction as well as reduce pressure from municiapl water supply authorities. Peoples' perception is very important before installing any kind of new system in thier locality. In this paper, peoples' perception on rainwater harvesting at KUET campus was assessed through a questionnaire survey. The structure of questionnaire was designed into two parts- one for the students of KUET and another one for faculties, officers and staffs of KUET. The questionnaire was organized in such a way to bring out the insight of people on rainwater harvesting. This questionnaire survey mainly focused on practice of rainwater harvesting at home, acceptance of rainwater harvesting to meet non-potable water demand, water savings and safety of rainwater, particular use of harvested rainwater at home, rainwater as an auxiliary water source at KUET, expected contribution to install rainwater harvesting at KUET etc.

2. METHODOLOGY

2.1 Study Area

KUET is situated in the district of Khulna with area of around 101 acres. The campus is situated at Fulbarigate, the northwest part of Khulna. The campus is around 15 kilometer away from the zero point of Khulna City, which is very much associated with the significant downtown areas by open and wide streets. It is at around 12 km from the Inter-District Bus Terminal and roughly 14 km from the Khulna Railway Station. At present, in KUET, there are three faculty, three institutes and twenty departments. Every year number of department is increasing and so number of infrastructures and facilities is also increasing. Number of students is also increasing every year. Currently 5700 students are studying, 318 faculties and 557 officers and staffs are working in the university.

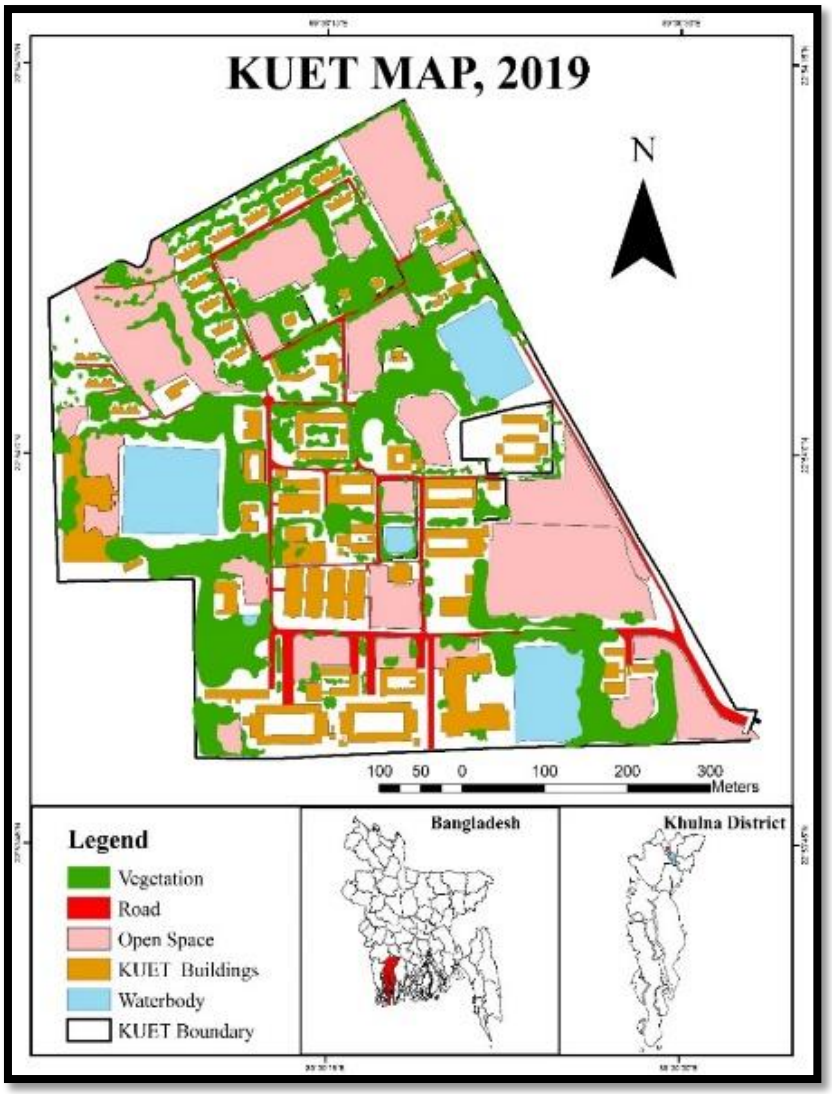

Figure 1:Map of KUET (Study Area)

Inside the university campus boundary, there are seven halls for students and eighteen quarters for faculties and officers and staffs. Moreover, there are three dean houses and a house for VC and a dormitory building for bachelor faculties of the university. The university also have some buildings such as- a central computer center, a medical center, student welfare center and cafeteria for the students.

2.2 Determination of Sample Size

It was quite difficult to study entire population of the study area. Hence, sample size was determined to know about the whole residents of KUET. In addition to the purpose of the study and population size, three criteria usually used to determine the appropriate sample size: the level of precision, the level of confidence or risk, and the degree of variability in the attributes being measured (Miaoulis & Michener, 1976). Yamane (1967) provides a simplified formula to calculate sample sizes (Israel, 1992). The formula given by Yamane is given below:

$$n = \frac{N}{1+N(e^2)} \quad (1)$$

Where n is the sample size, N is the population size, e is the level of precision in this formula. This formula was used in this study to calculate the sample size of the study area. In calculating sample size, population size is used as 6575 persons including all students, faculties and staffs of the university.

Precision level is assumed as ± 7% as the survey would be done only to know about the perception of people on rainwater harvesting. Confidence level is assumed as 95%. By using equation given by Yamane (1967), the sample size of the study area is given below:

$$n = \frac{N}{1+N(e^2)}$$
$$= \frac{6575}{1+6575 \times (.07)^2}$$
$$= 197.937834$$
$$\approx 198$$

2.3 Preparation of Questionnaire and Questionnaire Survey

A questionnaire survey was completed keeping focus on the point to know about the perception of people on rainwater harvesting. A draft questionnaire was prepared at first. The structure of questionnaire was designed into two parts- one for the students of KUET and another one for faculties and officers and staffs of KUET. The questionnaire was organized in such a way that it would bring out the insight of people on rainwater harvesting. After testing the draft questionnaire from field, a questionnaire was finalized for this study and questionnaire survey was completed inside the campus boundary.

3. ANALYSIS AND FINDINGS

3.1 Knowledge on Rainwater Harvesting among KUET Students

Water scarcity is very common in least developed countries and in developing nations. Rainwater harvesting is becoming a common practice for coping with water scarcity problem. Rainwater harvesting an alternative water supply option is a common practice in countries like Bangladesh where the annual precipitation is high (Sultana, 2007).

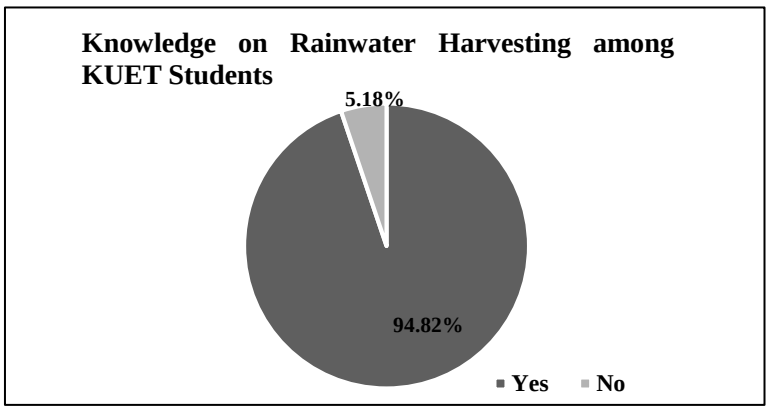

Figure 2: Knowledge on Rainwater Harvesting Among University Students

From analysis, it was found that students who are from small cities and rural areas knows more about rainwater harvesting. They usually harvest rainwater in the monsoon period and stores that harvested rainwater in gallons or jars to use it in cooking purposes later. From figure 2, it can be said that 94.82% of KUET students have knowledge of rainwater harvesting. They know how and why rainwater is collected. RAJUK has already made regulations which require buildings of Dhaka to harvest and reuse rainwater (Chowdhury, 2017).Therefore, students from Dhaka city also knows and some of them have the practice of rainwater harvesting in their buildings.

3.2 Practice of Rainwater Harvesting at Home

Rainwater harvesting has become a common practice nowadays. Rainwater harvesting system has already been introduced in many cities especially the coastal areas in Bangladesh (Bari & Hassan, 2016). This is an ancient practice for collecting and storing rainwater for further use in future. People usually use harvested rainwater for cooking purposes.

At KUET, 65.47% of students were found to have practice of rainwater harvesting at their home. At their home, their family members collect rainwater during monsoon period specially. All of them collects rainwater in small scale that means they collect rainwater for using it in daily life works.

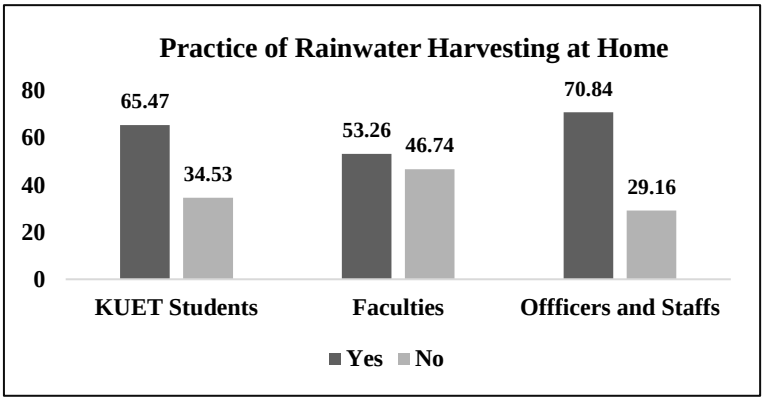

Figure 3:Practice of Rainwater Harvesting at Home

70.84% officers and staffs of KUET were found to have practice of rainwater harvesting.They also collect rainwater in small scale. They do not have any established structural system for collecting rainwater. They generally places their jars or water drums on the rooftop to collect rainwater directly and usually filter the rainwater before having it for potable consumption. They mostly stores rainwater to use collected water even in summer season. Faculties of KUET also captures rainwater in a small scale. 53.26% of them are found to have practice of rainwater harvesting at home. Like officers and staffs, they also do not have any established infrastructural system for collecting and storing rainwater. They normally collects rainwater in jars or water gallons and use it for potable purposes such as cooking.

3.3 Particular Use of Harvested Rainwater At Home

Rainwater harvesting is being practice from ancient times. In Bangladesh it is not a new concept. Different organizations such as WaterAid, RAiN forum is working on rainwater harvesting in Bangladesh and they have already established some projects regarding rainwater harvesting in some rural areas of Bangladesh.

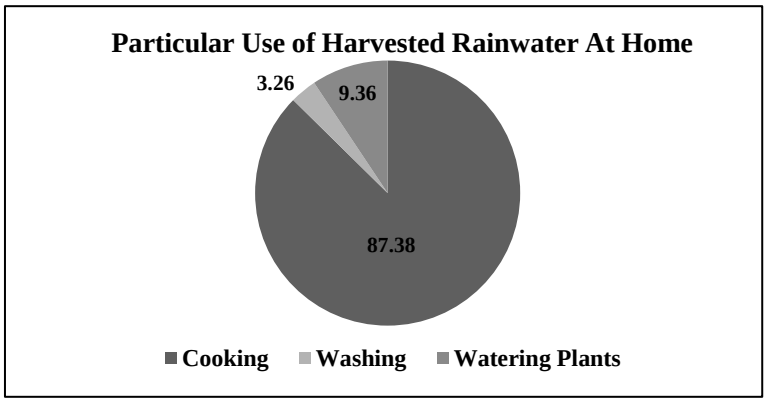

Figure 4: Particular Use of Harvested Rainwater At Home

At KUET, it was found that 87.38% of respondents generally use collected rainwater for cooking purpose. They thinks that rainwater is best for cooking rice or making tea after having some filtration. Washing utensils and watering plants are also done by them by using rainwater. Rainwater for watering plants is used by 9.36% of respondents and they expressed that rainwater works as natural manure to

plants and so they water their plants with collected rainwater. For washing purposes, at their house, 3.26% of them use collected rainwater.

3.4 Water Savings through Rainwater Harvesting

Rainwater harvesting ensures savings of water and also reduces pressure from water supply authority. At KUET, there is no direct connection of water supply from KWASA. In the whole campus, at present, water is being extracted from three ponds and twelve shallow tube wells are also being used for extracting water from ground level. Extracted water then goes to treatment plant before getting supplied to both residential and non-residential beneficiaries. This creates massive pressure on WTP as it is only supply source of water in the whole campus. Using rainwater minimize this pressure from WTP.

From figure 4, it can be said that, amongst the respondents, 84.36% of students, 82.11% of faculties and 75.37% of officers and staffs think rainwater harvesting would ensure savings of water. They consider that as WTP is the only source of water at KUET, rainwater harvesting would be the most effective supporting source of water with the existing system. They also thinks that as WTP is treating water before supplying it so it would reduce in a significant manner by single harvested rainwater.

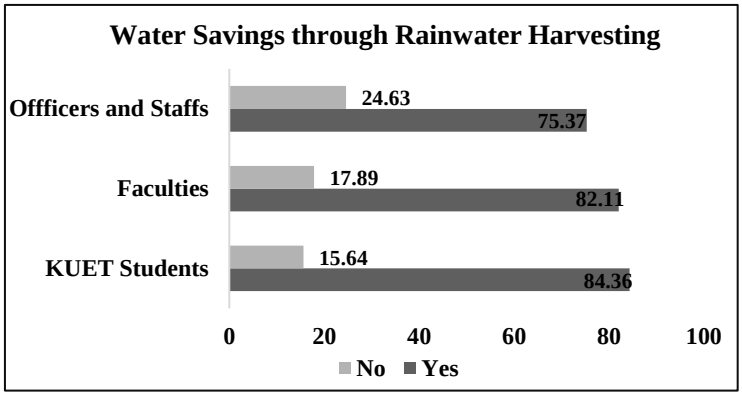

Figure 5: Water Savings through Rainwater Harvesting

Moreover, the rainwater which is getting wasted usually can thus be used for meeting the demand of beneficiaries.

3.5 Effectiveness of Rainwater as an Alternative Non-Potable Water Source at KUET

The benefits of rainwater harvesting are enormous (Krishna, 2005). Rainwater ensures free water only with storage and treatment cost and it supplement limited quantities of groundwater and reduce storm water runoff (Aladenola & Adeboye, 2010). Rainwater harvesting is thus effective to cope with both residential and non-residential demands. There are several reasons behind why faculties, students and officer and staffs thinks that rainwater harvesting system would be an effective and sustainable non-potable water source system at KUET. At present, water treatment plant (WTP) is the only source of water supplier at KUET for non-potable purposes. Halls and quarters demands a large quantity of water every day for non-potable purposes such as- bathing, washing clothes, washing utensils, cleaning , toilet flushing etc. Moreover, during working period, departments and schools of KUET also requires water.

From figure 6, it can be mentioned that, 65.16% faculties considers rainwater harvesting system as an effective system and they stated that it would be obviously a good initiative if the university authority adopt rainwater harvesting as soon as possible with existing water supply system.

Moreover, they consider that, as KUET is located in salinity prone region, it should adopt rainwater harvesting system for meeting non-potable requirements. Officers and

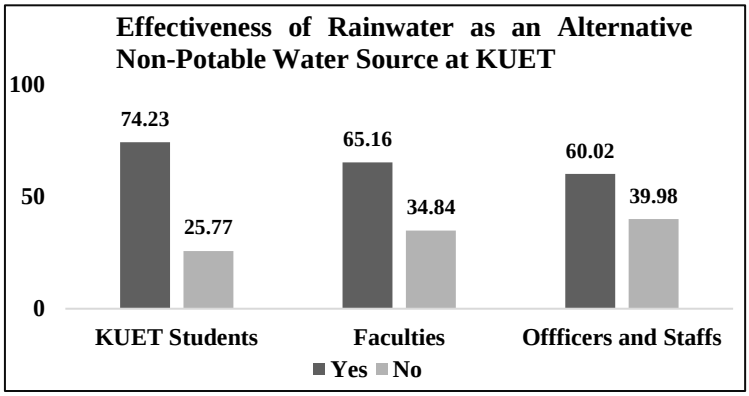

Figure 6: Effectiveness of Rainwater as an Alternative Non-Potable Water Source at KUET

staffs gave their complement in affirmative on rainwater harvesting and also said that accepting rainwater harvesting for fulfilling water demands at KUET would also inspire indigenous people to install rainwater harvesting structure in their existing and new dwelling units. Furthermore, students are also found to be positive on effectiveness of rainwater harvesting and willing to have this system in their university.

3.7 Safety of Rainwater for Non-Potable Water Consumption

Rainwater has the added advantage that it is free from arsenic (Ahmed, Anwar, & Hossain, September, 2013). Generally, serious chemical contamination of stored rainwater is rare (Pathak & Heijnen, 2006). Non-potable purposes such as bathing, washing clothes, washing utensils, cleaning, toilet flushing etc. requires a large amount of water every day.

From figure 7, it can be seen that, among the faculties, 49.32% of them considers harvested rainwater safe for non-potable consumption. Officers and staffs around 38.42% of them thinks rainwater safe for non-potable consumption.

They usually use rainwater for potable consumption with after having little filtration. Therefore, they considers that, harvested rainwater could be used for non-potable consumption without any treatment.12.26% of students also believe that harvested rainwater would be safe for any kind of non-potable consumption as rainwater have limited organic materials which are not harmful to human body.

Hence, harvested rainwater could be easily use for non-potable purposes.

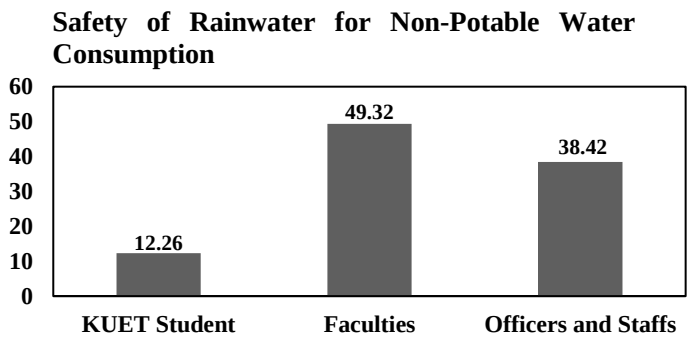

Figure 7: Safety of Rainwater for Non-Potable Water Consumption

3.8 Acceptance of Rain Water Harvesting (RWH) to Meet Non-Potable Water Demand

In Bangladesh where average rainfall varies from 1200 mm in the extreme west to over 5000mm in northeast (W.B, 2000), rainwater harvesting is considered to be the next option (Haq, 2005) to look into. Water scarcity is very common in Bangladesh. RWH offers an ideal solution in urban cities where inadequate ground water supply and surface water resources are either lacking or are insufficient (UN-HABITAT, 2012). Using harvested rainwater thus would not only be able to fulfil demand of water but also would minimize the amount of extraction of water from ground level as well as would also reduce treatment pressure from WTP at KUET. Faculties, officers and staffs and students expressed their positive acceptance of RWH to meet non-potable water demand.

From figure 8, it is seen that, faculties, officers and students showed their acceptance to use harvested rainwater at KUET for any kind of non-potable use. Their affirmative comments also specified that rainwater harvesting should be adopted in KUET so that local people get influence to install this system in their houses to cope with problem of excessive salinity in water.

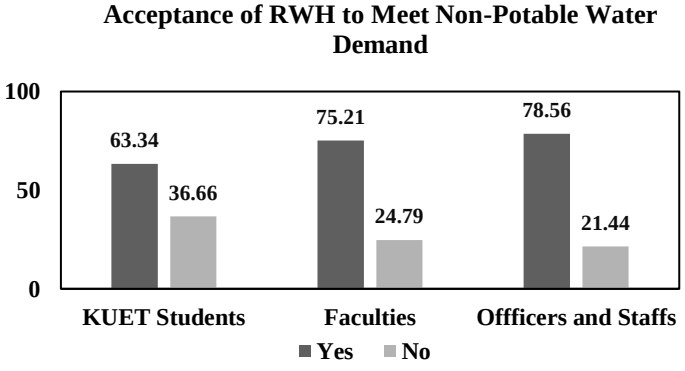

Figure 8: Acceptance of RWH to Meet Non-Potable Water Demand

3.9 Effectiveness of Harvested Rainwater to Meet Particular Non-Potable Water Demand at KUET

Non-potable water requirement generally consists of bathing, washing, cleaning and flushing toilets. As the water treatment plant is the only supplier source of water at KUET, so here rainwater harvesting would be an effective supporting source of along with the existing system. Harvested rainwater can be used for a specific non-potable water demand so that the demand can be fulfilled effectively with the amount of harvested rainwater.

From analysis it was found that, 65.84% of respondents considers that harvested rainwater would be most effective to use in washing purposes specially washing utensils and clothes. They also believes that rainwater would be more effective to clean utensils and clothes than current treated water by water treatment plant.

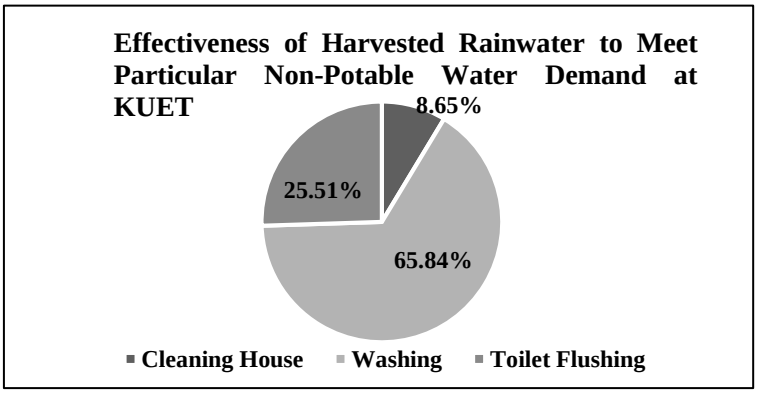

Figure 9: Effectiveness of Harvested Rainwater to Meet Particular Non-Potable Water Demand at KUET

25.51% people thinks that flushing toilets with harvested rainwater would also beneficiary especially to the authority as it would reduce the treatment cost of water treatment plant in a great scale. Few respondents expressed their complement for using harvested rainwater in house cleaning purposes. They also thinks that as rainwater is free from any harmful substances and so it would be safer from treated water.

3.10 Total Initial Investment Expected to be Available to Install Rainwater Harvesting System (RWHS) at KUET

Rainwater harvesting system consists of development of catching system, gutters, conduits, first flushing devices, reservoir, treatment components etc. Installation of RWHS in the KUET campus thus would involve a huge amount of installation cost.

If RWHS is installed at KUET, then benefit of this system would be enjoyed by students as well as faculties, officers and staffs who reside in quarters with their family members. From figure 10, it can be said that, 86.24% of respondents confirmed that they would like to contribute in between 2000~3000 taka at a time to install RWHS at KUET. 3.68% respondents said that they would like to contribute more than 3000 taka at a time as this system would bring numerous benefits

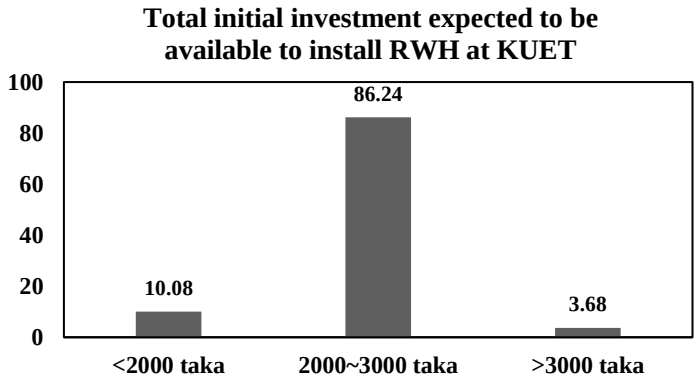

Figure 10: Total Initial Investment Expected to be Available to Install RWHS at KUET

university authority as well as to its beneficiaries. Among the respondents, 10.08% of them told that they would like to give less than 2000 taka at a time to install RWHS at KUET.

3.11 Expectation of Incentives by Government to Install Rainwater Harvesting System (RWHS) at KUET

KUET is a residential accommodation providing university. At present, here are seven halls for students and eighteen quarters for faculties and staffs of KUET. Moreover, there are also three dean houses and a VC house.

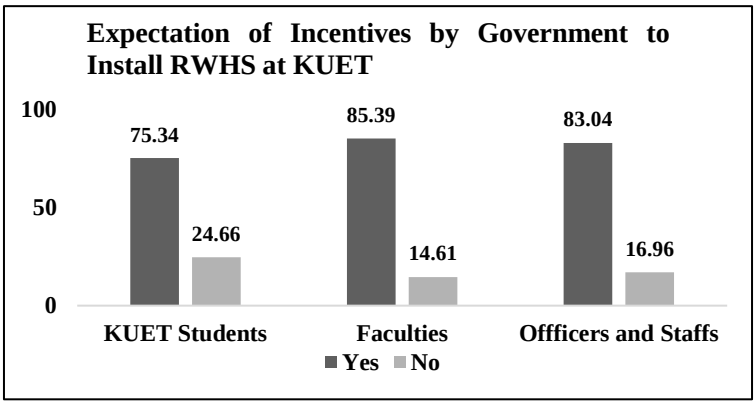

Figure 11: Expectations of Incentives by Government to Install RWHS at KUET

Installation of RWHS involves a huge amount of money. In Bangladesh, at present there are 37 public universities which also provides residential accommodation as well. From figure 11, it can be said, among the faculties 85.39% of them considers government should provide some incentive to install RRWH in residential providing universities. Officers also thinks that government should provide incentive and make it mandatory to install RWHS in every residential accommodation providing universities to cope with water scarcity problem. Students of KUET also thinks that the government should provide incentive to so that every large public educational institution of Bangladesh could maintain a sustainable water consumption practice.

4. CONCLUSIONS

Rainwater harvesting is the way to capture and store rainwater when it falls onto the surface of any structure to use it in future. At KUET, residential beneficiaries such as students resides in halls, faculties and staffs resides in quarters with their family members inside the campus boundary. This draws a large quantity of water to meet their demand each and every day. Currently, as the university does not have any municipal water connection, it have its own provision to extract and supply water in the whole campus area. In this case, rainwater harvesting is the most efficient way to fulfill the non-potable water demand of people. From analysis, it was found that, residential and non-residential beneficiaries of the university was found to be interested to have rainwater harvesting system in the campus. Respondents were also found to have practice of rainwtaer harvesting at their home. They stated that, using rainwater for non-potbale purposes at KUET would not only reduce the dependency from WTP but also ensure an environment friendly water supply source. Besides, respondents were also found to be interested to contribute in order to install RWHS at university. Hence, practicing rainwater harvesting along with the existing water supply system is a viable solution to meet non-potable water demand and to cope with water scarcity problem in any large educational institutions. Additionally, Bangladesh Government should take initiatives to practice rainwater harvesting system in every large educational institutions of the country with strong rules and regulations with logistical supports.

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