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USER'S PERCEPTION OF THE RAINWATER HARVESTING SYSTEM: A CASE STUDY AT AL-MUTTAQIN MOSQUE, KUALA LUMPUR

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ABSTRACT

Rainwater harvesting systems that serve as an alternative water supply have numerous societal and environmental benefits. However, Malaysian rainwater harvesting system implementation is focused on large commercial buildings and is still considered low in comparison to other developed or developing countries. This is due to a lack of community awareness. This paper investigates how users perceive rainwater harvesting systems. This study aims to assess the perception and effectiveness of the rainwater harvesting system from the user's perspective. This study also assesses the system's benefit to society and the environment. A case study was conducted at the Al-Muttaqin Mosque in Kuala Lumpur. An interview and questionnaire survey were conducted with the mosque community to assess the overall performance of the rainwater harvesting system. The results demonstrate how community satisfaction and perception of the system will be impacted by how well the rainwater harvesting system performs. As a result, more people will become aware of and interested in rainwater harvesting systems. According to this study, it is crucial to build rainwater harvesting systems to promote sustainability and prevent water shortages in the future.

Keywords: Rainwater Harvesting System, User Perception, Questionnaire Survey, Society and Environment

INTRODUCTION

A rainwater harvesting (RWH) system is a collection of rainwater that has been used as the primary source of water. Rainwater harvesting can be considered one of the best management practices (BMPs) to be adopted because of its benefit in reducing the negative impact on the environment. Rainwater harvesting was also identified as a green initiative to promote efficient water use. Aminuddin et al. (2018) stated that green technology can be defined as an application to mitigate the negative environmental effects caused by human activities. Water conservation is one aspect of the Green Technology Policy related to water and minimizing the impact on the environment caused by human activity (Aminuddin et al., 2018). Hence, reusing water and rainwater harvesting are among the solutions to conserve water usage that can help minimize natural resource devastation. In 2009, to expand the use of green technology, the Malaysian government launched the Green Building Index (GBI). GBI is recognized as a green rating index for eco-friendly buildings to promote sustainable development practices and awareness (Shaari, 2020). Domestic water conservation practices or water savings in buildings are given a rating of 12% in the index criteria. Thus, it provides potential room for designers and contractors to implement and improve the RWH system by examining the detailed building design and technical aspects of their projects.

Population growth and urbanization have led to an increased water demand, and water is a basic individual necessity (Aroua, 2022). Adequate water storage and management systems, such as rainwater harvesting systems, are needed to overcome water shortages (Derdour et al., 2022; Shah et al., 2022). With that, a rainwater harvesting system was introduced as an alternative water resource to help with the water shortage issue in the country. However, rainwater harvesting system practices and awareness in Malaysia are still considered low. In addition, the RWH system in Malaysia only focused on larger commercial buildings such as schools and shopping malls. This study aims to evaluate user perceptions of the RWH system and to analyze the effectiveness of the RWH system in terms of economics, society, and the environment.

Implementing a rainwater harvesting system was highly recommended because of its benefits. Rainwater harvesting has many advantages not only for the user but also for the environment and related stakeholders, such as local authorities and private agencies. For environmental benefits, the main advantages of rainwater harvesting are more water conservation and use as a water supply (Shaari et al., 2008). Rainwater harvesting can also help to control floods and soil erosion caused by runoff from impervious cover. In addition, using rainwater harvesting can help to reduce the utilization of portable water and minimize the reliance on water storage dams. According to Mohammed et al. (2003), rainwater harvesting can contribute to a good soil environment for root growth. The collected rainwater from rainwater harvesting can reduce the amount of salt concentration and can help in more remarkable root growth, which increases the drought tolerance of plants (Mohammed et al., 2003). Economically, rainwater harvesting can lessen the cost of providing water through centralized water systems or by good drilling (Lani, et al., 2018). It can help reduce the financial burden of operating a new water supply system such as reservoirs to meet the increasing demand. Therefore, in realizing the benefits of the RWH system, this study aims to assess the perception and effectiveness of the rainwater harvesting system from the user's perspective. This study also assesses the system's benefit to society and the environment.

RELATED STUDIES

A rainwater harvesting system, also known as rainwater collection, collects and stores rainwater for human usage. RWH systems range from simple rain barrels to more complex structures that include pumps, tanks, and purification systems (Ogale, 2019). It is a natural process of collecting, storing, and repurposing rainwater for domestic, industrial, agricultural, and environmental use (Che-Ani et al., 2014). Rainwater harvesting is an alternative solution used worldwide to save water resources and reduce the negative impact on the water supply caused by climate change (Mohammed et al., 2003).

Generally, rainwater can be used for potable uses, such as drinking, cooking, and bathing, and nonpotable uses, such as flush water for toilets (Ayob and Rahmat, 2017). For potable use, such as drinking and cooking, rainwater should be treated, and a filtration system is needed. For nonpotable usage, the first flush system is sufficient. In Malaysia, the implementation of rainwater harvesting is focused on buildings that have large catchment areas and consume a huge amount of water, such as government and commercial buildings (Lani et al., 2018). According to Aminuddin et al. (2018), 51% of the total number of RWH projects are for cleaning purposes such as toilet flushing and watering landscapes, and 11% are for educational buildings mostly located in Selangor. The study from the findings also shows that the RWH system that was implemented is more systematic at the government building than other building projects.

Malaysia is blessed with water resources and receives a massive amount of rainwater with an average annual rainfall of 2400 mm (Aminuddin et al., 2018). Malaysia's frequent rain event ranges from 132 to 181 days/per year (Che-Ani et al., 2014). However, uneven rainfall distribution has resulted in significant flooding in some areas. Floods are one of the most common natural disasters in Malaysia, occurring nearly every year during the monsoon season (Lee et al., 2016). States such as Kelantan, Terengganu, and Pahang are the most affected states. Lani et al. (2018) predicted that climate change would reduce rainfall in several Malaysian states in the future. Climate change can affect the availability, quantity, and quality of water resources, which may affect the entire water supply cycle that is drawn from surface water sources such as rivers (Ayob and Rahmat, 2017; Lani et al., 2018). Even though Malaysia has never experienced a serious water crisis in recent decades, water demand continues to rise as a result of population growth and industrial and agricultural expansion. According to observations at that time, Malaysia's water demand is predicted to rise from 10.4 billion m3/year in 1998 to 12.1 billion m3/year in 2010 and is expected to rise even further to 17.7 billion m^3/year in 2050 (Lee et al., 2016). In addition, water consumption in Malaysia is considered high, with 209 to 228 liters per capita per day (LCD) (Lani et al., 2018). Water consumption is believed to be greater than the WHO-recommended target of 165 liters per capita per day. Although the water tariff in Malaysia is low compared to other countries, water consumption needs to be controlled to avoid water shortages in the future.

In terms of maintenance, the rainwater harvesting system must be maintained regularly to ensure the quality of collected rainwater. The purpose of routine maintenance and inspection is to ensure that the RWH system works properly. Maintenance of the RWH system contributes to water quality protection in a variety of ways. This is because the systems are vulnerable to vandalism and environmental conditions such as dust, fallen leaves, and possibly trash. As a result, regular inspection and cleaning of system components such as the catchment area, gutters, filters, and tanks reduce the possibility of contamination (India Water Portal, 2009). Thus, the system elements must be maintained separately. In addition, as the water was also used for drinking, treating the stored water is also important. Hence, it is critical to ensure that the water is clean. The most common types of treatment are chlorination, boiling, filtration, and exposure to ultraviolet or natural sunlight (Urban, 2016).

Several studies have identified social acceptance of rainwater harvesting, such as community awareness. The Ministry of Housing and Local Government stated that instilling awareness among society can help support the Green Neighborhood Action Plan to conserve more water resources (Aminuddin et al., 2018). A research review by Shaari (2020) stated that 64% agree that rainwater harvesting is a way to achieve sustainable development, and 75% of housing developers in Malaysia are aware of the rainwater harvesting system. However, more than 80% of developers did not install rainwater harvesting in their residential projects. In addition, the NAHRIM Research Centre (2020) stated that government agencies and media should promote the importance of rainwater harvesting to encourage the public in rainwater harvesting practices. Campaigns or social media can help promote the benefits of the rainwater harvesting system and its utilization. Currently, rainwater harvesting is implemented in many urban and rural projects because of the sponsorships, grants, and community services received (Shaari, 2020).

In addition to the great advantages, the rainwater harvesting system has some unavoidable drawbacks, such as unpredictable rainfall. The success of the RWH system is greatly dependent on the quantity and temporal pattern of rainfall (Lani et al., 2018).

A lack of rainfall distribution, especially during the drought season, could also limit the rainwater supply. Rainwater harvesting is suitable for use in an area that receives a large amount of rainfall. Depending on rainwater alone for water needs is not advisable for an area with limited rainfall. Lani et al. (2008) also stated that the initial cost was an issue that is always debated for the implementation of the RWH system. Even though the water tariff in Malaysia is considered low, the cost to install rainwater is between USD 300 and

USD 2000, which is regarded as an expensive installation (Lee et al., 2016). In addition, regular maintenance of the RWH system was needed, as they may be exposed to algae growth, chemicals, or insects that can be harmful.

METHODS

The study was conducted at Al-Muttaqin Mosque, Wangsa Melawati, Kuala Lumpur, as shown in Figure 1. The water trough for the rainwater harvesting system was designed with a gradient to ensure that rainwater flowed smoothly through the delivery pipe to the tank. The water trough was installed on the roof, and a large tank of hot-dipped galvanized steel with a capacity of 100 m^3 was used to channel rainwater to thepump. They installed two water storage tanks, each with a capacity of approximately 100 m^3, for the storage tank. When faced with water supply problems, the storage in the two tanks can provide a sufficient supply for daily use (Pilus, 2018).

Figure 1: Rainwater Harvesting System at Al-Muttaqin Mosque

The data collection was done using a questionnaire survey and interview session with the Chairman of Al-Muttaqin mosque. The purpose of the interviews was to evaluate the rainwater harvesting system based on the mosque committee's feedback. A total of one hundred respondents were interviewed for this questionnaire survey. The data were analyzed using the Statistical Package for Social Sciences (SPSS) version 15, and all the data collected are shown in terms of statistical findings. A basic analysis of the cost–benefit of the RWH system has also been used to analyze the effectiveness of the system in terms of economic, social, and environmental aspects.

RESULTS AND DISCUSSION

The interview sessions were focused on cost reduction, maintenance, and system quality to meet the challenge of transforming the mosque into a green building or a green mosque as the purpose of RWH installation. This RWH system is used for irrigation, drinking water, and taking ablution. The primary goal of this system is to reduce water bills, and it has successfully reduced the basic water bill by 50%. Water from the storage tank can also be used for nonessential purposes such as washing and gardening. The tank has a capacity of 3000 liters. The roof of the mosques is used as a catchment area for rainwater, which is the most cost-effective method of collecting rainwater. The required maintenance work of the system is only done once a year to change, and the flushing system is only done once a month. Regular maintenance should be performed to ensure that the system can function for an extended period. The mosque's chairman also agreed that rainwater harvesting is a cost-effective alternative to water supply and is effective at reducing the use of metered water and energy. The interview shows the significant finding on the usefulness of the RWH system to the community. This system is very effective for societal use and benefits the community and the environment.

Questionnaire survey

A total of 73 male respondents and 27 female respondents were interviewed for this questionnaire survey. The respondents are the mosque's community and the committee that is most aware of the installed rainwater harvesting system at the mosque. Findings from the statistical analysis are presented in 3 sections of the questionnaire, which represent the maintenance issue, effectiveness of the system, and respondent's perception of RWH. Table 1 shows the respondents' views on the issue of maintaining the rainwater harvesting system. Forty-six percent of the respondents stated that cost is the main issue in maintaining the rainwater harvesting system. Next, 34% of respondents stated that the issue in maintaining the system is because of a lack of knowledge, and 20% stated that it is for other issues. Based on the responses, it can be concluded that most respondents experienced the issue of maintaining the rainwater harvesting system due to the RWH cost. This finding was also supported by Lani et al. (2018), who stated that the main issue in the implementation and maintenance of rainwater harvesting systems is cost. Moreover, the initial cost and maintenance of the RWH system are still debatable in terms of the affordability of the system for all societal levels, particularly those in rural and urban areas.

Table 1: The RWH system maintenance issue

		Frequency	Percent	Valid Percent	Cumulative percent
Valid	Other	20	20.0	20.0	20.0
	Cost	46	46.0	46.0	66.0
	Lack of knowledge	34	34.0	34.0	100.0
	Total	100	100.0	100.0	

Table 2 shows the frequency table of the respondent agreement level on the effectiveness of the RWH system. Seventy percent of the respondents strongly agree that the RWH system can help save water. Next, 19% of the respondents agree with the statement, and 11% of respondents are not sure about the statement that rainwater harvesting can help save water. This finding shows that the committee had experienced that the RWH system can help in water storage and reduce the usage of metered water. This could be related to the previous study conducted by Rahman (2014), which stated that rainwater harvesting is an effective option to provide adequate storage of water.

Table 2: Respondent Agreement Level on RWH Effectiveness

Statement	Not sure (%)	Agree (%)	Strongly Agree (%)	Total (%)
Effectiveness of RWH system				
I agree that RWH can help in saving water	11	19	70	100%
I agree that RWH can help in reduce water bill	12	23	65	100%
I agree RWH can reduce environmental damage	8	52	40	100%
I agree RWH is a way to achieve sustainable development	27	32	41	100%

Next, rainwater harvesting can help reduce water bills and reduce the energy required for water pumping and treatment. The following table shows that most of the respondents (65%) strongly agree that rainwater harvesting systems can help reduce water bills. Meanwhile, 23% of the respondents agree with the statement, and 12% of respondents are not sure about the statement. These benefits can be calculated to determine the advantages before and after using the system. It can be concluded that the respondents agree that their water bill will be reduced by the existence of this rainwater harvesting system. The results are also supported by Foong (2010), who stated that rainwater harvesting systems could effectively reduce water bills by 20-30% and in some cases by 60% based on a previous study.

Rainwater harvesting can minimize the problem of the water crisis and reduce the negative impact on the environment, such as air pollution, acid rain, global warming, hot spots, and flash floods. From the table, 52% of the respondents agree that the RWH system can reduce the negative impact on the environment. Forty percent of respondents strongly agreed with the statement, and 8% of respondents were not sure about the statement. This finding shows that the respondent who had experienced the RWH system agreed that the system may reduce the negative impact on the environment, such as flash floods. Aminuddin et al. (2018) also stated that the RWH system may help in controlling flooding and soil erosion and minimizing natural resources.

RWH systems are known to have many benefits and can also be categorized as a sustainable way to achieve sustainable development goals. Table 2 shows that most of the respondents (41%) strongly agree with the statement that the RWH system is a way to achieve sustainable development. Thirty-two percent of respondents agreed with the statement, and 21% of respondents were not sure about the statement. From the response, the respondent believes that the rainwater harvesting system is a good alternative to achieve sustainable development. This finding is similar to the past studies conducted by Shaari (2020), which show that 64% of respondents agree that rainwater harvesting is a way to achieve sustainable development.

Table 3 shows the rating of the respondent's perception of the implementation of the RWH system. Rainwater harvesting performance is rated as good by 50% of the respondents. The rainwater harvesting system is rated excellent by 45% of respondents, and the remaining 5% rate it as not sure. In total, more than 90% of respondents rate the RWH system as a good or excellent practice to be adopted in the community area. According to Shaari (2020), rainwater harvesting is implemented in many urban and rural projects because of the positive feedback received. Based on respondents' responses, it is possible to conclude that the RWH system is receiving positive feedback from the community.

Table 3*: Respondent rating of the RWH system*

		Frequency	**Percent**	**Valid Percent**	**Cumulative percent**
Valid	Not Sure	5	5.0	5.0	5.0
	Good	50	50.0	50.0	55.0
	Excellent	45	45.0	45.0	100.0
	Total	100	100.0	100.0	

Table 4 shows the percentage of respondents' satisfaction with the performance of the RWH system. According to the table, 82% of respondents are satisfied, while another 18% are not satisfied with the performance of the rainwater harvesting system. It is possible to conclude that most respondents were pleased with the performance of the rainwater harvesting system, which provides information about how respondents experienced the system. This finding is in concurrence with a study conducted by Nafisah et al. (2018) that stated that most of the rainwater harvesting system users are satisfied with the system's performance.

Next, the table shows the respondents' perceptions of the effectiveness of the rainwater harvesting system. Only 6% of respondents disagreed with the majority (94%) agreeing that the rainwater harvesting system is effective. A study by Che-Ani et al. (2014) found that rainwater harvesting is an effective alternative to a water supply. In summary, based on the respondents' personal experiences, the respondents believed that the RWH system was efficient and beneficial to the community. Table 4 also shows how likely the respondent is to recommend installing an RWH system in another building. There are 80% who would likely recommend and 20% who would not recommend the RWH system to other buildings due to personal experience with the system's performance. A previous study by Lani et al. (2018) stated that implementing rainwater harvesting was highly recommended because of its benefits. This demonstrates that respondents' perceptions of the RWH system are favorable.

Table 4: Respondent Perceptions of the RWH system

Statement	Yes (%)	No (%)	Total (%)
User Perception of RWH system			
Do you satisfy with the RWH performance	82	18	100%
Do you think that RWH system is effective	94	6	100%
Would you recommend the RWH system	80	22	100%

Correlation analysis

To measure the strength between variables, a correlation test was used to perform the analysis. This study uses the Pearson method to measure the significance of the variables. The variables of this study are RWH performance, RWH effectiveness, respondent satisfaction, respondent perception, and respondent background.

Table 5 shows the correlation results of the analysis. The correlation between variables is significant if the level of significance is not more than 0.05 and 0.01. The table below shows the strongest correlation between RWH effectiveness and respondent satisfaction with a positive correlation ($r = 0.663$) that is significant at a p value less than 0.001.

Next, the respondent perception, respondent background, and RWH performance also have a positive correlation at $r = 0.342$, $r = 0.568$, and $r = 0.216$ with RWH effectiveness. Two variables (respondent perception and respondent background) are significant at level 0.01, and RWH performance is significant at the level of 0.05.

In addition, three variables, RWH performance, respondent perception, and respondent background, have a positive correlation with respondent satisfaction ($r = 0.210$, $r = 0.201$, and $r = 0.478$) and are signed with p values of 0.036, 0.045, and 0.001, respectively. However, three variables (RWH performance, respondent perception, and respondent background) are not significant to each other with p values of 0.500, 0.582, and 0.708, respectively. Finally, it can be concluded that RWH performance, respondent background, respondent perception, and respondent satisfaction have a significant relationship with RWH effectiveness.

Table 5: Correlation Results

		Respondent Background	RWH Performance	RWH Effectiveness	Respondent Satisfaction	Respondent Perception
Respondent Background	Pearson Correlation	1	0.56	0.568**	0.478**	-0.38
	Sig (2-tailed)		0.582	<.001	<.001	0.708
	N	100	100	100	100	100
RWH Performance	Pearson Correlation	0.56	1	0.216*	0.210*	-0.068
	Sig (2-tailed)	0.582		0.031	0.036	0.500
	N	100	100	100	100	100
RWH Effectivenes s	Pearson Correlation	0.568**	0.216*	1	0.663*	0.342**
	Sig (2-tailed)	<.001	0.031		<.001	<.001
	N	100	100	100	100	100
Respondent Satisfaction	Pearson Correlation	0.478**	0.210*	0.663*	1	0.201*
	Sig (2-tailed)	<.001	0.036	<.001		0.045
	N	100	100	100	100	100
Respondent Perception	Pearson Correlation	-0.38	-0.068	0.342**	0.201*	1
	Sig (2-tailed)	0.708	0.500	<.001	0.045	
	N	100	100	100	100	100

Regression analysis

Regression analysis is a statistical way to measure the relationship between the dependent and independent variables. In this study, the dependent variable is RWH effectiveness, and the independent variables are the respondent's background, satisfaction, perception, and RWH performance.

The table below shows the regression result. In the regression test, the adjusted R-square and the R-square value are required to have a difference to proceed to the next step. Table 6 shows that the adjusted R-square value and R-square value are 0.605 and 0.589, respectively. The difference value is not far, so the result is satisfactory to proceed with the next step. The significance value of the analysis is < 0.001, which is presented as less than the significance level chosen for this study, which is 0.05. Therefore, the result is significant; thus, there is the possibility of rejecting the null hypothesis.

The independent variable's significance level must be less than the tolerable level of significance. The null hypothesis is rejected if the significant value is less than 0.05. If the significance value is greater than 0.05, the null hypothesis is not rejected. When a null hypothesis is rejected, it indicates that there is an impact. If a null hypothesis is not rejected, it implies that there is no impact (Jain & Chetty, 2019). Table 7 shows the summary of the hypothesis analysis. The analysis suggests that the effectiveness of the RWH system has a significant positive relationship with the respondent's background, satisfaction, and perception.

Table 6: Regression result

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std.Error	Beta	t	Sig.
1	(Constant)	-.303	.268		-1.131	.261
	Respondent Background	.381	.074	.382	5.132	<.001
	RWH Performance	.185	.094	.131	1.967	.052
	Respondent Satisfaction	.652	.129	.395	5.070	<.001
	Respondent Perception	.668	.157	.286	4.261	<.001
	Sig.			<.001		
	Adjusted R Square			0.589		
	R square			0.605		

Table 7: Hypothesis Analysis

Independent Variable	Sig Value	Hypothesis	Interpretation
Respondent Satisfaction	0.001	Null Hypothesis Rejected (0.001< 0.05)	The respondent satisfaction is significant to the RWH effectiveness.
Respondent perception	0.001	Null Hypothesis Rejected (0.001< 0.05)	The respondent perception is significant to the RWH effectiveness.
Respondent background	0.001	Null Hypothesis Rejected (0.001< 0.05)	The respondent background is significant to the RWH effectiveness.
RWH performance	0.052	Null Hypothesis not rejected (0.052 > 0.050)	The RWH performance is not significant on the RWH effectiveness.

The analysis also reveals that RWH performance is not significantly related to RWH effectiveness, with a value of 0.052 exceeding the significance level of 0.050. RWH performance, on the other hand, is one of the factors that influences RWH effectiveness. This is because good RWH performance indicates that the RWH system is effective. The small difference in the significant value implies that the analysis may have some error.

These findings are in concurrence with a previous study that stated that most of the rainwater harvesting system users are satisfied with the overall system and would likely implement it because of its benefit. This shows that RWH effectiveness has an impact on user satisfaction and perception.

Cost Benefit Analysis

Table 8 shows the basic analysis of the cost–benefit of the RWH system, which provides numerous economic, social, and environmental benefits. These benefits will affect the user, and in this study, we referred to the mosque's committee and neighborhood. It also demonstrates the potential of a commercial building's rainwater harvesting technology and the long-term progress of the nation.

Table 8: Cost–benefit analysis of RWH

	With RWH system	Without RWH system
Environment	Rainwater harvesting has many environmental benefits and is an effective way to control the environmental damage caused by stormwater. By collecting rainwater and installing a RWH system, it can keep the water out of the way while also reducing floods and other environmental issue.	Without RWH system and a proper water management, will cause environmental damage such as flood. Malaysia receives an enormous amount of rainwater. However, the uneven distribution of rainfall has resulted in significant flooding in some areas. Floods are one of Malaysia's most frequent natural disasters, occurring nearly every year during the monsoon season
Social	RWH will be extremely beneficial to society. For example, RWH system can help individuals save money on their water bills while also lowering overall community costs. RWH is an important source of clean water that increases the amount of potable drinking water available. Rainwater is frequently harvested in developed countries to be used as a supplemental source of water rather than the primary source.	Without a RWH system, society will have to rely on treated water, which is very concerning. Because of increased water demand, the country will face water shortages issue in the future. According to observations, Malaysia's water demand will rise even further to 17.7 billion m^3/year in 2050.

Economic	Installing an RWH system in a building or houses will significantly reduce utility bills and household expenses. According to the interview with the mosque's chairman, the RWH system helped them save 50% of their water bill. A previous study found that a small catchment area of 686 sq.m could save 361,000 liters of water per year. The RWHS is a low-cost system that only requires storage and treatment and functions as a free water source. Finally, the economic benefits of RWHS can be demonstrated by infrastructure savings.	Without rainwater harvesting, a lot of energy and water will be wasted. It will result in an expensive water bill. For example, a mosque's water bill will be around RM200, not including the electricity bill. In Malaysia, for example, 40m^3 of water per month costs about RM 36.59.

CONCLUSION

Rainwater harvesting systems can be viewed as an effective water supply alternative for use in the future. The findings suggest that the effectiveness of the RWH system can influence user perception. Furthermore, findings from this study indicated the positive perception and feedback of RWH implementation. Based on the basic cost–benefit analysis, RWH shows the effectiveness of the system through economics, society, and the environment. This significantly shows that the system brings numerous advantages to environmental, social, and urban development, which may contribute to the country's development.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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