

Recycled water for non-potable use: Understanding community perceptions and acceptance in Malaysia

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ABSTRACT

Sustainable water supply is one of the key issues for water resources management. The future demand for clean water is putting pressure on the Malaysian government to find alternative supplies and best management practices in managing water resources, such as the use of reclaimed water. This paper evaluates the perceptions and acceptance of the use of treated water for non-drinking purposes in Malaysia from the responses of 1,004 participants. The results show that age and level of education play an important role in the level of community acceptance. Females tend to be more selective than males in their acceptance to use reclaimed water. To guarantee that the public receives accurate information about reclaimed water, social media can be used for disseminating information, especially to younger generations.

Key words: Climate change, Non-potable use, Public acceptance, Reclaimed water, Water consumption

HIGHLIGHTS

- Reclaimed water is one of the options to reduce the impact of climate change.
- High levels of daily water consumption give impact dependence on clean water in the future.
- The level of education is able to influence the community's acceptance of using reclaimed water.
- Water supply disruptions cause consumers to seek alternative ways, such as the use of reclaimed water.
- Social media help in imparting information.

1. INTRODUCTION

One of the main challenges in water resources management is to ensure the continuity of water supply with sufficient water quantity and quality that is acceptable to consumers. With climate change-induced water scarcity, booming development, and advanced technologies, the increasing water demand is putting a strain on the existing water resources. According to the Malaysian Water Association (MWA, 2018), Malaysians consume an average of 201 L of water per person per day, comparable to 134 bottles (with a capacity of 1.5 L each), which is greater than the World Health Organization (WHO) recommended daily intake of 165 L per day. Furthermore, the domestic daily demand in Malaysia is significantly higher than that in neighbouring countries. In comparison, Singaporeans consume an average of 141 L per person per day (PUB, 2018), while Thais consume up to 193 L per person per day (Kamaruddin, 2020). With the growing population in Malaysia, an increase of 0.4% from 32.62

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million for the same period in 2020 (Department of Statistics Malaysia, 2020), the high future demand for clean water resources is putting pressure on the government to find alternative sources and best management practices to manage water resources.

Increased focus on future water security among Malaysians plays a critical role in reducing water consumption, which poses a challenge as the society feels comfortable, because Malaysians believe there are abundant water resources. This is supported by the fact that Malaysia experiences humid tropical weather throughout the year and the annual rainfall ranges between 2,000 and 2,500 mm (Department of Information Malaysia, 2016). Climate change will have an impact on water resources by affecting the precipitation quantity, variability, timing, form, and intensity. While rising evaporation rates are expected to lower water availability in many areas, climate change-induced more frequent and severe droughts may have substantial management consequences for water resources (Adams & Peck, 2008). Global climate change has also been a contributor that will further accelerate the water supply crisis in the country (Man *et al.*, 2014).

One of the alternatives that can be practiced is to use reclaimed water. Water reuse entails repurposing cleansed wastewater for usable purposes, which enhances the water supply for a community making it more reliable, especially during droughts (National Research Council, 2012). In line with industrial terminology, we will use reclaimed water in this paper instead of recycled water, although both share the same meaning. The usage of reclaimed water is an effective choice worldwide for the conservation of water resources, which reduces effects on the environment in addition to reducing the expenses and energy needed for water source management (Takeuchi & Tanaka, 2020).

Awareness of the use of reclaimed water in Malaysia is receiving more attention, especially from the relevant authorities. Several projects have been established to encourage the use of treated reclaimed water for non-potable use to secure the availability and long-term management of water and sanitation for everybody. The cooperation established between the Indah Water Konsortium (IWK) is responsible for managing wastewater with the state water body to supply reclaimed water to industrial users in Selangor, Kuala Lumpur, and Putrajaya. IWK together with the Ministry of Environment and Water (KASA) is developing a water rehabilitation initiative as an alternative source for the country through the Green Technology Master Plan 2017–2030 by reusing 33% of the total treated wastewater for various purposes that can benefit all Malaysians.

Providing reclaimed water comes with numerous demanding factors including costs, complex treatment procedures, and stringent rules, which the government is working to overcome. Producing reclaimed water can be difficult, but with the evolution of technology, water treatment is becoming less expensive, simpler to process, more accessible, and more acceptable within the community. Several Asian countries have successfully implemented the use of reclaimed water for potable and/or non-potable use such as Singapore and Japan. In Japan, the usage of reclaimed water for purposes apart from drinking has been applied in various towns since 1980, especially for toilet flushing and irrigation (Takeuchi & Tanaka, 2020).

Singapore was the first country to utilise NEWater, the potable, high-grade reclaimed water that passed the necessary scientific tests and meets the requirements of the WHO. Singapore has had one of the most successful experiences with NEWater in the world. Prior to the launch of NEWater, there were extensive data, communication, and training efforts that impacted a wide range of people: decision-makers who needed long-term protection and reliability; the general public who needed to deal with potential concerns; industries that would be potential consumers; and the media (Tortajada & Nambiar, 2019). The commitment of NEWater to self-sufficiency and national security is one of the reasons why it is so well-liked among Singaporeans (Tortajada *et al.*, 2013). The successful use of reclaimed water depends on community acceptance (Buyukkamaci & Alkan, 2013). Considering the success of Singapore, numerous studies have been conducted to assess the local public's acceptance of using reclaimed water.

Baghapour *et al.* (2017) conducted a study in Shiraz, Iran, to examine the public acceptance and attitudes of residents towards reclaimed wastewater. They found that public consumption of treated wastewater for landscape, park irrigation, and firefighting had the highest acceptance with 87%, vehicle washing (85%), and tank flushing (80%), respectively. At 8%, cooking and drinking are related to the lowest level of acceptance. Furthermore, there was a substantial link between the desire to use reclaimed wastewater, education, gender, knowledge of the wastewater treatment procedures, and knowledge of the high quality of reclaimed wastewater.

Malaysia could utilise reclaimed water for non-potable use in the future. However, if the community is not exposed to the significance of the usage of such water and assumes that the supply of clean water is enough, Malaysians may be reluctant to consider the usage of reclaimed water. Comments from the community on the acceptance of reclaimed water may be used as a benchmark for future planning concerning its usage for non-potable purposes avoiding indirect or direct difficulties in quality determination and public perception issues (Lazarova *et al.*, 2003).

The achievements of Singapore and Japan in implementing the usage of reclaimed water may serve as a guide for Malaysia. Proactive measures need to be taken earlier than the implementation of the usage of reclaimed water to secure community acceptance. An understanding of the main concerns and questions concerning reclaimed water may help determine the information individuals need. Recognising this, the study focuses on the perception and acceptance of the community in Malaysia regarding the usage of reclaimed water for non-potable uses and identifies the key parameters to increase the level of acceptance.

2. METHODOLOGY

2.1. Surveys

A set of questionnaires was created using the Google Form application that can be easily distributed and is easy and safe to complete considering the restriction of movement imposed due to the COVID-19 pandemic. We targeted Malaysian respondents from diverse backgrounds to evaluate the general level of acceptance of recycled water. The questionnaire was divided into four sections (i.e. A, B, C, and D). A total of 1,004 respondents completed the questionnaire.

Section A (Demographic information) was created to gather information about the socio-demographic backgrounds of the respondents, including gender, age, religion, educational history, profession, years of residence in the area, and number of family members. Section B (General information) comprised five questions with three preference answers, designed to determine what the communities realise about the wastewater treatment process, and problems associated with water supply in Malaysia. This section also included the level of daily water consumption for which the following three options were provided: low (1), medium (2), and high (3).

Section C (Level of acceptance of the use of reclaimed water) was designed to measure the acceptance of the use of reclaimed water and allow respondents to determine the suitability of using reclaimed water for non-drinking usage such as toilet pumps, cleaning purposes (e.g. household cleaning), as well as savings for emergencies. A Likert scale was applied to assess the level of acceptance of reclaimed water for non-potable use (where 1 = most unacceptable; 2 = unacceptable; 3 = neutral; 4 = acceptable, and 5 = most acceptable). The questionnaire also explored the attitudes of the respondents towards the benefits of using reclaimed water to determine effective methods to expose the community to such usage through social media, television, and newspaper articles.

Section D (Primary problems of using reclaimed water in the community) was designed to select the factors that are most likely to influence their level of acceptance as well as solutions to modify the perception of reclaimed water. To facilitate the completion of this questionnaire, the definition of reclaimed water was included.

2.2. Statistical analysis

Descriptive, correlation, and regression analyses were used to analyse the data. Correlation coefficients defined the strength and direction of a relationship between two continuous variables, whereas regression analysis used a model to define the relationship between the dependent and independent variables in a simplified mathematical form (Schneider *et al.*, 2010). The p -values < 0.05 were considered statistically significant (Shan & Gerstenberger, 2017).

2.3. Qualitative data analysis

Qualitative methods (i.e. interviews) can offer a deeper understanding of social phenomena than could be acquired from purely quantitative methods (Henderson, 2011). Apart from collecting information based on questionnaires, an interview was also held to obtain views from those who manage the treatment and supply of reclaimed water in the industrial sector in Malaysia. According to Gill *et al.* (2008), the purpose of research interviews is to discover the perspectives, reviews, ideals, and motivations of people on specific topics consisting of acceptance of the communities in the use of reclaimed water.

The interview was attended by the IWK and Air Selangor Sdn Bhd, the state water body. The questions asked in the interview were more towards understanding the readiness and challenges faced by both companies towards the adaptation of reclaimed water for industrial applications. The interviews evaluated the current developments on reclaimed water supply projects as well as the response from the industrial sector to the use of the water. Cooperation was arranged between IWK and Air Selangor to establish the Central Water Reclamation Sdn Bhd (CWR). IWK plays a role in supplying treated bio-effluents to CWR, while Air Selangor produces reclaimed water that is treated and used safely in the industrial sector. Moreover, Air Selangor also has the role of distributing reclaimed water through a special distribution network.

The interview session discussed the preparations for the future and initiatives to promote reclaimed water. We also evaluated how reclaimed water helps the industry save energy and reduce dependence on clean water while planning to use reclaimed water for non-potable purposes involving the community in Malaysia.

3. RESULTS AND DISCUSSION

3.1. Demographic information

Demographic data obtained from the questionnaire can be seen in Figure 1. The percentage of male respondents is higher than that of females (69% compared to 31%, respectively). Almost 83% of the respondents are Muslims. The majority of the respondents are within the age group of 40–49 years (36%) followed by the age groups of 30–39 years, 50 years, and above. In addition, approximately half of the respondents have a degree and above and approximately 63% work in the private sector, followed by the government sector.

For the period of residence, more than half (57%) of the respondents have lived in Malaysia for 10 years and above. In addition, the number of family members for approximately 72% of the respondents is 0–5 and the remaining 28% corresponds to six people and above. This demographic data is an important element that can be used to determine the acceptance of the usage of reclaimed water for non-potable use inside the community in Malaysia.

3.2. General knowledge

The general knowledge of wastewater treatment, the use of reclaimed water, as well as the efforts made to obtain information on water-related problems is medium level. Results indicate that there are certain groups within the communities that either have no interest or are not aware of the current water issues and developments as only 58% of the respondents have some knowledge about the use of reclaimed water. More efforts are needed to spread information to the general public as the effectiveness of reclaimed water use is directly tied to the acceptance and awareness of communities (Baawain *et al.*, 2020).

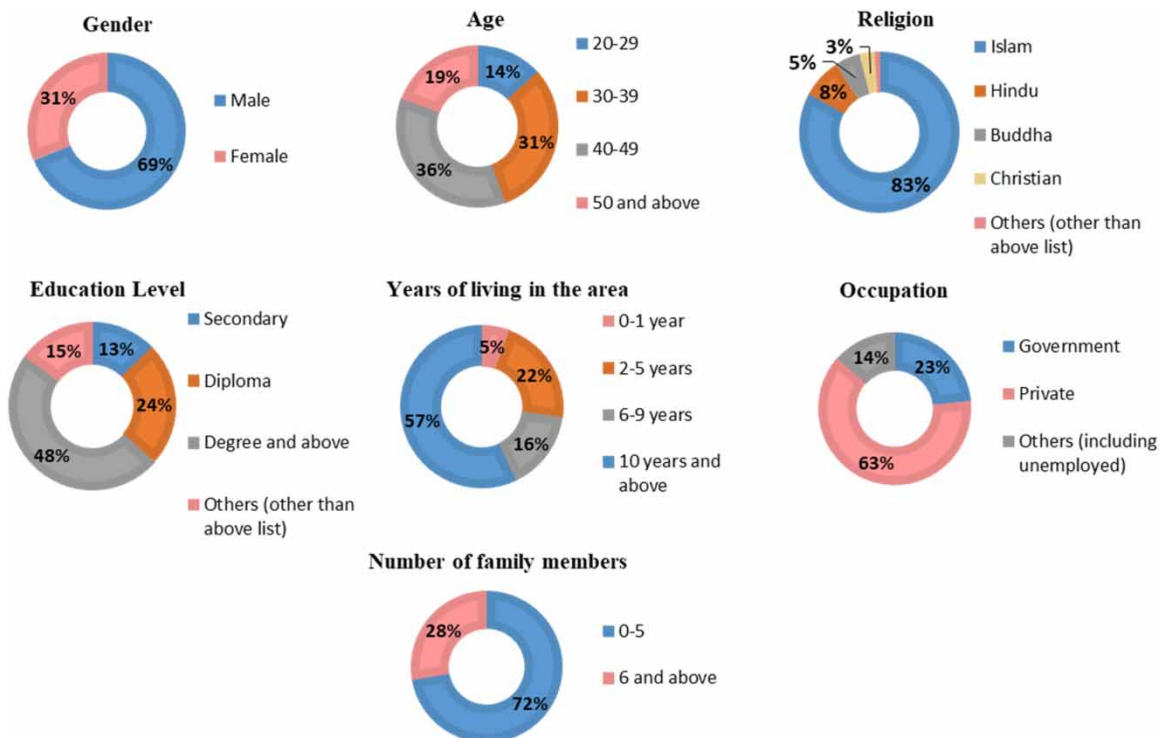


Fig. 1 | Demographic information of respondents.

Based on [Figures 2 and 3](#), gender has a significant relationship with the knowledge of wastewater treatment and also knowledge of utilisation of reclaimed water (p -values < 0.05), with males having a higher level of information compared to females. [Hayes \(2001\)](#) highlighted some discrepancies concerning various studies, where men are more concerned about the environment than women, whereas women can be more concerned about the environment but only in relation to a narrow range of risk-related environmental issues, and still other studies show no significant differences.

The respondents with higher educational backgrounds have a greater understanding of the benefits and disadvantages of reclaimed water. However, only gender is significantly correlated with general knowledge, while age and educational background are not significant. [Kaplowitz & Levine \(2005\)](#) found a positive association between the level of education, the field of study, and the level of environmental understanding among university students and the general public.

Building trust and credibility reserves with the public and depending on those reserves when needed is a good idea ([Hartley, 2006](#)). Therefore, the use of reclaimed water may be concentrated in urban areas to build their trust and level of acceptance before being implemented in rural areas. This is because rapidly developing urban areas, as well as being a focal point involving working and educated people, will help to increase their level of knowledge and acceptance. This is in parallel with the early behavioural models of [Kollmuss & Agyeman \(2002\)](#), who demonstrated a linear relationship between knowledge, awareness, and attitudes, as well as behaviours towards the environment. According to this model, supplying knowledge will increase awareness and attitudes, and in turn will increase the number of individuals who have more positive behaviours towards the environment.

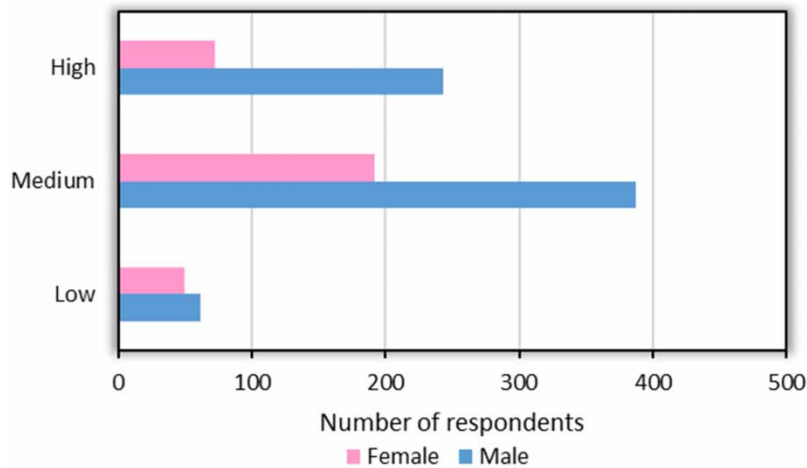


Fig. 2 | Knowledge of wastewater treatment in Malaysia against gender (p -values < 0.05).

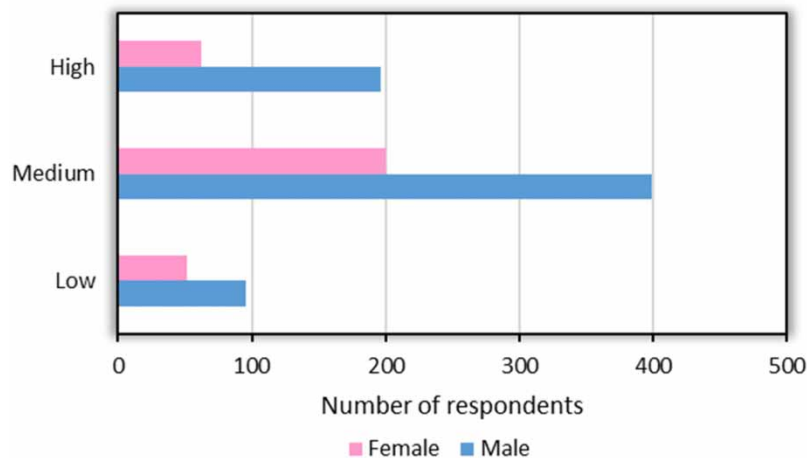


Fig. 3 | Knowledge of utilization water for non-potable use against gender (p -values < 0.05).

3.3. Level of daily water consumption

The Malaysian Urban–Rural National Indicators Network for Sustainable Development specifies three categories of daily domestic water consumption standards in Malaysia, which are low (≤ 165 L/cap. day), medium (166–200 L/cap. day), and high (≥ 201 L/cap. day). Figure 4 shows that the level of daily water consumption is at a medium level (69%), while consumption at high and low levels is at 16 and 15%, respectively. Based on these standards, most of the respondents use approximately 166–200 L/person in a day, about the national daily average domestic consumption at 201 L/cap. day.

On the other hand, the level of daily water consumption increased not in parallel with the increase in age (p -value < 0.05 , Figure 5). This means that younger generations (aged 20–29 years) may contribute more to the increased level of daily water consumption compared to that older respondents (aged 50 years and above).

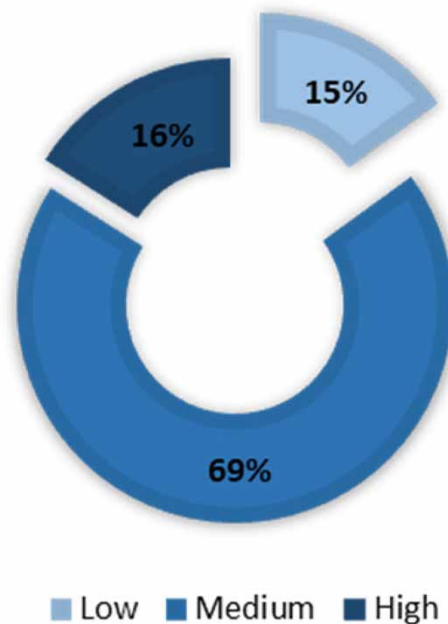


Fig. 4 | Percentage level of daily water consumption.

Based on the questionnaire, 98% of the respondents agree that water conservation is necessary to overcome water shortages. The community must be educated on the importance of water resources as well as the negative consequences of continuing to unsustainably exploit them.

3.4. Level of acceptance of using reclaimed water for non-potable use

In this section, we assess the level of readiness and acceptance of the community in Malaysia to use reclaimed water for non-potable use. Almost half of the respondents (50.2%) have never used reclaimed water. This is because the use of reclaimed water is not fully applied in Malaysia. The Likert scale was used to determine the level of acceptance of the use of reclaimed water for non-potable use. A total of 331 respondents (33%)

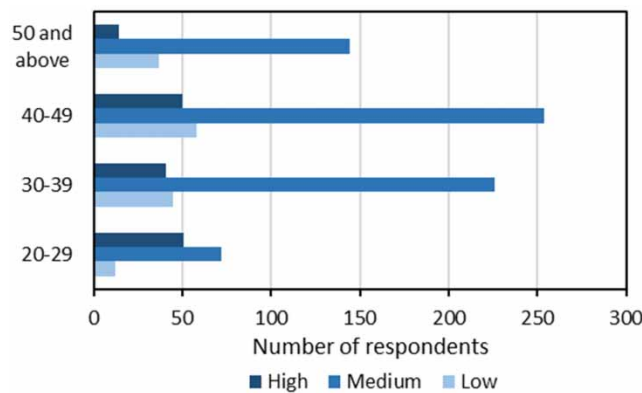


Fig. 5 | Level of daily water consumption against age (p -value < 0.05).

chose scale 4 (at an acceptable level) to use reclaimed water compared to only 26 respondents (2.6%) who chose scale 1 (most unacceptable level). The results demonstrate a positive response because the majorities are on a scale of 3–5.

Table 1 shows the regression model on the relationship between the level of acceptance, general knowledge, and demographic information. The education level is positively related to the acceptance of the use of reclaimed water for non-potable use (p -value < 0.05). This indicates that respondents with higher levels of education, particularly those with tertiary education, will find it easier to accept it. Zhu *et al.* (2019) also found that the respondents with greater levels of education were more confident in their use of reclaimed water than those with lower levels of education. The respondents with a greater level of education had more knowledge and comprehension of reclaimed water, specifically the benefits and disadvantages of reclaimed water use. Age is statistically significantly associated with the level of acceptability of reclaimed water use. Figure 6 shows that the fact that the majority of the respondents were between the ages of 40–49 years old contributed to the result. In general, as people get older, they become more accepting of recycled water (Dolnicar *et al.*, 2011).

Table 2 shows the regression analysis of the relationship between the most appropriate non-potable use and effective methods for providing exposure to the use of reclaimed water. The responses on the most appropriate non-potable use of reclaimed water are influenced by gender and level of education as well as the difficulties faced during water supply disruptions (p -value < 0.05). The highest choice is to use reclaimed water for watering plants (87%), cleaning purposes such as cleaning the yard and drain (83%), toilet flushing (82%), car washing (57%), and the least favoured option was storage for emergency (31%), as shown in Figure 7. Other studies have shown that people are more willing to use recycled water for reasons other than drinking (Boyer *et al.*, 2012). For example, a study conducted in Australia by Dolnicar & Schäfer (2009) found that communities strongly support the use of recycled water for non-drinking purposes such as toilet pumps (90%), gardening (89%), firefighting (86%), field irrigation (82%), and vehicle washing (79%).

The data show that most of the respondents are less likely to use reclaimed water for storage during emergencies. The community needs to receive more information that usage during emergencies includes firefighting and alleviating water shortages. The attitude of Malaysian communities is that reclaimed water is not clean, which needs to be changed to increase the acceptance level. This attitude is linked to a study by Wester *et al.* (2015), who used the term ‘yuck factor’ to describe a broad category of unpleasant emotional reactions towards water reuse.

Table 1 | Regression model on the relationship between the level of acceptance, general knowledge, and demographic information

Variables	Levels				
	1	2	3	4	5
(Intercept)	4.1824 (0.0000)	4.1684 (0.0000)	4.1440 (0.0000)	4.1424 (0.0000)	4.1478 (0.0000)
Demographic info					
Age	−0.0772 (0.0289)	−0.0769 (0.0383)	−0.0792 (0.0205)	−0.0799 (0.0189)	−0.0800 (0.0188)
Education level	0.1531 (0.0000)	0.1502 (0.0000)	0.1529 (0.0000)	0.1528 (0.0000)	0.1523 (0.0000)
General knowledge					
The effort to search for information on water-related issues	0.1755 (0.0035)	0.1654 (0.0079)	0.1767 (0.0025)	0.1789 (0.0021)	0.1797 (0.0020)

Note: Level 1 indicates most unacceptable level, while Level 5 indicates most acceptable level, value in brackets indicates p -value.

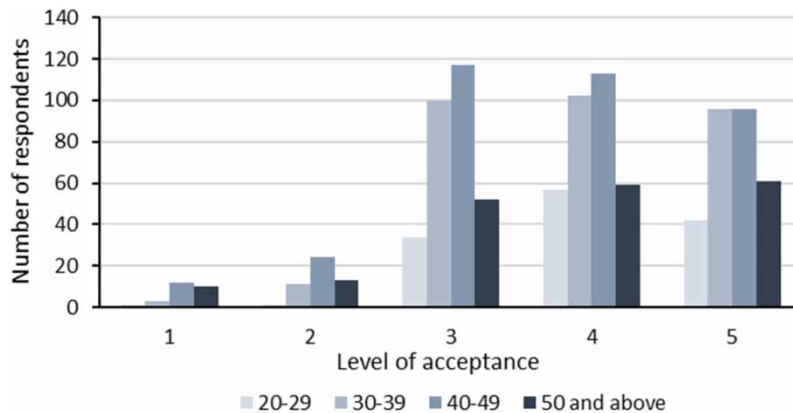


Fig. 6 | Number of respondents with level of acceptance based on age (p -value < 0.05).

Table 2 | Regression analysis on the relationship for most appropriate non-potable use and effective methods for providing exposure on the use of reclaimed water

Variables	Choices				
	1	2	3	4	5
<i>Most appropriate non-potable use of treated reclaimed water</i>					
(Intercept)	4.1824 (0.0000)	4.1684 (0.0000)	4.1440 (0.0000)	4.1424 (0.0000)	4.1478 (0.0000)
Demographic info					
Gender	0.2793 (0.0014)	0.2905 (0.0009)	0.2808 (0.0013)	0.2841 (0.0011)	0.2934 (0.0008)
Education level	0.1778 (0.0000)	0.1773 (0.0000)	0.1776 (0.0000)	0.1758 (0.0000)	0.1745 (0.0000)
General knowledge					
Feel burdened by water disruption	0.1550 (0.0124)	0.1511 (0.0146)	0.1560 (0.0117)	0.1552 (0.0121)	0.1559 (0.0098)

Note: Value in brackets indicates p -value.

Numerous studies show that the acceptance level of skin contact is associated with community readiness for applications including bathing, washing clothes, and swimming. For example, a study by Mainali (2013) found that the resident's support dwindles when the suggested usage of recycled water is applied to the personal eye and skin contact (only 19% for the home pool and 6% for showering). Furthermore, skin contact with recycled water is one of the most important variables in the reaction to the choice of recycled water as a long-term solution; thus, it may take time for the use of reclaimed water to be accepted in daily life, especially for bathing and washing clothes (Friedler *et al.*, 2006). This can also be related to the lowest choice for the use of recycled water for emergency storage.

In addition to the acceptance of use of reclaimed water for non-potable use, this study also assessed whether the extent of water supply disruption affects the level of community acceptance. This is because people who are affected by water shortages are more likely to use recycled water (Wester *et al.*, 2015). The percentage of respondents who have ever experienced water supply disruption is high (85%) compared with those who have never experienced this problem. Moreover, approximately 49% faced challenges during water disruption episodes, while 42% were slightly burdened, and the rest were not burdened at all with water supply disruption problems.

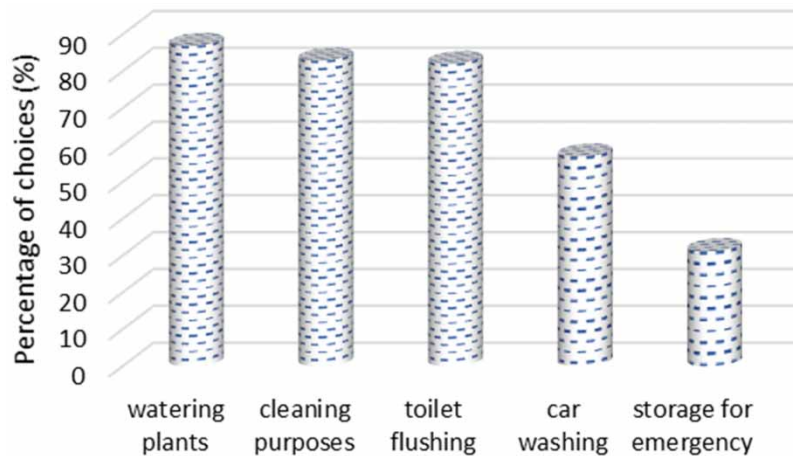


Fig. 7 | Percentage of the choices for non-potable use of reclaimed water.

The use of reclaimed water for non-potable uses is proposed as a long-term solution in the community and 736 respondents agree with the proposal. In other words, when communities are faced with water supply disruptions, reclaimed water is typically accepted as an alternative water source; however, when communities have more secure water resources, they are far less amenable to adopting recycled water (Exall, 2004). Most of the respondents (74.7%) chose long-term solutions for water supply problems as the main benefit, while the choice for energy saving for the industrial sector was the lowest with 64%.

The results of the interviews with the parties that manage the supply of reclaimed water, which are IWK and Air Selangor Sdn. Bhd., provided some insights into the development and readiness of the use of reclaimed water for the industrial sector in Malaysia. Currently, there is one plant built to supply reclaimed water to an industry, where water undergoes treatment tailored to the quality of the demand. Usage of reclaimed water indeed reduces demand for treated water, and a continuous high-grade reclaimed water supply was feasible. Despite promising wide-scale application, the cost-efficient treatment proved to be a challenge at the moment. Public acceptance may change the scenario, as increasing demand for reclaimed water may reduce the treatment cost. This step can be adopted elsewhere and be one of the alternative sources for consumers in the industrial sector, especially industries that prioritise sustainability in their management. Treated wastewater, according to Hardy *et al.* (2015), provides an alternate supply of water, particularly in locations where water is scarce. Wastewater treated to the correct quality can refill water resources and close the demand or availability gap, from agriculture to commercial uses to potable supply.

Malaysia, being a Muslim country with a Muslim population of 61% based on the 2010 census by the Department of Statistics Malaysia, may face challenges based on religious arguments due to the 'origin' of reclaimed water. However, based on the results of the questionnaire, the hypothesis proved to be somehow incorrect, with more than 51% of Muslim respondents accepting the use of reclaimed water if it is implemented. Studies in Durban also showed no evidence of refusal to use recycled water by Muslims based on religious beliefs (Wilson & Pfaff, 2008).

If impure wastewater is treated with modern scientific processes that have been shown to eliminate pollutants in terms of taste, colour, and odour, as witnessed by specialised and informed professionals, impure wastewater can be considered just like the original pure water (Amery & IWRA, 2001). This shows that with proper information, the potential of utilising reclaimed water in reducing the strain on water treatment plants is high.

Similarly, the World Fatwa Management and Research Institute (WFMR) declared that if a treatment restores the taste, colour, and odour of unclean water to its original state, it can be considered as clean and can be used for irrigation and other useful purposes (Kayhanian & Tchobanoglous, 2016). According to Wester *et al.* (2015), there are inconsistencies among studies, with some demonstrating a link between religious beliefs and community acceptability of recycled water and others refuting this relationship.

Media commercials, public seminars, and active campaigns can raise public knowledge of the quality of reclaimed water and encourage its use. According to Baghapour *et al.* (2017), organisations that are more knowledgeable about the wastewater treatment process as well as its physical, chemical, and biological features are more likely to use treated recycled water. This could be related to the positive response of the community to treated recycled water. They also discovered that the quality of processed recycled water differs significantly from that of raw wastewater and that its use is associated with a lower risk of adverse effects.

There are five media that can be used to provide exposure to the community, as shown in Figure 8. The method that received the highest choice from respondents was the Internet and social media (89%), followed by programmes on television and radio (85%). These results are in line with the development of the country, which is increasingly advanced in technology and facilities. Table 3 provides the relationship of the effective methods in providing exposure with the use of reclaimed water. Age and effort to search for information on water-related issues (p -value < 0.05) affect the selection of effective methods for providing exposure to the use of reclaimed water for non-potable uses.

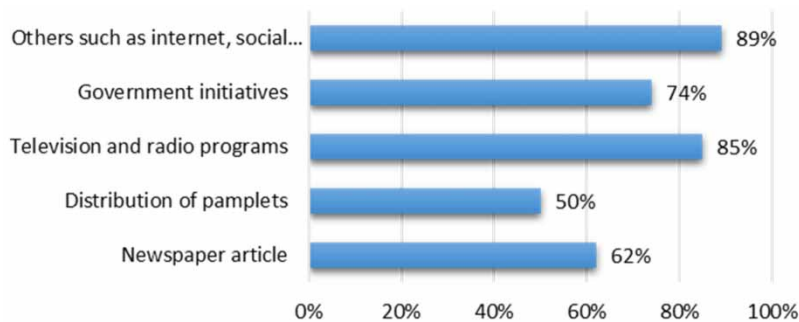


Fig. 8 | Percentage of the choice for effective methods for providing exposure on use of reclaimed water.

Table 3 | Regression analysis on the relationship for effective methods in providing exposure on the use of reclaimed water

Variables	Choices				
	1	2	3	4	5
<i>Effective methods for providing exposure on the use of reclaimed water for non-potable use</i>					
(Intercept)	3.5077 (0.0000)	3.4391 (0.0000)	3.4987 (0.0000)	3.5252 (0.0000)	3.5203 (0.0000)
Demographic info					
Age	0.1313 (0.0132)	0.1312 (0.0135)	0.1334 (0.0115)	0.1328 (0.0119)	0.1340 (0.0113)
General knowledge					
An effort to search for information on water-related issues	0.1848 (0.0411)	0.1649 (0.0693)	0.1766 (0.0497)	0.1805 (0.0452)	0.1788 (0.0477)

Note: Value in brackets indicates p -value.

Social media has gained the attention of each age group of people, keeping with the increasing development of advanced technologies. Teens particularly see social media as the latest trend with which to fill their free time in addition to socialising in cyberspace (Fauzi, 2017). Therefore, social media platforms such as Instagram, Facebook, and Tik Tok may influence the community among the ages of 20–29 and 30–39. This is because good examples and ideas can influence more people to learn about the use of reclaimed water.

According to Kaplan & Haenlein (2010) and Alsanie (2015), the main reason social media applications have succeeded in attracting the interest of various groups is that they are easy to use to communicate in various dimensions whether, in the form of voice, email, picture messages, or sharing information links with just one click. Modern technology and the usage of smartphones make it easier for people to accumulate and share information quickly.

Articles in newspapers and the distribution of pamphlets can be used as an alternative medium for older generations (between 40 and 49 years old), particularly in rural communities. According to Baawain *et al.* (2020), approximately 47.8% of the respondents believe that sharing information through articles in daily newspapers is beneficial, while 46.1% believe that public television programmes and radio channels are the most effective way to inform the public about the use of reclaimed water. As a result, the media is the primary means of disseminating information to society, playing a larger role in increasing public awareness of wastewater treatment and the use of reclaimed water.

3.5. Challenges of using reclaimed water in the community

The last section of the questionnaire evaluated the challenges faced in the community to use reclaimed water for non-potable use. In general, Malaysians (based on 91.7% of respondents) agreed that the country's water resources are polluted and the demand for clean water is increasing due to urban development. In a booming international economy and quickly growing population, water may be a limited resource (Baawain *et al.*, 2020). To reduce the strain to meet the demand for increased water consumption, reclaimed water now is seen as an attractive solution, particularly for non-potable uses. Socio-economic issues and technical challenges in providing adequate water infrastructure are the key aspects in the adaptation of big-scale reclaimed water, especially for nations with low annual rainfall.

The distrust in the use of reclaimed water needs to be scrutinised to improve community acceptance. Based on Table 4, gender influences the extent of suspicion in the acceptance of the use of reclaimed water (p -value < 0.05). The values 1–4 indicate the reasons for the suspicion to use reclaimed water, especially among females. This statement is supported by Mankad & Tapsuwan (2011) who indicated that women, the elderly, and people with less education tend to view the risks related to recycled wastewater as higher than other demographic groups.

Table 4 | Regression analysis on the relationship of the reasons for suspicion of using reclaimed water

Variables	Choices			
	1	2	3	4
<i>The reasons for the suspicion of using reclaimed water</i>				
(Intercept)	2.5109 (0.0000)	2.4732 (0.0000)	2.4908 (0.0000)	2.4882 (0.0000)
Demographic info				
Gender	0.2005 (0.0091)	0.2072 (0.0067)	0.2067 (0.0069)	0.2076 (0.0067)

Note: Value in brackets indicates p -value.

The results of the questionnaire (Figure 9) show that doubting the effectiveness of wastewater treatment is the most influential reason, followed by long-term health effects and the content of toxic substances and bacterial pathogens, for suspicious about reclaimed wastewater. The reason that has least affected the community involves energy consumption and the costs of sewerage services. This indicates that the Malaysian community places emphasis on the standard quality of the reclaimed water and is willing to pay for the additional costs if imposed.

The main problems are biological and chemical contamination as well as aesthetic and physical water quality parameters like odour, colour, and turbidity. For example, Higgins *et al.* (2002) found that the primary worries about the use of reclaimed water were infections and chemical agents. Furthermore, Thu *et al.* (2015) found that 76% of the respondents identified odour difficulties as the leading source of aversion to using reclaimed water in an Australian survey. As a result, the efficacy of wastewater treatment is critical in persuading communities to adopt reclaimed water.

The main challenge of using reclaimed water is the perception of the water source even after going through the treatment process. The way to change such perception is a quality assurance from the authorities on the reclaimed water supplied. In addition, the parties involved need to provide disclosure in stages on reclaimed water so that the correct information can be conveyed to the community. Thayer (2011) also emphasised the importance of agencies explaining the need for water recycling because projects are more likely to succeed when agencies engage their entire community and openly explain the issues. When everyone in the community understands the need and is invested in the outcome, the project can move forward.

4. CONCLUSION

The purpose of this study is to examine the perceptions and acceptance of the local community of the use of reclaimed water for non-potable purposes in Malaysia. It is also necessary to consider the knowledge of the use of reclaimed water as the baseline on the current standing of the Malaysian community on reclaimed water as an alternative water resource. In addition to economic and technological constraints, the success of its deployment is contingent on community support.

Age and level of education are important factors in determining how well the Malaysian community accepts this initiative. The view and attitudes towards treatment and reclaimed water use may be influenced by addressing the information gap. In addition, the quality assurance of reclaimed water before use is also able to change the perception of consumers. Out of possible non-potable uses, the least preferred option from the community is storage for emergency use, as it is directly related to human health. Interestingly, from the religious point of view,

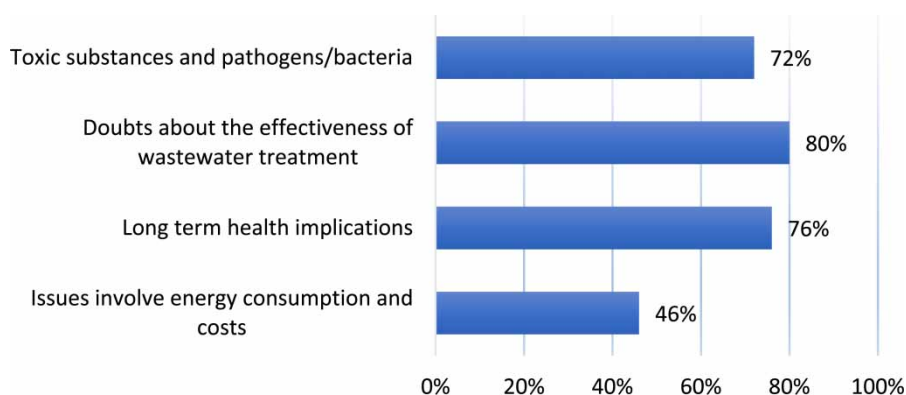


Fig. 9 | Percentage of the choice for the reasons of suspicious for reclaimed water use.

wastewater that has undergone the treatment process and has been rigorously tested, and passed stringent guidelines can be used as a source of water as long as it is not harmful to public health.

The perception of consumers is one of the most important variables in the successful utilisation of reclaimed water. Short informative campaigns can be used as a medium to communicate the importance of reclaimed water within the community, particularly among the younger generation in urban areas. The dissemination of information in this century is faster and highly likely to be well received through media-sharing platforms such as online apps, not forgetting the ‘traditional’ media of television, radio, and newspapers that remain important venues of reaching out, particularly to the older generations. Authorities should promote public awareness and through community acceptance, successful policy initiatives can be implemented.

Reclaimed water as an alternative water resource aligns with the revised Malaysian Environmental Sustainability Plan 2020–2030, targeting 1,500 MLD of water reclamation by 2030. With currently reclaimed water at less than 5 MLD, although it seems far out of reach, all-out campaigns, strong public–private partnerships, and lucrative initiatives to the water sectors are crucial in scaling up the application of reclaimed water in the industry. Malaysia could be gearing towards adapting reclaimed water for key industries such as power plants, refineries, and factories, which may put the country at achieving the established target in the year 2030. Reclaimed water can help address critical water shortages, particularly during drought events and not only minimise water cuts for domestic consumption but also ensure a continuous supply of irrigation for crops.

DATA AVAILABILITY STATEMENT

All relevant data are included in the paper or its Supplementary Information.

CONFLICT OF INTEREST

The authors declare there is no conflict.

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