

# Household Preferences for Domestic Water Conservation Practices: A Systematic Literature Review

Nurshafiqah Abdul Malek, Zuraini Anang\*, Mahirah Kamaludin

Faculty of Business, Economics and Social Development, Universiti Malaysia Terengganu, Malaysia

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**Abstract** Water resources are threatened by water scarcity, making it crucial for households to play a significant role in conserving water to ensure its sustainability. This study aims to identify the preferences of households regarding domestic water conservation. The research followed the PRISMA 2020 review protocol and utilized the Scopus and Web of Science databases to conduct a systematic literature review. It is reflecting advancements in methodology for identifying, selecting, evaluating, and synthesizing related articles. Through thematic analysis, the study identified ten main themes, including: water-saving technologies, water conservation initiatives, households' characteristics, psychological factors, media influence, reduction in water usage, reduction in households' water demand, environmental protection, compliance with water conservation policies, and cost savings, with a total of 14 sub-themes. The findings emphasize the importance of understanding households' preferences in domestic water conservation to develop effective water-saving programs for future action plans and to provide necessary information for stakeholders. As a result, this study aims to provide policymakers and stakeholders with ideas and proposals for developing ways to boost community participation in water conservation activities. Aside from that, the systematic review recommended that more research be conducted on households' preferences for water conservation in Middle Eastern, Central Asian, and Southeast Asian nations. As a result, it is vital to research families' preferences for water conservation to understand their willingness to change their water usage habits and what alternatives they would

explore if water conservation programs were implemented in their area.

**Keywords** Domestic Water Conservation, Household, Preference, Systematic Literature Review, Water Saving

## 1. Introduction

Water conservation has given us huge advantages to protect freshwater resources all over the world. It can reduce the impacts on water resources from various sources such as climate change, population growth and increasing development. Water conservation comes with different definitions depending on the context and targeted population or environmental surroundings. Researchers have formed the definitions of water conservation to provide better understanding of the context. Jeff et al. [1] defined water conservation as restricting or changing in human water consumption so that water quantity and quality will remain unchanged within any cycle beyond those produced by natural phenomena. James and Kyle [2] and Michael et al. [3] also defined the meaning of water conservation as any beneficial reduction of water consumption or loss, including the act of preserving, caring, and protecting water resources.

The fact that the percentage of freshwater covered on the Earth's surface is only 2-3% and the rest of 70% saltwater shows that freshwater resources are limited. According to

AQUASTAT database [4], the total of freshwater withdrawal increased from 3,847.7 billion m<sup>3</sup> to 3,920.5 billion m<sup>3</sup> in 5 years between 2014 and 2019 meanwhile the amount of renewable freshwater resources per-capita decreased from 5,879.33 m<sup>3</sup> to 5,555.38 m<sup>3</sup> per person per year. By 2050, the annual renewable freshwater resources per capita will be below 1,700 m<sup>3</sup> per person per year in 87 out of 180 countries around the world [5]. Freshwater has been increasingly withdrawn from the supply every year because of higher water demand by the consumers. The World Health Organization (WHO) recommended the amount of water consumption per person per day is 165 litres. It is enough to cover human's basic needs for water including healthcare and sanitation. However, some countries around the world have recorded the amount of water consumption per person per day exceeding the recommended amount of water usage per person per day by WHO such as China - 185 litres [6], United States - 314 litres [7], South Africa - 237 litres [8], Saudi Arabia - 235 litres [9], and Malaysia (Peninsular Malaysia and Labuan) - 237 litres [10]. Other than climate change and geographical characteristics, researchers believed that there are some factors of increasing water consumption, including water pricing, awareness and education about water conservation, the influences of attitudes and social norms, adoption of water conservation technologies and socio-demographic characteristics [11, 12]. This explains that households can give a significant impact on the change of water usage to prevent water usage to be overconsumed and not be controlled.

To understand why households conserve water, researchers studied the behavioral changes related to water conservation and tried to predict human behavior when practicing water-saving habits. Most researchers used the Theory of Planned Behavior by Icek Ajzen to study water conservation behavior. According to Icek [13], human's behaviour to do certain actions can be predicted and explained through attitudes towards behaviour, subjective norms and perceived behavioural control which can influence personal intention to perform the actual behaviour. One of the previous studies found that attitude and information publicity have a strong influence on water-saving behaviour [14]. Seyyed et al. [15] found that intention, perceived behavioural control and familiarity are the strongest determinants of water conservation behaviour.

Studies on water conservation behavior have delved deeper into understanding human preferences for water conservation. Research on water conservation preferences helps in understanding households' desires and choices in relation to the benefits they gain from practicing water conservation. Researchers have used various approaches to study the attributes that households prefer when adopting water conservation, such as discrete choice experiments and the best-worst scale. Previous studies have shown that households prefer water-saving technologies that are low cost, easy to use, and do not require complicated

installation procedures [16, 17]. Gloria et al. [18] found that households preferred to reuse greywater for toilet flushing, laundry, gardening irrigation and showering but not for drinking because they considered the quality of greywater to be not suitable for drinking. When the quality of greywater becomes worse, they prefer monetary incentives to treat the quality of greywater by reusing greywater continuously. Janine and Patrick [19] discovered that households prefer water conservation policies such as water budget policies to be increased by 30% and drought surcharges which are not more than USD\$10. From the results of the previous study, it is important to understand households' preferences towards water conservation in establishing water conservation programs or policies that are suitable for their choices.

In conclusion, studying households' preferences for domestic water conservation is crucial for gaining knowledge about what households prefer in adopting water conservation practices. This kind of study allows us to identify the benefits or gains that households would choose if they practiced water conservation. Additionally, such studies can contribute to the establishment of water policies aimed at managing water resources more efficiently and sustainably.

### **1.1. Problem Statement and Research Gap - The Existing Studies Related to Water Conservation Preferences among Households**

Water conservation studies have been conducted by researchers for decades with fulfilling the research objectives to solve water issues and increase the productivity of water resources management. One of the branches of knowledge that is explored by research related to water conservation is the study of households' preferences or attributes of domestic water conservation. Households have preferences which are heterogeneous when it comes to practicing water conservation. Previous studies have explored the attributes of water conservation preferred by households such as Ifedotun et al. [16], Ifedotun et al. [17], Gloria et al. [18], and Janine and Patrick [19]. Although there are many studies that focused on the attributes or preferences of the individuals towards water conservation, there was still lacking the number of researchers who conducted systematic review of the existing studies. It is important to review past studies systematically compared to the traditional literature review which is often less thorough and rigorous, and does not conduct specific methodology or apply ad hoc approach. For this study, it offers a significant contribution to the current body of knowledge about water conservation and the preferences of water conservation among households by conducting a systematic literature review.

Systematic literature review is one of the methods of writing a literature review systematically and assessing the topic with critical appraisal in order to solve research problems. According to John and Bart [20], the uses of

explicit methods to find the articles methodically, critically appraisal and combining the literature based on specific issue make the fulfillment of the objectives for reviews more satisfying. Reviewer bias can be reduced by focusing on the objective, criteria to choose relevant publications and their validity. The process of conducting SLR is according to a protocol for locating and evaluating the previous studies. SLR protocol is effective not only to provide guidance for researchers through the process but also to increase the transparency of literature review. Thus, the quality of reviews is improved with more transparency, a much broader range of studies and less implied researcher bias [21].

Although there are studies that conducted systematic literature review focusing on water conservation on the individuals' or households' behaviour. Nevertheless, their focus is not on the preferences of the individuals or households towards water conservation or in other words, the attributes of practicing water conservation at the domestic level. For example, Carolina et al. [22] conducted a study of the barriers and motivators of household water conservation behaviour using bibliometric and systematic literature review. A study by Sudheer et al. [23] conducted a systematic literature review about the holistic approach to water conservation behaviour in terms of psychological, situational, demographic, and contextual factors. Phillip et al. [24] focused on the household water conservation interventions using the information-motivation-behavioural (IMB) skills framework. There is a lack of studies on households' preferences towards domestic water conservation. This could give an impact on the knowledge and information about domestic water conservation attributes which may lead to lack of references for developing the future water policy intervention. Hence, this study will develop a systematic literature review about the preferences of water conservation among households. The process of developing systematic literature review is based on the following research question:

- a) What are the preferences of domestic water conservation among households?
- b) What are the factors influencing households' decision making to choose preferences for domestic water conservation?
- c) What are the impacts of domestic water conservation preferences on households' water consumption?

The primary objective of this study is to address the existing research gap by conducting a comprehensive and systematic review of previous studies. Through this review, we aim to develop a deeper understanding and acquire substantial knowledge regarding the factors influencing

households' choices and preferences in relation to water conservation. This study seeks to lay the groundwork for enhancing our understanding of how households make decisions related to water usage and conservation, with the ultimate goal of fostering more effective water conservation strategies and initiatives.

## 2. Methodology

This section describes the method used to collect relevant articles on the preferences or attributes regarding water conservation among households. The systematic literature review is guided by PRISMA (Preferred Reporting Items for Systematic Review and Meta-Analyses) 2020. The PRISMA 2020 statement provides an updated reporting guideline for systematic literature reviews reflecting advancements in methodology for identifying, selecting, evaluating, and synthesizing related articles [25]. The process of conducting systematic literature review is detailed in Figure 1.

### 2.1. Identification

In this study, we utilized the main databases Scopus and Web of Science due to their status as the primary databases for indexed journals. The purpose of using two databases is to prevent retrieval bias towards sampled articles. One of the benefits of using these major databases is their reliability, as they offer empirical data and cover a wide range of study fields, including social sciences [26]. Junwen and Weishu [27] stated that Scopus and Web of Science are highly competitive citation databases because they offer various features that enable accurate literature searches. Unlike Google Scholar, these databases provide specific features such as document types and language options that allow users to choose the type of document like article journals, proceedings, and chapter in books and the language preferences.

We identified specific keywords, such as domestic water conservation, water saving, water efficiency, household, resident, attribute, preference, benefit, characteristic, advantage, criteria, strength, interest, and parameter are combined to form the search string and related search terms in order to provide more strategic searching for related articles. These keywords were combined to form a search string and related search terms to facilitate a more strategic search for related articles. The search string was created using field codes, Boolean operators (AND and OR) and truncation functions. Through this process, we found a total of 2197 articles from the Scopus and Web of Science databases. Table 1 displays the related keywords in the search string.

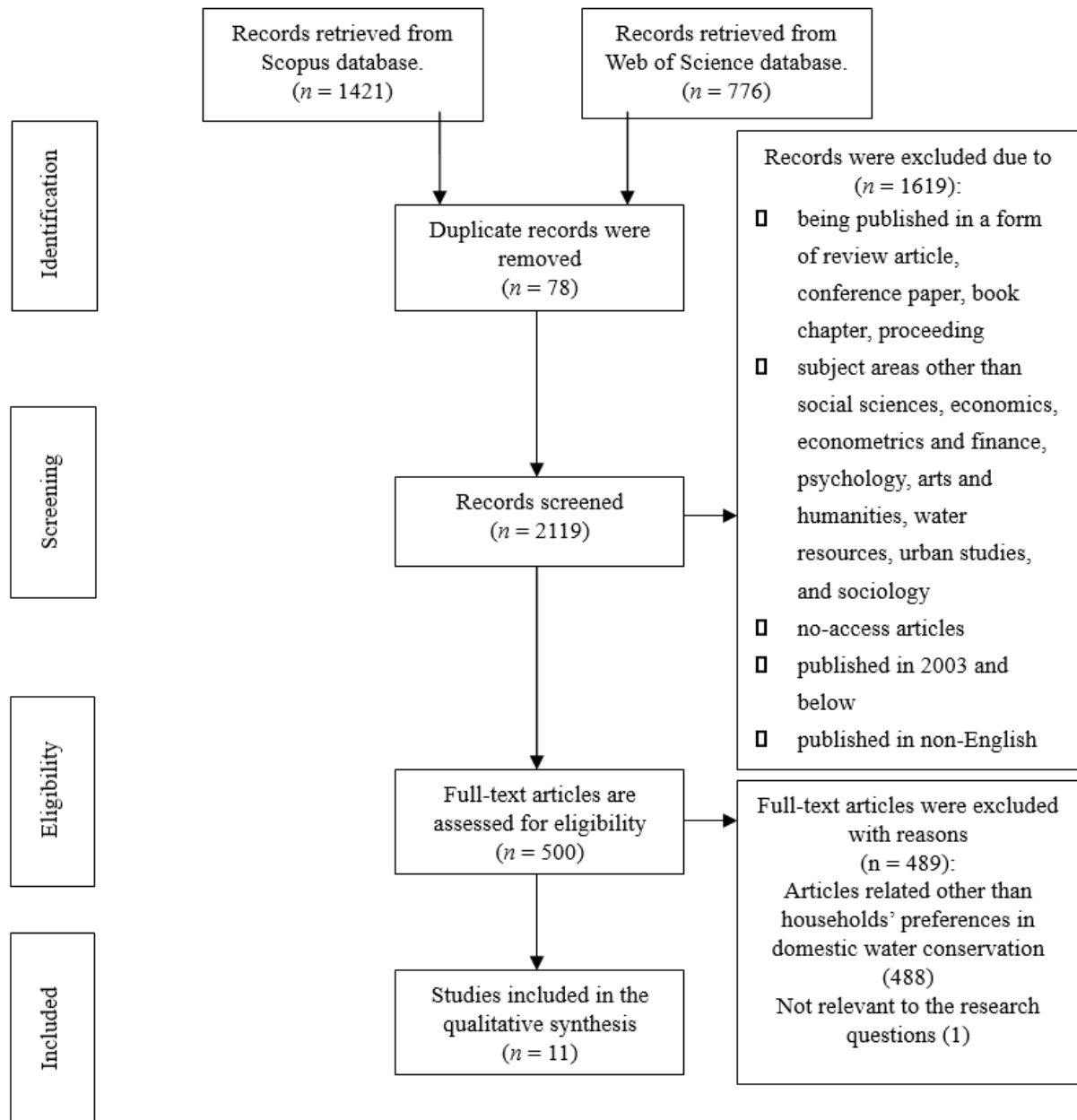


Figure 1. The Flow Diagram (adapted from Jamilah et al. [26])

Table 1. Search String

Database	Search String
Scopus	TITLE-ABS-KEY (("water conservation" OR "water-saving" OR "water saving*" OR "save water" OR "water efficient" OR "water efficiency") AND ("household*" OR "resident*" OR "residential") AND ("attribute*" OR "preference*" OR "benefit*" OR "characteristic*" OR "advantage*" OR "criteria" OR "strength" OR "interest*" OR "parameter*"))
Web of Science	TS = (("water conservation" OR "water-saving" OR "water saving*" OR "save water" OR "water efficient" OR "water efficiency") AND ("household*" OR "resident*" OR "residential") AND ("attribute*" OR "preference*" OR "benefit*" OR "characteristic*" OR "advantage*" OR "criteria" OR "strength" OR "interest*" OR "parameter*"))

## 2.2. Screening

Analysis of 2197 articles were proceeded through the screening process involving inclusion and exclusion of articles based on specific criteria. The initial step involved removing duplicate articles. Types of documents excluded from consideration included review articles, conference papers, book chapters, and proceedings. Only articles published in English were included in the study to avoid problems with translating the articles during systematic review analysis. Subject areas related to the study’s topic include social sciences, economics, econometrics and finance, psychology, arts and humanities, water resources, urban studies, and sociology. The study focused on a specific timeframe during the screening process starting from 2003 until 2023, spanning approximately 20 years (Table 2). The reason why it is needed to put a specific timeframe in conducting the review is to build a review on the recent literature related to households’ preferences of domestic water conservation besides limiting the search for a certain period of publication [28]. A total of 1697 articles were excluded due to not meeting the inclusion criteria, including duplicates, leaving 500 articles for the subsequent eligibility assessment process.

**Table 2.** The Inclusion and Exclusion Criteria of the Review

Criteria	Inclusion	Exclusion
Document type	Journal Article	Review article, conference paper, book chapter, proceeding
Subject areas	Social Sciences, Economics, Econometrics and Finance, Psychology, Arts and Humanities, Water Resources, Urban Studies, Sociology	Other than selected subject areas
Years of publication	2003-2023	2003 and below
Language	English	Other than English Language

## 2.3. Eligibility

Through this process, articles will be selected after careful consideration of their titles and abstracts, as well as a comprehensive review of the full text in order to identify those that align with specific objectives. Articles suitable for quality assessment in the subsequent phase will be segregated from those that do not meet the criteria or are

unsuitable for assessment. From a total of 500 articles, 488 articles were excluded due to their focus on topics such as water conservation in forest ecosystem services, water conservation through landscapes, sustainable river basin management and water conservation in agriculture. The remaining 12 articles have been earmarked for the subsequent phase of the review analysis.

## 2.4. Quality Assessment

Upon completion of the eligibility process, the chosen articles underwent an evaluation to ascertain their content quality and suitability for data analysis. The assessment was carried out in accordance with the established criteria of high-quality articles outlined in the protocol. Two experts in the field of water resources management independently reviewed the articles, assessing their ability to address the research questions [29]:

- QA1:** The households’ preferences for domestic water conservation.
- QA2:** The factors influencing households’ decision making to choose preferences for domestic water conservation.
- QA3:** The impacts of domestic water conservation preferences on households’ water consumption.

The remaining articles will be given the scores for each research question to identify whether the articles fulfill the assessment criteria [29]. The scores given as defined:

- Yes (Y)** = 1, if the information in the article could fully answer the research question
- Partly (P)** = 0.5, if the data or information in the article could answer the research question partially
- No (N)** = 0, if the data or information in the article could not answer the research question

The articles were assessed by experts who assigned scores indicating low, medium, or high quality in the quality assessment form [30]. After the experts evaluated the selected articles, the authors discussed with each other to resolve any inconsistency that exists between the two assessment forms. Additionally, a mutual agreement had also been made among the authors that at least medium- or high-quality articles are considered good quality and can be included in the review. This helps to improve the validity of the review findings by reducing individual review biases. Consequently, 11 articles, comprising 6 of medium quality and 5 of high quality, were chosen for the subsequent review process (Table 3).

**Table 3.** Related Findings in the Quality Assessment

List of Studies	QA1	QA2	QA3	Total Score	Inclusion in the review
Roman and Jiri [32]	Y	Y	N	2.0	√
Janine and Patrick [19]	Y	Y	P	2.5	√
Djiby et al. [33]	Y	Y	Y	3.0	√
Gloria et al. [18]	Y	Y	Y	3.0	√
Sorada et al. [34]	P	P	P	1.5	√
Isabel et al. [35]	P	Y	P	2.0	√
Xavier et al. [36]	Y	P	N	1.5	√
Gwendolyn et al. [37]	Y	Y	P	2.5	√
Ronald and James [38]	Y	Y	Y	3.0	√
Timothy and June [39]	Y	P	P	2.0	√
Jean and Kemi [40]	Y	P	N	1.5	√

\*Notes: QA = Quality Assessment; Y = Yes (1); P = Partly (0.5); N = No (0)

### 2.5. Data Abstraction and Analysis

The study applied a qualitative synthesis technique to analyze data from 11 selected articles that were relevant to the research questions. The qualitative data extracted from the articles were combined, evaluated, and summarized based on key points and information found. The data abstraction process involved reading the abstract, results and discussions to find information that could address the research questions. Thematic analysis was then used to identify themes and sub-themes based on the outcomes from the data abstraction. Information patterns were recorded and organized into themes and sub-themes to generate new interpretations of the data to answer the specified research questions.

An inductive thematic analysis approach was employed to allow the themes to emerge directly from the data using inductive coding. Following the process outlined by Hayrol Azril et al. [31], theme were generated by identifying patterns in the abstracted data. Similar data or information was grouped together to form themes. After re-examining and finalizing all themes and sub-themes, names or codes were assigned to the main and sub-groups of themes. The authors discussed the factors influencing the development of

themes and sub-themes, ensuring they were critically evaluated and properly justified through debriefing and external checking.

## 3. Results and Discussion

In a comprehensive thematic analysis of 11 meticulously chosen articles, a rich tapestry of 10 prominent themes surfaced, shedding light on the multifaceted landscape of water conservation. These encompassed a wide array of crucial aspects such as innovative water-saving technologies, impactful water conservation initiatives, the discernible influence of households' characteristics, intricate psychological factors at play, the powerful sway of media influence, tangible reductions in water usage, effective strategies for reducing households' water demand, the imperative nature of environmental protection, the significance of compliance with water conservation policies, and the substantial cost savings associated with water conservation efforts. Furthermore, an in-depth analysis unveiled a total of 14 sub-themes resonating across the selected articles, underscoring the intricate nuances of water conservation discourse.

Additionally, the publications encompassed a wide temporal spectrum, spanning from 2011 to 2023, with the distribution as follows: one article each in 2011, 2015, 2017, 2018, and 2019, two articles each in 2013 and 2021, and one article each in 2022 and 2023. Geographically, the studies provided a diverse global perspective, with four articles originating from the United States, and one from each of the following countries: the Czech Republic, South Africa, Chile, Australia, Colombia, Spain, and the United Kingdom, offering valuable insights into water conservation practices across different regions of the world.

Meanwhile, the review discovered that one study was conducted in Czech Republic, four studies were conducted in the United States, one study was conducted in South Africa, one study was conducted in Chile, one study was conducted in Australia, one study was conducted in Colombia, one study was conducted in Spain and one study was conducted in the United Kingdom.

### 3.1. Themes and Sub-themes

The review revealed 10 primary themes and 14 sub-themes that address the research questions: "What are the preferences of domestic water conservation among households?", "What factors influence households' decisions in selecting preferences for domestic water conservation?", and "What are the impacts of domestic water conservation preferences on households' water consumption?" The findings pertaining to these research questions are discussed in the following section (refer to Table 4 for details).

**Table 4.** Findings According to the Themes and Sub-themes

Authors/Themes	Water-saving technologies					Water conservation initiatives		Households' characteristics		Psychological factors					Media influence	Reduction in water usage	Reduction in households' water demand	Environmental protection	Compliance of water conservation policies	Cost savings
Sub-themes	EU	TF	FN	CO	SV	PR	PO	SE	SD	AK	TC	PE	AP	CM						
Roman and Jiri [32]	√	√						√	√	√	√				√	√			√	
Janine and Patrick [19]						√	√	√	√		√	√	√		√	√				√
Djiby et al. [33]	√	√		√				√	√	√									√	
Gloria et al. [18]		√	√		√			√	√				√			√			√	
Sorada et al. [34]		√	√	√				√					√							√
Isabel et al. [35]			√	√										√					√	
Xavier et al. [36]								√					√	√					√	√
Gwendolyn et al. [37]	√	√	√		√			√	√	√		√			√	√			√	√
Ronald and James [38]	√							√								√			√	
Timothy and June [39]							√	√	√	√			√	√				√	√	√
Jean and Kemi [40]							√	√		√		√	√							

EU = Ease of Use  
 TF = Technological Features  
 FN = Functionality  
 CO = Costs  
 SV = Savings in Water Bills  
 PR = Water Pricing  
 PO = Water Conservation Policies  
 SE = Socio-Economic Characteristics  
 SD = Socio-Demographic Characteristics  
 AK = Awareness & Knowledge  
 TC = Trust, Support, & Commitment  
 PE = Personal Experience  
 AP = Attitude & Perception  
 CM = Concern & Motivation

### **Research Question 1: What are the preferences of domestic water conservation among households?**

#### **3.1.1. Water-saving Technologies**

This theme encompasses five sub-themes: ease of use, technological features, functionality, the costs of water-saving technologies, and the amount of savings in water bills. The first sub-theme under water-saving technologies is ease of use. Ease of use attribute refers to the user-friendliness of the technology and whether it can be operated without the need of training [33]. Households prefer to adopt water-saving technologies that are easy to use and require significant time and effort to practice [32]. This indicates that users are concerned about the ease of use and level of difficulties associated with the technologies [33, 37]. There are different types of water-saving devices and appliances. Some require minimal time and effort to use, such as low-flow faucets, low-flow showerhead, and low-flow sprinkler nozzle. Others, such as rainwater harvesting, and greywater reuse systems require more time and effort to use. In South Africa, households often prefer devices and appliances that are low complexity to make their water-saving practices much more comfortable in terms of installation, use and maintenance [16]. This leads to increased self-confidence, feasibility and ease adoption of water-saving technologies.

The second sub-theme under water-saving technologies is technological features. Water-saving devices and appliances come in different sizes, appearances, technological lifespans, materials, and designs, allowing potential buyers to choose the device or appliance they prefer for water conservation [17]. Households prefer devices or appliances with a longer lifespan, so they can use water-saving technologies for an extended period [33]. In addition to lifespan, households also consider the colour and smell of purified water or greywater system when reusing water [18, 33]. Due to potential health effects of reusing or recycling water, households prefer recycled or purified water that is clean and hygienically safe [32]. They are aware of the possibility of waterborne disease when in contact with wastewater [33]. Another consideration for water-saving technologies is the size, material and design of a device, appliance or system that can be installed around their house [34]. High-quality and durable material for rainwater tanks, such as polyethylene with slimline design, are preferred by households for water conservation [34]. Additionally, households look for an Energy-Star or Water-Star rating label on the water-saving products before installing them to ensure the products are highly water efficient [37]. The higher the number of stars in the rating, the greater the water efficiency of a product.

The third sub-theme related to water conservation technologies focuses on their functionality. Households consider the purpose of water-saving technology before adopting it. Different types of water-saving technologies serve different functions, aiming to make water conservation easier for users [16]. For example, water from

rainwater harvesting and greywater reuse system is used for various indoor and outdoor activities such as toilet flushing, garden irrigation, washing clothes, washing hands, showering, watering the plants and laundry [18, 34, 35]. Some households prefer to use recycled water from greywater and rainwater for outdoor purposes only [34]. However, households are less inclined to reuse water for drinking due to health concerns and they prefer clean water for drinking or cooking [18]. The preference for using water-saving technologies depends on water quality, especially from rainwater harvesting and greywater reuse systems [18]. This indicates that water recycling serves multiple purposes for indoor and outdoor water usage, except for drinking, as households consider water quality and hygienic factors. For other water-saving appliances such as water-efficient washing machines, households consider the gentleness of clothing and the machine as it uses less water, and the process depends on whether it is a top-loading or front-loading washer [37].

The fourth sub-theme relates to the costs of water-saving technologies. Cost is a key factor that one of the households consider when adopting water conservation at the domestic level. Before deciding to adopt water-saving technologies, they take into account the purchasing cost, the cost of installing the device or appliance and maintenance cost in case of malfunctions [16, 17]. Djiby et al. [33] found that the average cost of purchasing the technology is about R9732.00, which is still affordable and significant reflecting households' willingness to purchase affordable technologies to prevent water crisis in their area. Sorada et al. [34] revealed that households were willing to pay about \$2300 for the cost of purchasing and installation of rainwater tank and would pay an extra 11 cents for every additional litres of tank volume. Some households preferred to have both greywater and rainwater systems, which have a higher cost than one of the systems alone. Isabel et al. [35] discovered that households preferred to install both greywater and rainwater systems in their home which have a higher cost (\$1041) than installing one of the systems which has a lower cost (greywater - \$524 and rainwater - \$533). This suggests that households aim to maximize water and cost savings in the future, even though they need to invest more money in water-saving technologies to prevent water scarcity.

The final sub-theme under water-saving technologies focuses on the amount of savings in water bills. Using water-saving technologies can reduce the costs of water bills and support households water savings [41]. Households are often seeing the potential of using water-saving technologies by looking at their ability to help them reduce their costs of water bills so that they can cut their expenses for their utility supplies [16]. Based on households' experience of using water-saving technologies, about 10 to 30% amount of savings in water bills are gained and they are preferred to have this range amount of savings [18]. This shows that households are willing to adopt water-saving technologies and prefer to purchase water-



saving devices and appliances that offer a certain amount of savings in water bills compared to normal water devices or appliances. Gwendolyn et al. [37] found that households prefer energy and water efficient washing machines, which can lead to substantial energy and water savings. By benefiting from these improvements, households can reduce water consumption, particularly for multiple loads of laundry per week. The costs of the utility bills including water and energy cost, can decrease by \$242 to \$408 per year after replacing regular water appliances with more ones [42].

### 3.1.2. Water Conservation Initiatives

The second theme regarding domestic water conservation preferences focuses on water conservation initiatives. These initiatives can help to manage domestic water demand through policies that restrict water usage. Implementing these initiatives aims to prevent excessive water consumption and its negative impact on the availability of freshwater resources for the future. The subthemes under water conservation initiatives include water pricing and water conservation policies.

The first sub-theme regarding water conservation initiatives involves water pricing. Water pricing is a method used to manage water demand through water infrastructure [12]. Access to clean water requires substantial investment to cover costs such as water extraction, treatment, distribution through pipes, and maintenance [43]. Even though water is a free resource, it should not be used without considering water usage to prevent water wastage. Implementing water pricing can make households more aware of their water consumption and encourage them to practice water conservation [43]. Preferences for water pricing vary depending on households' socio-economic backgrounds. Low-income households that use less water prefer to use water at a uniform rate, while high-income households that use more water prefer to use water at an increasing block rate [38]. Janine and Patrick [19] discovered that households preferred a certain amount of base charge (fixed fee) on water bills which increases by \$15.00, and the marginal price of water must be increased by 30%. What can be seen from this preference is that households prefer water prices that is within their budget and not too high unless the households are from higher income levels.

The second sub-theme is related to water conservation policies. These policies are being developed to provide initiatives for water consumers to encourage water consumers to conserve water. The policies prepared by local governments to help households control water usage and reduce their water demand such as the infrastructure for water-saving technologies, water restrictions and water usage information through water bills. The preferences of water conservation policies have been ascertained from a study by Timothy and June [39] that households' main preference of water conservation policy is updating building codes to mandate technologies and second most

preferred is subsidies for water-saving technologies. Building codes for water efficiency requirements is a legislative approach to improving water conservation in residential and commercial buildings [44]. This preference shows that households are more likely to adopt water conservation practices if building codes and requirements are updated to include the latest information about water conservation measures. Subsidies for water-saving technologies are preferred by households, which explained that households do have the intention or desire to adopt the technologies if the water management company offers financial assistance to purchase and install less expensive water-saving technologies at home [45]. Additionally, households prefer water restrictions to reduce water consumption by 15%, particularly during drought [19]. This shows their awareness of water scarcity and their efforts to save water. It is also an action in response to the drought which has happened in South Africa during Day Zero. They also prefer better water consumption information in their water bills to stay alert about their monthly water usage [40].

### **Research Question 2: What are the factors influencing households' decision making to make choices for domestic water conservation?**

#### 3.1.3. Households' Characteristics

Household characteristics play a significant role in influencing the decision-making process when it comes to water conservation preferences. These characteristics can be categorized into two main types: socio-economic and socio-demographic. Socio-economic characteristics include factors such as income, occupation, and education, while socio-demographic characteristics encompass aspects like age, gender, and race.

Research findings have consistently highlighted the significant impact of socio-economic factors on the decision-making process for water conservation preferences. Household income has emerged as the primary influencer in shaping these decisions, as indicated by several studies [18, 19, 32, 33, 34, 37, 38, 39]. Moreover, educational attainment has also been identified as playing a crucial role in influencing households' choices regarding water conservation, as evidenced by research findings [18, 19, 32, 33, 36]. Other factors that influence households' decision to choose their preference of water conservation practice are household occupation and percentage of household members under unemployment or retirement [32, 34, 36], house size or property [32, 34, 38], property value [38], ownership status [40], water bills amount [33], household size [40] and type of residence [32].

Various factors are important in determining which water conservation preferences households might choose. Households take into account variables such as income, educational level, occupation, and others, when deciding on their preferences. The current socio-economic status of a household can lead to different results in terms of their

willingness to pay for water conservation, their level of appreciation, and their valuation of water resources [11, 46, 47]. For instance, households with lower household income may prefer lower price to purchase water-saving technologies and lower water restrictions, in vice versa, higher household income may prefer higher price to purchase water-saving technologies and be comfortable with higher water restrictions.

The second sub-theme is related to socio-demographic characteristics. The age of households plays a major role in their decision-making process when choosing their water conservation preferences [18, 19, 32, 33, 37, 39]. On the other hand, gender also has a strong and significant influence on households to decide which water conservation practice is more suitable and easier to implement by themselves [18, 19, 32, 33]. These results explained that age and gender are the most dominant socio-demographic characteristics that contributed to households' decision-making for water conservation preferences. Both characteristics are associated with households' physical capability to contribute to and participate in water conservation. The higher the capability of a person to practice water conservation, the higher the confidence to decide their preferences of water conservation.

#### 3.1.4. Psychological Factors

Household's preference of water conservation practice is influenced by psychological factors, which is the second theme related to the decision-making process. These psychological factors serve as indicators to study the drivers and barriers that influence households to practice water conservation. This is related to personal attitudes, perceptions, and knowledge towards water conservation that can potentially change people's behavior to adopt water conservation in their homes. This plays a significant role in developing sustainable water management policies to encourage households to save water, including public acceptance of water-saving methods or programs. There are several subthemes found in this review to explain the factors influencing households' decision-making for water conservation preference in terms of psychological behavior.

The first sub-theme under psychological factors is water conservation awareness and knowledge. One of the psychological factors that affect households in choosing their preference of water conservation is their awareness and knowledge about water conservation. They tend to choose their preference for water conservation because of their experience managing their water resources during drought [33, 39]. In addition to experience, households' decision to choose water conservation preference is influenced by their awareness of water conservation alternatives and technologies [40]. It is also important for households to choose their preference if they have knowledge about water conservation, especially on how to adopt water conservation and the benefits of using water-saving devices and appliances to save water [32, 37]. Households' awareness and knowledge are essential when

making decisions about consumption and how they are going to manage the resources in any type, whether it is related to water or energy resources. Previous studies have discovered that higher awareness and knowledge could change their behavior in water usage because they understand the risks of water scarcity and the benefits of adopting water conservation practices [48, 49, 50].

The second sub-theme under psychological factors is households' trust, support, and commitment. The people who are familiar with or closer to the households such as family members, friends and relatives tend to build changes in households' decision-making of water conservation preferences [51]. This is because they have put trust in the closest people including the person who has a great influence on the community such as influencers or public figures [32]. When water conservation policies and regulations are introduced early, households become familiar with them, which then strengthens their support and commitment to comply even after the regulation have been removed, [19]. The support and commitment of households to adhere to the policies and regulations can affect their choice of water conservation practices [51].

The third sub-theme is related to households' personal experience. Preferences of water conservation chosen by the households are based on their experience of drought in terms of the way they manage their water resources in their homes and the difficulties in handling or using limited water resources at that time [19]. Similarly, a study by Jean and Kemi [40] found that water consumption experience could influence households' decision-making process in choosing water conservation preference. The experience of using water-efficient appliances is also being considered by households to choose the preference of water conservation [37]. This could help the households to use water-saving appliances and their features more easily and water usage becomes more efficient compared to using a normal water appliance. Drought and water scarcity experience can build their self-action to be more committed and actively conserving water whatever they can for building resistance towards water scarcity and climate change.

The fourth sub-theme is related to households' attitudes and perceptions of water conservation. Water conservation attributes chosen by the households are determined by their water consumption attitudes and beliefs towards drought and water conservation policies [19]. Additionally, households' attitudes towards using water-saving technologies can influence their decisions regarding water conservation preferences, based on their experiences with practicing water conservation [18, 34, 36]. This can lead to behavioral changes, influencing whether they prefer traditional or modern water-saving methods [39]. Furthermore, water users' attitudes vary depending on geographical areas, such as rural and urban areas, in terms of their consumption practices and adoption of technologies [40]. The perception of water conservation among consumers can alter their views regarding the preferred potential benefits in terms of water usage and

health risks [36, 40]. Households' attitude and perception are influenced by the culture surrounding, rational opinions and emotion that improve the households' adoption of green practices and the feeling of social responsibility to protect water resources [45, 52].

The fifth sub-theme regarding psychological factors is households' concern and motivation. Households' concern is related to the environment where water conservation provides benefits by protecting the environment through conserving the current water resources available [35]. They tend to be more concerned about water conservation when natural disasters happen such as drought or flooding [39]. Hygiene is the most concerned by households especially when using greywater reuse and rainwater harvesting systems [36]. In addition, personal motivation to conserve water could help choosing water conservation preference if this preference can lower their water bills [39]. These findings show that households' concern is associated with the impacts of water scarcity, environment, and climate change. Households' awareness of these impacts tends to change their water consumption and bring motivation for them to contribute to protecting the availability of water resources by practicing water conservation.

### 3.1.5. Media Influence

The influence of media is the third theme regarding the factors influencing households' decision-making towards water conservation preferences. Mass media plays a major role in quickly and effectively conveying information to the audience. In today's digital age, there are numerous platforms that people use to stay updated on current events, including social media, newspapers, and television. In the scope of environmental issues, water supply is one of the issues related to environment which has been in the media for a long time [53]. This could influence the households as the viewers in shaping their attitudes and mindset towards water conservation preferences since they watch the media every day [32]. Advertisement and news coverage are the primary media sources that influence households' decisions about water conservation preferences [19]. Information available on the internet, such as consumer advice websites and manufacturer websites, can also guide households in making decisions about water conservation, particularly in relation to water-saving technologies [37].

**Research Question 3: What are the impacts of domestic water conservation preferences on households' water consumption?**

### 3.1.6. Reduction in Water Usage

Water conservation preferences can effectively reduce household water usage by practicing water-saving steps and changing water habits [32]. For instance, households can conserve water by refraining from filling and watering lawns, swimming pools, and garden pools during droughts, as these activities require significant amounts of water [32].

In addition to water conservation practices, implementing water conservation policies can reduce water consumption by about 30% [19]. These policies are developed by considering the availability of freshwater in the area, the amount of water usage, and consumer welfare among households in order to control water consumption during certain circumstances such as high population and drought events [45]. The preference for adopting water-saving technologies can increase the recovery of mains water consumption by up to 50% and increase the acceptability of using water-saving technologies by 18.7% for indirect uses and 18.9% for direct uses [18]. Importantly, using water-saving technologies can save both water and energy consumption [37]. Water tariff preference can also help in controlling households' water usage to prevent water resources from being overconsumed [38]. These water conservation attributes will indirectly influence the actual water consumption patterns caused by the actions taken to cut down their daily water consumption and conserve more water.

### 3.1.7. Reduction in Households' Water Demand

Water demand is a crucial aspect of managing water resources to make sure that every household gets easier access to water supply and fulfills their basic needs. However, the continuous increase in water demand leads to higher water usage, which can result in overconsumption [54]. Since water resources are limited, water conservation preferences are effective in reducing households' water demand for preventing water crisis. Not only can water conservation help households to save money on water bills, but it also provides mitigation strategies to encounter water scarcity especially during drought events [33]. Additionally, water conservation attributes can reduce the demand for drinkable water, so that it can bring more savings on potable water [35].

### 3.1.8. Environmental Protection

The impact of water conservation preferences by households can give a huge advantage on preserving the environment since the environment would get affected by humans' increasing water consumption. When households decide to adopt water conservation, they may help to increase environmental preservation by decreasing the impacts of climate change such as droughts and water scarcity [32]. Households that possess a solid understanding of the importance of water conservation and demonstrate responsible water usage are more inclined to prioritize and actively engage in water-saving practices for the explicit purpose of safeguarding the environment [18, 36, 39]. They are attuned to the long-term benefits associated with water conservation, recognizing its role in ensuring the sustained replenishment of freshwater resources and upholding a pristine environment.

### 3.1.9. Compliance of Water Conservation Policies

Water conservation policies and regulations are one of

the initiatives to encourage households to adopt sustainability in water management. The preferences of water conservation in forms of policies and regulations are usually chosen carefully because these policies and regulations considered are related to their welfare and willingness to pay certain amount of money to gain benefits from water conservation [51]. By choosing specific water conservation measures, households can help to reduce overall water consumption by following government guidelines [19]. Policy makers have also worked on promoting the adoption of water-saving technologies by offering a range of water-efficient appliances and alternatives. This gives households the freedom to select the technologies that best fit their needs and contribute to greater water savings [36, 37]. When it comes to water restrictions, most households prefer to have minimal impact on their water usage, particularly during drought conditions [34]. However, some households, especially low-income or average households, are not comfortable with more stringent water restrictions. For instance, they may prefer uniform water rates (UR) over increasing block rates (IBR), which are favored by high-income households [38]. Despite this, average households are willing to invest more in water conservation if the costs align with their budgets [39].

#### 3.1.10. Cost Savings

The adoption of water conservation provides cost savings on water bills and is cost-effective in terms of the cost for installation, maintenance, and long-term investment [18, 35, 36]. Households' preferences of water conservation technologies such as higher cost-savings in the water bills and energy bills and cost-effectiveness will increase their motivation to reduce their water consumption [39]. The decision to choose the preference depends on the frequency of doing household chores [37]. For instance, households prefer to adopt water-efficient washing machines because they do more loads (4 to 7 loads) per week which increases their sensitivity towards water and energy concerns. This highlights the fact that the benefits of water conservation can attract and encourage households to save more water and reduce water consumption.

## 4. Recommendations for Future Studies

In this study, several recommendations for future water conservation studies are highlighted. The United Nations predicts that by 2050, 87 out of 180 countries will experience a decrease in renewable freshwater resources, potentially leading to the ability to supply only 1700 m<sup>3</sup> of water per person per year. This is concerning as household water usage worldwide exceeds the recommended amount of 165 litres per day set by World Health Organization (WHO) [5]. To address this issue, various water conservation activities and programs, such as such as

water-saving technologies, water pricing and water conservation policies have been implemented. Additionally, water education programs and awareness campaigns are effective to provide a better understanding of the importance of practicing water conservation at the household's level. However, the review suggests that households show less interest in selecting their preferences of water education and awareness campaign. This matter has not been discussed further since there are lack of studies related to the preferences of water education and awareness campaign activities. It must be noted that water education program and awareness campaign could reduce water consumption from 4 to 8 percent and up to 19 percent [55, 56]. The review suggested that there should be more studies which need to be carried out about water conservation preferences towards water education and awareness campaign to gain more knowledge and a deeper understanding about households' preferences of other water conservation activities.

Aside from that, the systematic review also suggested that further studies need to be discovered which are related to households' preferences of water conservation among countries in the Middle East, Central Asia and Southeast Asia region. It is important to conduct these studies in these countries because Middle Eastern countries face extremely high baseline water stress and have low water resources availability as seen in UAE, Kuwait, Saudi Arabia, and Egypt [4, 57, 58]. Additionally, Central Asian and Southeast Asian countries such as China, India, Malaysia, and Singapore suffered from groundwater overexploitation and overconsumption due to receiving a substantial amount of rainfall which generates to renewable water resources due to its hydrological cycle, depending on the climate conditions [59]. Therefore, it is necessary to investigate households' preferences for water conservation to understand their willingness to change water usage habits and what alternatives they would consider if water conservation programs were implemented in their area. According to Felipe et al. [60], existing studies have not provide sufficient explanation and understanding regarding effective water conservation alternatives, whether they involve price or non-price mechanisms to enhance sustainability in water management and potentially change households' water usage habits to save more water by adopting these alternatives.

## 5. Conclusions

The aim of this study is to systematically review the previous studies related to households' preferences for water conservation in order to gain a better knowledge of how households choose their preferences of water-saving options. The review's findings will be used to address research questions about households' water conservation preferences, the factors influencing their decisions, and the effects of these preferences on their water consumption.

The study found that households generally prefer water-saving technologies, as well as water conservation initiatives such as water pricing and conservation policies. Households' choices regarding water conservation are influenced by their socioeconomic and sociodemographic characteristics, psychological factors, and media influence. Water conservation preferences can impact households' water usage by reducing water consumption, improving environmental protection, encouraging compliance with water conservation policies, and leading to cost savings. This study is intended to offer ideas and suggestions to policymakers and stakeholders, helping them develop strategies to encourage community participation in water conservation efforts.

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