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Rainwater Harvesting (RWH) Systems: Is the Conservation of Water in Colombo Urban Areas Worth It?

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Abstract: In Sri Lanka, the wet zone of Colombo and other urban areas usually experience urban flooding situations. Furthermore, the urban setting is rapidly changing. The community perceives flood control and water conservation relatively poorly. Rainwater harvesting is a low-impact development (LID) method to control urban flash flood situations. However, considering people's interest in and awareness of rainwater harvesting (RWH), it was found that RWH is a lost factor in urban conservation. Therefore, using economically attractive choices, this study estimated the trade-off of residents practicing RWH in urban areas affected by high surface water runoff. The study's selected area was the Thimbirigasyaya Divisional Secretariat Division (DSD) flooding spots, an ideal location to estimate the preferences/trade-offs of individuals regarding rainwater harvesting practices. This estimation was calculated using a choice experiment (CE) method, which is an economic valuation method. Under this method, the conditional logit model was used to analyze people's preferences. The results showed that people are motivated and prefer to use RWH due to selected attributes in the field survey. This promising result implies that individuals prefer to use the RWH system as a method of stormwater management and water conservation. Moreover, most residents are willing to adopt these systems looking at their monthly water bill reduction and as promoters of green building concepts.

Keywords: rainwater harvesting; stormwater management; water conservation; urban flooding; choice experiment; conditional logit model; perceptions; preferences

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Citation: Ranasingha, C.M.; Wattage, P. Rainwater Harvesting (RWH) Systems: Is the Conservation of Water in Colombo Urban Areas Worth It? *Conservation* **2024**, *4*, 23–35. https://doi.org/10.3390/conservation4010002

Academic Editors: Deborah Panepinto, Marco Ravina, Marta Domini and Vittorio Martone

Received: 20 August 2023
Revised: 3 December 2023
Accepted: 25 December 2023
Published: 8 January 2024

1. Introduction

Rainfall changes in some parts of the world are affected by dry conditions; at times, they may cause flood conditions in other areas. Therefore, RWH is an essential strategy for water stress in the dry zone and a solution for the urban stormwater detention method to help to reduce urban flooding [1]. The concept of RWH is probably the most ancient practice in the world to cope with water scarcity and help to conserve water [2,3].

Urban floods and surface runoff are the most critical phenomena that cause an extra burden for people economically, socially, and environmentally in metropolitan areas. Surface runoff is the primary cause of urban floods. As a result of drainage facilities, prolonged rainfall, low slopes, blocking of the drainage system, and inadequate water storage, impervious surfaces contribute to urban flash flooding conditions. As a result, only a low amount of infiltrated water eventually reaches the underground water table [4,5]. Hence, rainwater harvesting (RWH) emerges as a practical strategy for effectively managing high urban stormwater runoff conditions while simultaneously contributing to water conservation. Furthermore, its incorporation into urban planning reflects its integral role in sustainable water management within urban environments [6]. According to water management systems, RWH systems can play a critical role in controlling flash flood situations and high runoff conditions in the watershed areas of urban settings [7]. RWH is a technique that makes optimum use of rainwater by catching and storing water by not allowing it to drain away, which prevents rainwater from causing floods or flash floods elsewhere [1].

Meanwhile, RWH has been integrated with different intelligent tools and technologies by experts for stormwater management (SWM) in the world's cities [8]. Designing and deploying RWH technology in urban areas requires understanding communities' preferences within their social, economic, environmental, and legal contexts [8,9]. Community preference, perception, and acceptance of the implementation of RWH are considered important factors in reducing the urban flooding situation. Low-impact development techniques like RWH are currently emerging practices in most areas [10]. Therefore, there have not been many studies to examine community preferences and values for these practices [11]. Additionally, few studies have assessed individual values and community priorities in adopting such practices to control stormwater runoff. Social planning is a prerequisite to eliciting individuals' preferences before introducing any product or program [11]. Moreover, the level of knowledge and understanding, regulatory gaps, lack of motivation, attitudes, and economic and financial constraints would be identified as factors that obstruct the implementation of RWH [12,13]. However, the question remains as to whether the world's urban areas should adopt such green practices [8,10].

Most of the Colombo District in Sri Lanka is vulnerable to urban flooding due to intense rainfall for a prolonged period [14,15]. Most of the urban areas' rainwater flows to the sea without use, comprising around 60% of the total flow [16]. The city's rapid expansion during recent decades, land-use changes, impervious surfaces, landfilling, and urban floodplain encroachments by the community have been the main reasons for severe flood conditions in Colombo's urban areas. Many research projects have ascertained that RWH effectively achieves on-site detention of runoff water, which mitigates the unfavorable situation of urban flooding; therefore, RWH can contribute to more sustainable water management practices [17]. Several roof RWH methods are practiced in the dry, intermediate, and wet zones to reduce stormwater runoff and drought conditions in Sri Lanka [18]. The Urban Development Authority (UDA) of Sri Lanka gazette legislation states that "every new building in urban areas should have an RWH system" to support the implementation of RWH [16]. However, in practice, the progress of people adopting RWH in the urban context is still slow and gradual [16]. This shows that urban communities have little interest and awareness of RWH system practices in urban areas.

Many studies in the literature discuss urban RWH and stormwater management in Sri Lanka. These studies demonstrate that policymakers and urban planners are inclined to provide guidance and establish rules and regulations to promote the practice of RWH in the Colombo urban context [14,18]. However, it is essential to extend these discussions to encompass RWH systems in the context of public acceptance, particularly in urban or suburban areas in Sri Lanka. This is crucial because effective rainwater conservation can contribute significantly to mitigating high runoff conditions. Therefore, RWH practice and the public willingness to adopt such strategies are more vital factors [19]. The conservation of water and the reduction in high runoff conditions stand as essential pillars of sustainable urban development. Consequently, strategic planners and policymakers must evaluate the perspectives of experts and communities and their willingness to invest in or financially support rainwater harvesting systems (RWHSs). This comprehensive assessment is imperative for crafting sustainable urban water management strategies that align with both technical considerations and community preferences [20,21].

Urban areas have demonstrated little community acceptance of RWH in Sri Lanka [22]. This is because decision-makers have tried to implement their technical understanding of RWH without seeking residents' perceptions. Therefore, the urban community would not be aware of the importance of RWH and control of flash flooding situations in an urban context. For instance, a domestic RWH system could reduce 20% of urban flood conditions in the Colombo DSD [14]. This would contribute to the control of flash flooding and play a pivotal role in water conservation within the area. Acknowledging and incorporating the perspectives of urban residents is crucial for fostering community awareness and understanding of the benefits of RWH practices in urban environments.

The uniqueness of this research is that it conducts a robust, in-depth study on the perception of city dwellers regarding the use of RWH to conserve water. Further, it investigates the potential of RWH to reduce runoff and motivate people to practice RWH. According to the 2050 National Physical Plan, the Colombo metro region proposes a development corridor. As a result, the surrounding suburban area becomes an urban settlement that supports around three and a half million residents. It means the Colombo metro and the sub-urban population will increase steeply [23]. As a result, the current face of the region will change along with the land use and the increased storm runoff. Therefore, there should be a policy to develop RWH to control runoff that could create a disaster in the area. Unfortunately, no evidence exists that laws have given an efficient framework to promote rainwater harvesting in urban areas [18]. This drawback points out the missing parts in the RWHS policy direction.

Most of the research needs to pay more attention to public preferences and the willingness of urban residents to adopt (WTA) domestic RWH in an urban context to control stormwater runoff [24]. The City of Colombo and sub-urban areas are subject to heavy rain and flooding in built-up areas. The Water Board of Sri Lanka provides drinking water for all citizens. However, water bills gradually increase, affecting the public, but the water conservation effort could be more effective. In addition to the water bills, surface water runoff due to city build-up areas contributes to flooding. Therefore, using economically attractive choices will estimate the trade-off of residents practicing RWHS in urban areas that are being affected by high surface water runoff. This will motivate the urban community to practice RWHS as a water conservation method and reduce stormwater runoff in the metropolitan area.

This study would be helpful to decision-makers, planners, and other specialties to understand public views and how to improve public acceptance of RWH. The Western Region Master Plan (WRMP) of 2030 in Sri Lanka states that water conservation strategies like RWH practices and energy production should be made mandatory in an urban setting [25]. Furthermore, this will help with proper land-use planning of the cities, preparing guidelines, and designing RWH systems.

This paper is structured as follows. The following section describes the case area, experimental design, data collection process, and analytical technique. Section 3 interprets the results based on the objective. Finally, Section 4 discusses conclusions and future research directions.

2. Materials and Methods

This section includes this study's methods and how they reveal people's preference for RWH practices and determine the trade-off in RWH practices. Furthermore, this section clearly explains the empirical study, data collection, methods, and analysis.

2.1. Case Study Area

The selected case study area is in the Colombo Municipal Council area, which entails the administrative area of Thimbirigasyaya DSD (Figure 1). It is determined based on the urban setting, which consists of severe urban flooding over several years. The selected case study area is in the Kirulapana area.

Moreover, the study area consists of micro drainage areas. Therefore, the site has flash flooding conditions during the heavy rainfall in most years. Furthermore, in 2019 and 2020, most of the areas had flash flooding conditions, and some roads encountered significant traffic jams [15,26].

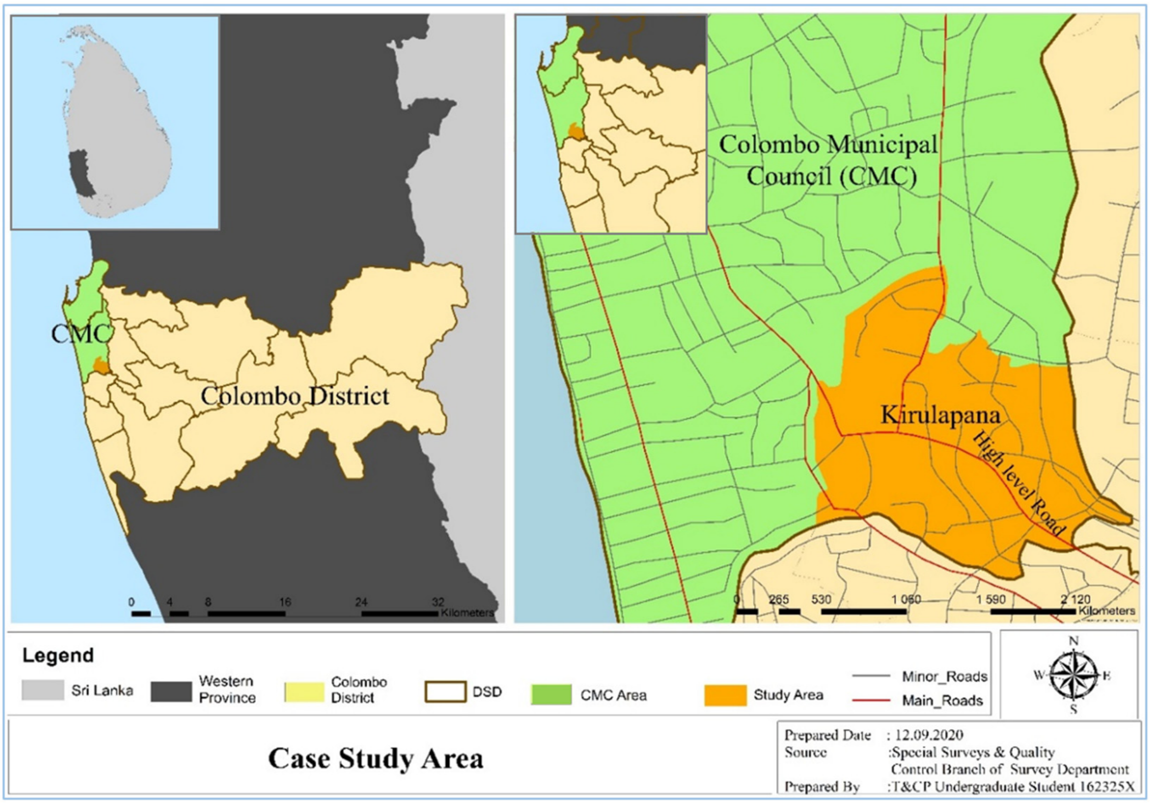


Figure 1. Case study area.

2.2. Choice Experiment (CE)

This study used CE to find the general preference for RWH. There were a few studies on the valuation of stormwater management and applying CE directly to RWHS practices [27]. Initially, Louviere Worthworth (1983) proposed the method of CE in environmental valuation. It is a derivative of conjoint analysis, widely used in market research [28]. This method is a practical approach to policy management that implements new guidelines [29]. CE is a preferable method for social science surveys. It focuses on trade-offs of individuals among different levels of attributes [8,27]. According to Roger's concept of compatibility, this method included compatibility and flexibility [30].

Further, this is an attribute-based valuation method [30]. CE, using a questionnaire, asks communities to choose levels of attributes among different variables/attributes relative to the status quo (present condition) to find trade-offs in RWH. Those attributes and levels are decided based on literature reviews, experts, and field experience. Under CE, this study selected the conditional logit model (CLM) model. Several steps and considerations have to be followed before implementing a CE study under the selected CLM model.

CE data collection procedure allows respondents to choose one of the alternatives that are shown on the choice card. According to the study's objective, people's choice will interpret how far they will trade off in RWH practices based on the mixture of levels and alternatives. In this procedure, this study will design a series of choice scenarios. Finally, those choice sets will be used in the questionnaire survey.

The level of attribute selection is a crucial task in designing a CE [27]. This study generates attributes using expert discussions, virtual space, field experience, and a literature review. These are the most common sources of selecting levels and attributes [31] and field experience. Therefore, in this study, two steps were taken. The first step was an in-depth literature review, which gave most of the ideas to select attributes. Most of the studies show that the public was interested in reducing water bills and saving money [16,27]. The second step was selecting field experts and public discussions via virtual spaces like phone calls. In this discussion, most experts also introduced an attribute for reducing some rupees from water bills and their levels [32], and a sustainable monitoring system with subsidies and the reduction in property bills [33]. As a result, this will conserve piped water, reduce the energy costs associated with pumping, minimize flooding, and provide an opportunity to inject rainwater into the ground through proper drainage system improvements.

The final suitable attributes and levels were decided based on the expert's views. Tables 1 and 2 show the desired levels, attributes, and descriptions. Before the questionnaire survey, choice cards were prepared and piloted.

Table 1. Selected levels of attributes.

Attributes	Level 1 (Status Quo/Present Condition)	Level 2	Level 3
Reduction in water bill	0%	−20%	−30%
Water uses	Use of pipe-borne water	Use of 20% RWH	Use of 50% RWH
Drainage system	Partial improvement	Full improvement	-

Table 2. Description of selected levels of attributes.

Attributes	Description
Reduction in water bill	People are interested in saving money from the water bill. Therefore, this water bill reduction is ongoing, and this opportunity will motivate people to practice RWH.
Water uses	This attribute will give a chance for people to conserve water, help the city's economy, and reduce surface runoff from the property area.
Drainage system	Drainage system improvement will help to reduce street runoff, control some diseases, and protect stream health. Using the drainage system reduces surface runoff and injects water into the ground.

Before the questionnaire survey, choice cards (Figure 2) were prepared and piloted. As shown in Table 1, the levels and attributes composition were 3 levels of 2 attributes and 2 groups of 1 attribute. Therefore, the total combinations of levels of attributes are $3^2 \times 2^1 = 18$, the full factorial design choice sets. However, after running the orthogonal design in the SPSS 23 Software, it created nine fractional factorial design cards. The orthogonal design tool is an effective method for isolating the effects of individuals' levels of attributes on the set of choices [30].

The questionnaire field survey was the procedure to collect general information, people's perceptions, and choice set selection. Under those, there was a series of questions. This empirical study focused on urban flooding areas within the selected location. Roughly about 350 of the sample size were selected using the random sampling method, as is appropriate to select respondents to the survey in the CE [27]. This study procedure used house-dwellers aged 18 to 70 in the chosen study area. This age group will give each active person an equal probability of being selected for the survey. The questionnaire survey using one-to-one personal interviews collected all of the necessary information. In addition, it allowed an understanding of more unknown factors of the study.

2.3. Analytical Technique

The conditional logit model (CLM) was used to analyze CE data using IBM SPSS analytical Software 23. CLM gives a probability to individual "i" to select alternative "j" as a function of the attributes changing for the unknown parameters and alternative [34]. Furthermore, an individual's satisfaction/utility level depends on a series of choice sets, "C". Therefore, the respondent selects one of the alternatives of "c_i" as described in Equation (1). This value is the expected value of the utility of alternatives divided by the total expected utilities.

$$p\left(\frac{c_i}{C}\right) = p\left(\frac{\exp(U(c_i))}{\sum_{j=1}^{m} \exp(U(c_j))}\right) \quad (1)$$

exp ($U(c_i)$): Exponential of utility of the alternative;

$\sum\exp(U(c_j))$: Exponential utilities sum;

$P(c_i/C)$: Probability of individual choosing one of the alternatives from a set of choices.

The collected data are analyzed using Equation (1), and the results are analyzed according to the study's objective.

Figure 2. Choice card.

3. Results and Discussion

This section discusses the empirical study's analysis, results, and interpretation. Before presenting the survey analysis results, it helps to understand the background socio-demographic information.

Out of the 350 questionnaire survey participants, as seen in Table 3, regarding gender composition, 54.86% were male, and 45.14% were female in the total sample. Considering the age group, most of the participants were in the 28–37 age group, comprising 109 out of 350. Apart from that, most of the sample, 51.4%, have achieved a higher level of education. Therefore, many people are very interested in gaining knowledge on stormwater management even though they are at different educational levels. Under the personal monthly income level category, 28% of participants come under the 30,000–45,000 category. Almost 3/4th of the survey participants are full-time employees, representing 266 out of 350. The results also showed that most of the participants live in their own houses, about 90%. Further, 6% of participants live in rented houses, and 4% live in rented annexes.

Table 3. Socio-economic information in the collected data.

Gender			Age			Monthly Income Level		
		%			%			%
Male	192	54.86	18–27	57	16.29	Below 15,000	36	10.29
Female	158	45.14	28–37	109	31.14	15,000–30,000	91	26
			38–47	73	20.86	30,000–45,000	98	28
Marital Status			48–57	62	17.71	45,000–60,000	62	17.71
		%	58–67	44	12.57	60,000–75,000	43	12.29
Single	56	16	67+	5	1.429	75,000+	20	5.714
Married	294	84						
Level of Education			**Employment Status**			**Housing Arrangement**		
		%			%			%
Primary	96	27.4	Full-Time	266	76	Owned House	315	90
High	180	51.4	Part-Time	9	2.571	Rented House	21	6
University	70	17.7	Unemployed	36	10.29	Rented Annex	14	4
Postgraduate	4	1.14	Studying	15	4.286			
			Retired	24	6.857			

3.1. The Results of the Choice Model

Table 4 presents the analysis of CE data, including the interpretations of the choices among levels of alternatives based on the CLM. Firstly, using Cox regression analysis, it estimated the model test statistics. The significance of the model is shown using the likelihood ratio, wald, and score based on chi-squared (χ^2) values. The values obtained indicate that the model is significant at α levels of 0.01 (Table 4). Thus, it rejects the null hypothesis of no relationship between the choices and the levels of attributes. Therefore, the model test statistic indicates that the model has a high significance with probability $p < 0.0001$.

Table 4. Model test statistics (Global $H0$: $\beta = 0$).

Test	χ^2	df	Pr > χ^2
Likelihood ratios	369.962	5	<0.0001
Scores	475.757	5	<0.0001
Wald	475.757	5	<0.0001

The maximum likelihood estimates the parameter values of the model, which are presented in Table 5. As shown in the table, some of the parameter values (β), like the water bill reduction of 20% and the use of 50% RWH, are significant at the $\alpha = 0.05$ level.

However, all other variables are statistically significant to the $\alpha = 0.01$ level. Thus, the estimated parameters show zero reference levels indicating the status quo (no water bill reduction, 100% pipe-borne water, drainage system partial improvement).

Table 5. Estimation of maximum likelihoods for all respondents.

Parameter Variable	Estimates (β)	S.E.	χ^2	Pr > χ^2
Reduction in water bill				
Water bill reduction—30%, (WBR30)	0.957	0.172	31.051	0.000
Water bill reduction—20%, (WBR20)	0.355	0.149	5.705	0.017
Water bill reduction—0% (status quo), (NWBR)	0			
Water uses				
Use of 50% RWH, (USE50RW)	0.360	0.147	5.782	0.016
Use of 20% RWH, (USE20RW)	1.034	0.173	35.674	0.000
Use of 100% pipe-borne water (status quo), (USEPBW)	0			
Drainage system				
Drainage system (DS) full improvement, (DRAINFI)	1.420	0.130	119.875	0.000
DS partial improvement (status quo), (DRAINPI)	0			

According to the estimated maximum likelihood parameters, the "water bill reduction" attribute relative to the reference level is highly significant. For example, the estimated part-worths utility for the variable status quo of no water bill reduction is structurally zero, while the part-worths utility for 30% is +0.957. This preference is the highest level related to the sum of ranges across all attributes of water bill reduction. This value is significant at the $\alpha = 0.01$ level since the Pr > χ^2 is 0.000, <0.01. Furthermore, the water bill reduction of 20% is +0.355, the second-highest part-worths utility. This value is significant at the $\alpha = 0.05$ level as 0.017 < 0.05. Both of these levels are preferred over the status quo of no water bill reduction indicating the urge for RWH if there is an economic gain. Hence, considering their preferences, the objective of increasing RWH practice among the general public in the particular case study area is sustainable.

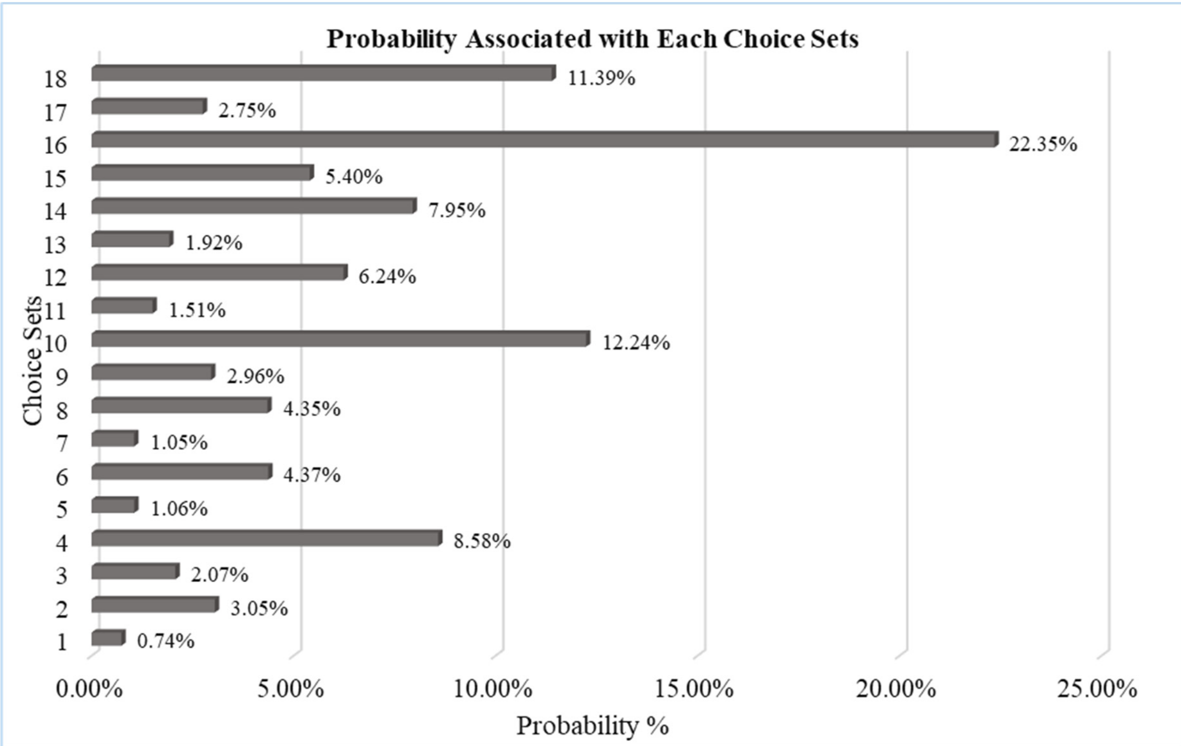
The second tested attribute was "rainwater use" (water conservation habit). The part-worth utility for using 100% pipe-borne water or other sources is the current practice (status quo), a structural zero. However, 20% RWH appears to be the most preferred level, with the estimated parameters of +1.034 indicating it as the preferable choice. This parameter value is significant at the $\alpha = 0.01$ level. In total, 50% RWH appears to be the second most preferred level with the parameter estimated value of +0.360. This attribute is significant at the $\alpha = 0.05$ level. This attribute level is vital to water conservation and control of flash flood situations in the case study area. Considering the above result, the general public prefers to use RWH within their property.

The third tested attribute in the model was "drainage system improvement." All parameters were perfectly significant at the $\alpha = 0.01$ level. According to the general preference, the estimated part-worths utility for the drainage system's total improvement presented a higher estimation value. It is about +1.420 with the part-worth utility for the total improvement, while the partial improvement is structurally zero. These results indicate that the public likes to inject adequate rainwater into the ground as a source of water conservation. Furthermore, harvested rainwater can be used in other activities such as watering plants and washing. All this helps the rainwater conservation in the case study area, ultimately reducing prevailing surface runoff conditions to control flash floods.

The results of the attribute associated with part-worth utility indicate the public's willingness to practice RWH as an idea for conservation purposes and to reduce their monthly water bill payment. Thus, this practice will contribute to the social, environmental, and economic benefits and the sustainability of the case study area.

3.2. Probability of Choice

The likelihood of parameter estimates table is also helpful in estimating the probability for the originally selected eighteen levels of alternatives considering the choice probabilities. Figure 3 presents the possibilities associated with each choice set. As interpreted in Table 6, the most preferred combination of attributes is a water bill reduction of 30%, the use of 20% RWH, and the drainage system's total improvement. The choice set has the highest probability compared with other choice sets (see Table 6), which is about p = 0.224. These three levels are essential, along with controlling surface runoff and water-conserving efforts. Figure 3 presents the ranking of all choices, suggesting that Choice Set Number 16 is the most preferred. This choice set includes the highest combination of probability levels, 22.4%.



Choice Sets	**Water Bill Reduction**	**Water Uses**	**Drainage improvement**	**Probability %**	**Choice Sets**	**Water Bill Reduction**	**Water Uses**	**Drainage improvement**	**Probability %**
1	WBR0	USEPBW	DRAINPI	0.74%	**10**	WBR20	USE20RW	DRAINFI	12.24%
2	WBR0	USEPBW	DRAINFI	3.05%	**11**	WBR20	USE50RW	DRAINPI	1.51%
3	WBR0	USE20RW	DRAINPI	2.07%	**12**	WBR20	USE50RW	DRAINFI	6.24%
4	WBR0	USE20RW	DRAINFI	8.58%	**13**	WBR30	USEPBW	DRAINPI	1.92%
5	WBR0	USE50RW	DRAINPI	1.06%	**14**	WBR30	USEPBW	DRAINFI	7.95%
6	WBR0	USE50RW	DRAINFI	4.37%	**15**	WBR30	USE20RW	DRAINPI	5.40%
7	WBR20	USEPBW	DRAINPI	1.05%	**16**	WBR30	USE20RW	DRAINFI	22.35%
8	WBR20	USEPBW	DRAINFI	4.35%	**17**	WBR30	USE50RW	DRAINPI	2.75%
9	WBR20	USE20RW	DRAINPI	2.96%	**18**	WBR30	USE50RW	DRAINFI	11.39%

Figure 3. Probability associated with each choice set.

Table 6. Estimation of probability for Preferred Choice 16.

Choice 16	Water Bill Reduction 30% (p = 0.957)	Use of 20% Rainwater Harvesting (p = 1.034)	Drainage System Full Improvement (p = 1.42)	Prob. = 0.224 (22.35%)

The second and third top preference under the utility are the Choice Set Numbers 10 and 18, with 12.24%, and 11.39% probabilities, respectively (see Tables 7 and 8).

Table 7. Estimation of probability for Preferred Choice 10.

Choice 10	Water Bill Reduction 20% (p = 0.355)	Use of 20% Rainwater Harvesting (p = 1.034)	Drainage System Full Improvement (p = 1.42)	Prob. = 0.122 (12.24%)

Table 8. Estimation of probability for Preferred Choice 18.

Choice 18	Water Bill Reduction 30% (p = 0.957)	Use of 50% Rainwater Harvesting (p = 0.360)	Drainage System Full Improvement (p = 1.42)	Prob. = 0.114 (11.39%)

Furthermore, after giving some idea about this kind of water conservation method, most people strongly agree to adopt water conservation methods, which are about 44.6% and 38%, respectively (Figure 4). As in Figure 4, most people mentioned that the government/organization should guide water conservation technological methods. According to the relative importance index, this is the public's priority at 86.29% (Figure 5).

This section interpreted the results and findings of the study. According to the results, we can check whether the findings would help to fulfill the study objective. Also, when considering communities' trade-offs within RWH practices, it suggests that a water bill reduction of 30%, the use of 20% RWH, and the complete improvement of the drainage system are highly preferred. This result implies that individuals prefer to use this RWH system for stormwater management, water conservation, and monthly water bill reduction.

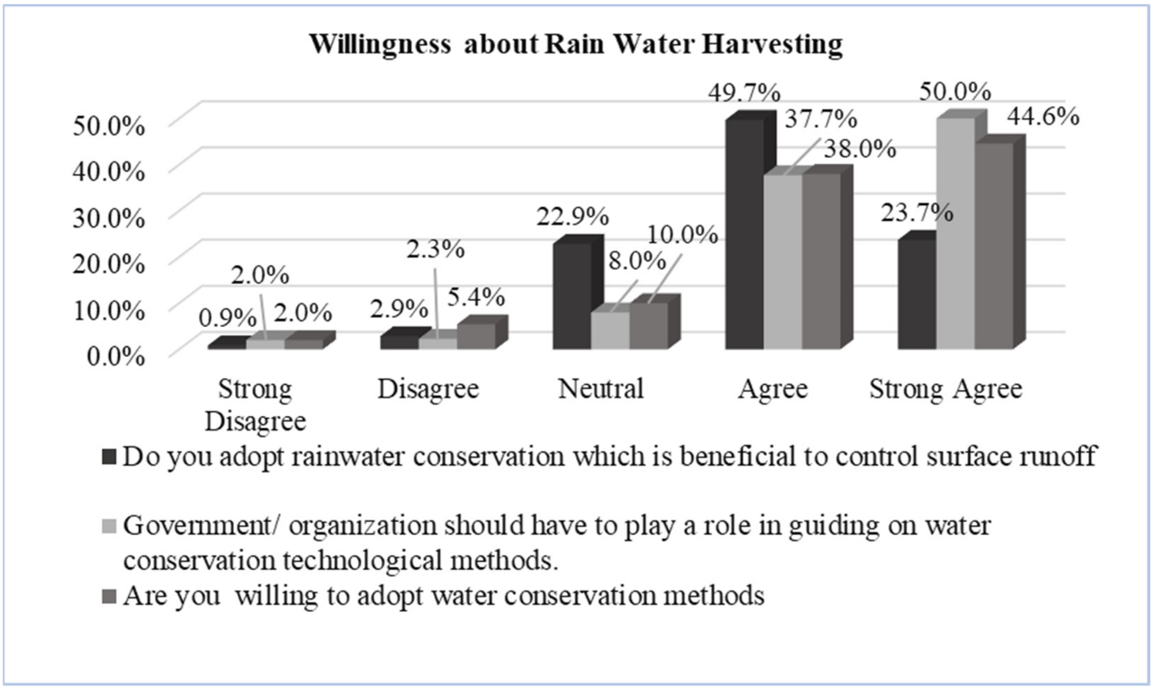


Figure 4. Willingness about RWH.

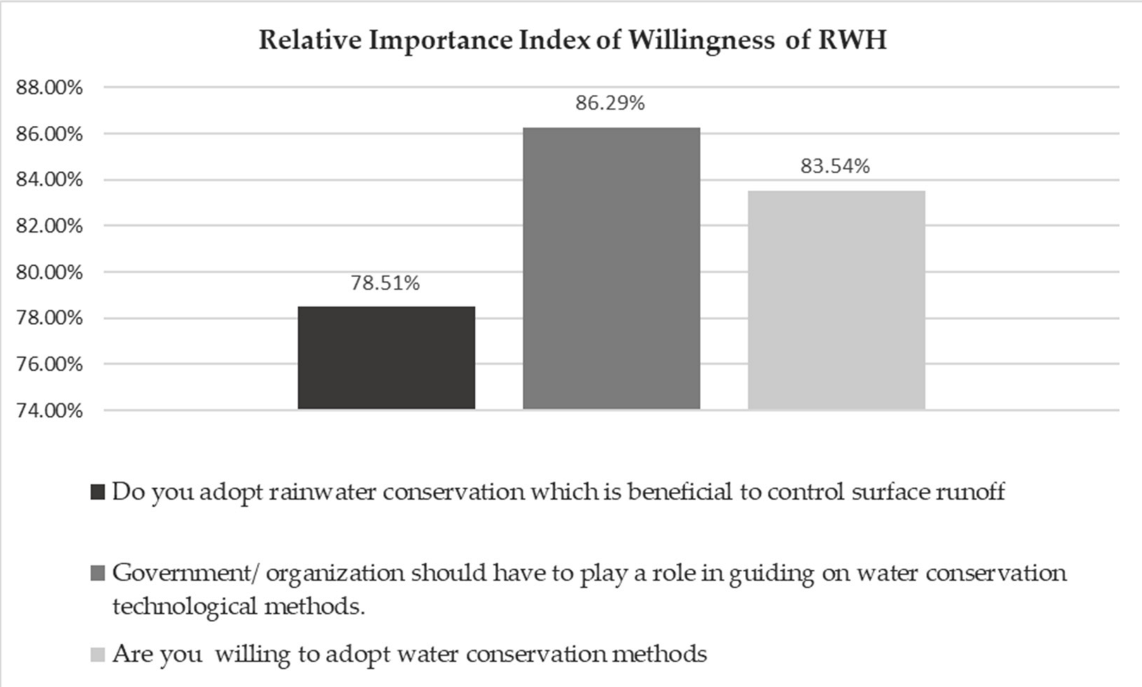


Figure 5. Relative importance index of willingness of RWH.

4. Conclusions

The study attempts to promote and motivate the urban community for RWH as a strategy for conservation through mitigating stormwater runoff and flooding in urban areas. Therefore, this survey is organized with research objectives to give people in the case study area relevant knowledge on RWH. The study reveals that the case study area in Thimbirigasyaya DSD has endured severe flooding for several years. Field surveys and expert discussions also revealed that highways become obstructed by traffic jams during heavy rain and high runoff times. Fortunately, most quantitative research showed that the RWH system effectively controls urban flooding events [14]. The area elevation shows that drainage system improvement and RWH practices are vital factors. However, the practical situation is that people must practice RWH in the urban context. There needs to be more research among the government, experts, and people to find an amicable answer. Therefore, this study mainly estimated the trade-off of individual decision-making on RWH practices using the CE method.

The field survey has pointed out different experts, government organizations, and community ideas related to the RWH practice in the high surface runoff area. Most organizations mentioned that people are not considering water-conservation methods like RWH in their neighborhoods because they have no drought conditions. Generally, water-conservation methods like RWH are not used in their community because they have had no drought conditions for a prolonged period. Furthermore, there are new methods for RWH, but people need to be fully aware of those techniques. However, in the field experience, it was identified that some residents use a bucket to collect rainwater during rainy times. The case area respondents said they used those for washing and cleaning during high surface runoff times. As experts said, residents are attentive to practicing RWH but need more technical knowledge of the RWH systems. Therefore, this study cannot support the idea that most people are not interested in practicing rainwater harvesting in the case study areas.

Moreover, these results could help to increase the aesthetic quality in the case study areas. The levels of attributes that people value support the reduction in neighborhood flooding and severe urban flooding. Additionally, adopting RWH techniques would not only manage the challenging flood situation. It would also increase the use of RWH in the household. Thus, it may be better to conduct an awareness program for the public [8]. Then, it would support them to practice an RWH system.

CE is a flexible approach to understanding the preference between multi-level attributes [21]. This technical method supports exploring residents' preferences for adopting residential stormwater management. Residents practicing RWH is a vital factor for the long-term water-conservation method. Because of total improvement, drainage systems support groundwater recharge. Urban flooding control will support Sustainable Development Goal 11, "making cities and human settlements inclusive, safe, resilient and sustainable" [20]. This analysis consistently indicates that residents value conservation rainwater harvesting systems and adapt them within their neighborhoods based on their benefits.

As the public prefers to practice RWH in the urban context, policymakers, urban planners, municipalities, and authorities of water-resources management should recommend promoting RWH systems in an urban setting through appropriate strategies and technical guidance and encouraging people to adopt RWH systems practices. These systems provide more profitable and environmentally sensitive development practices [11]. However, we identified during the survey that residents needed clarification about current urban development and flash flood situations. They also mentioned that people need to gain appropriate knowledge about these kinds of techniques. However, providing more accurate information to residents about this technique would increase interest in RWH [11]. Even though these findings are micro-scale, they contribute broad implications for environment valuation, climate change adaptation, and stormwater management.

The study proved that CE is a method that can be supported to effectively analyze public preferences and use those for controlling urban high-runoff situations. Consequently, this might help to conserve water in Colombo and the urban context.

The selected case area is limited to small urban locations in the western province of Sri Lanka and focuses only on domestic rainwater harvesting in the urban setting. Future research should investigate commercial, industrial, and institutional RWHS and how it will reduce stormwater runoff in the urban context.

Author Contributions: Conceptualization, C.M.R. and P.W.; methodology, P.W. and C.M.R.; software, P.W. and C.M.R.; validation, C.M.R. and P.W.; formal analysis, C.M.R. and P.W.; investigation, P.W.; resources, C.M.R.; data curation, C.M.R.; writing—original draft preparation, C.M.R.; writing—review and editing, C.M.R. and P.W.; visualization, C.M.R. and P.W.; supervision, P.W.; project administration, P.W. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: Data are contained within the article. The data presented in this study are available upon request.

Conflicts of Interest: The authors declare no conflicts of interest.

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