The Perception of Guyanese to Urban Wastewater Reuse

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Abstract

Support of the public is critical for wastewater reuse projects to succeed. The findings of an online questionnaire-style survey conducted with 117 participants to measure the public's opinion toward potential urban reuse opportunities in Guyana are examined in this article. Support for and resistance to 13 reuse options are examined in this article. Wastewater reuse for irrigation of agricultural crops, public park irrigation, sidewalk landscape irrigation, cooling purpose in industries and firefighting received the highest support ranging from 73% to 84%. With the exception of reuse for irrigation for agricultural crops, participants generally preferred low-contact reuse options. Wastewater reuse for potable water, commercial launderette and discharge to surface water bodies received the lowest support ranging to 23% to 41%. The public, in general, may be reluctant to accept any wastewater reuse that is directly or indirectly tied to humans. Prior to the implementation of any wastewater reuse project in Guyana, public campaigns should focus on disseminating information about wastewater treatment, technologies, health issues, the environmental impact of water reuse, and create good public opinion, as these factors help to determine individuals endorsement to reuse projects.

Keywords: Wastewater, Water Reuse, Effluent, Reclamation

1. Introduction

Industrial and household wastewater reclamation and reuse are now seen as viable options for combating global water shortage and for significantly contributing to sustainable development (Maryam and Büyükgüngör 2019b; UN-Water 2017 as cited in Jemal and Van Hulle Stijn, 2021). Potable applications are on the horizon, with Namibia, Singapore and Australia setting the stage (Sheikh, 2008). Reclaimed water is used for irrigation in the agricultural sector, landscape irrigation, urban park irrigation, fish farming, industrial process cooling, firefighting, toilet flushing, and aquifer recharge worldwide (Maryam and Büyükgüngör 2019a; Huertas et al. 2008; Garcia and Pargament 2015 as cited in Frito & Van Hulle Stijn, 2021). Jemal & Van Hulle Stijn (2021) noted from studies conducted by IWA in 2012, National Water Agency in 2018 and Angelakis and Snyder in 2015, found that reusing recovered water has recently covered a considerable percentage of the freshwater necessary for agricultural irrigation in Israel, Spain, Singapore and California.

In Guyana, urban wastewater reuse is not practised. Wastewater collection is provided to a section of the city through the Central Georgetown and Tucville Sewage system. The former functions by collecting wastewater from a section of Georgetown and discharging it to the mouth of the Demerara River and the latter transports wastewater from a reception chamber to the settling tank through a mechanically operated pump and then discharges the effluent to the Laing canal. The latter was built to treat domestic wastewater physically and biologically using the extended aeration activated sludge process but has been inoperable for some years. However, a wastewater treatment plant (WWTP) is now being piloted for the Tucville sewage system by the Guyana Water Incorporate (GWI) with the objective of obtaining feasible treatment solution for the residence wastewater. It's appropriateness as well as the removal efficiency of contaminants are being determined by the treatment process which entail screening, grit removal, biological treatment using the up-flow anaerobic sludge blanket (UASB) reactor followed by a constructed wetland and ultraviolet disinfection. This is an excellent initiative as it would permit the recovery of biogas, water for non-potable use and fertilizer. This is in alignment with the ideas which the scientific community are exploring based on recycling wastewater and recovering resources using the circular economy concept. Essentially, the circular economy seeks to retain materials (waste) in the economic system for as long as possible, with the goal of converting wastes into resources (Neczaj and Grosser 2018 as cited in Jemal and Van Hulle Stijn, 2021). The circular economy aims to recover resources and reuse them several times inside a closed-loop system that may be applied to a variety of industries (Sgroi et al. 2018 as cited in Jemal and Van Hulle Stijn, 2021).

While there are reuse technologies that provide little or no risk to users, the general public is frequently unprepared for them (Miller 2012 as cited in Portman et. al., 2022). Human psychology and socio-institutional aspects can provide larger challenges than technology, which has a wide range of ramifications for engineers and planners (Goulden et al. 2018; Bohman et al. 2020 as cited in Portman et. al., 2022). Friedler and Lahav (2006) indicated that despite scientific evidence, public opposition can lead to the failure of wastewater reuse initiatives before, during, or after they are implemented. Jeffrey and Temple (1999) notes that regardless of what conclusions the scientific data leads to, public perceptions and attitudes may quickly and successfully put an end to any treated wastewater reuse project. The issues at hand are both complex and nuanced, involving ideas, attitudes, and trust. While water reuse inside a single household may be acceptable to many people, ideas for reusing water from next door or the next street may be received with skepticism. According to Gibson and Apostolidis (2001) based on multiple instances from Australia, communities are particularly volatile on recycling problems, and public opinion frequently moves substantially depending on a slight change in the information presented. When Queensland, Australia's driest state, suggested using recycled wastewater to supplement its drinking water supply, it was publically rejected, despite the fact that it is currently used for irrigation (Mcguirk, 2007 as cited in Chen, Maksimovic & Voulvoulis, 2011). Denunciation by critics was motivated mostly by fear (Manners & Dowson, 2006; Frew & Marriner, 2007 as cited in Chen et al., 2011). Singapore's public acceptability was due to open discussion about the importance of absorbing reclaimed water to replenish Singapore's water supply (Chen et al., 2011). According to Ashley et al. (2001), the main aspects of effective design and execution of water or wastewater projects are, education, and participation of all stakeholders in the decision-making process.

Despite a few public opinion surveys on water reuse in the literature, virtually all originate from a small number of countries (the United States, Australia, and Western Europe), however studies are likely to be necessary in each country and possibly at a sub-national setting. This is owing to the wide range of differences in culture, climate, water supply, economics, and so on, which makes transferring findings from one nation to another fairly difficult. A survey done in Doha, Qatar, found that, in sharp contrast to most results reported elsewhere, a considerable number of respondents opposed even very low-contact reuse choices (Ahmad, 1991) as stated in Friedler and Lahav (2006). This research aims to (i) determine the degree of resistance / support for various wastewater reuse opinions and to (ii) identify areas of concern that should be addressed particularly for wastewater reuse in Guyana.

2. Method

A quantitative online survey was developed to obtain information pertaining to the perception of Guyanese to wastewater reuse for different purposes using the Likert Scale. The survey was pretested to check for errors, ambiguity and the required completion time and then sent out to 300 persons in administrative regions 2 to 6 to fill for a period of two weeks. The questionnaire included definition of wastewater, reuse, and brief description of the research topic, goals, basic instructions and various questions for the participant to complete. Engineers, students, technicians, academics, businessmen, and others were selected at random for the study. Questions covering the following areas were incorporated in the questionnaire:

- Demographic data such as gender, age range, occupation and region.
- Knowledge of water and wastewater terminologies.
- Acceptance levels for various reuse applications, including as irrigation, potable usage, and industrial use.
- The level of trust in the water and wastewater company (GWI) for high treatment efficacy.
- Health concerns about wastewater reuse.
- Environmental perceptions.
- Public communication methods that are desirable.

The survey findings were automatically gathered by the online survey tool and imported into Microsoft Excel for further analysis using statistical data analysis tools to determine the perceptions of Guyanese to reusing treated wastewater.

3. Results and Discussion

Demographic Data

The response rate for the completed survey was 117 out of 300 or 39%. This is slightly below the average online survey response rate of 44.1% (Wu, Zhao & Fils-Aime, 2022). The determined confidence level for the number of response is 90% with a margin of error of 7.5%. This is considered acceptable by the researcher for statistical inferences regarding Guyanese perceptions to wastewater reuse. Table 1 displays the demographic information of the respondents. The results show a gender bias in the response with 58% of those surveyed were men, while the remaining 42% were women. The response rate from age ranges 18–29 significantly surpassed the other age ranges accounting for 67% of all respondents; responses from age range 30–40 years old amounted to 17%, and that of 41-50 totaled 14%. The majority of respondents were from Administrative Region 4, accounting for 75% of all respondents; 15% were from Administrative Region 3. Approximately 35% of those surveyed were university students, 18% engineers and 8% academics. The composition of the population is defined by the demographic which is an important factor in determining acceptability and attitude toward wastewater reuse in this context (Baawain et. al., 2020).

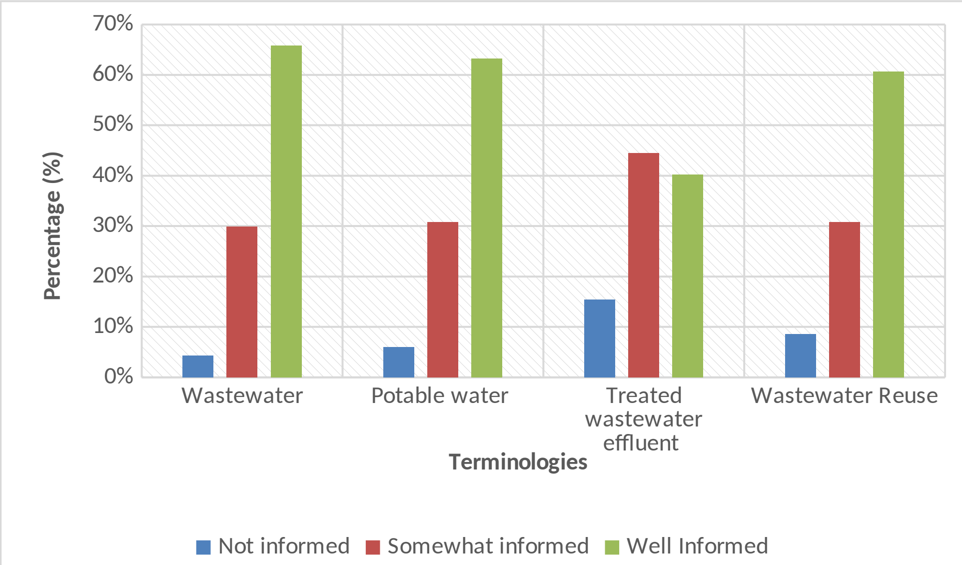
Table 1: Summary of Respondents' Demographics

Personal Attributes	**Distribution (%)**
Gender	
Male	60
Female	40
Age Range (Years)	
18-30	78
31-40	20
41-50	14
51-60	2
Above 60	3
Administrative Regions	
2	2
3	15
4	73
5	5
6	5
Occupation	
Engineers	18
Accountants	3
Managers	3
Academics	8
Technicians	3
University Students	35
Employees	13
Others	17

Respondents' Knowledge of Water and Wastewater Terminologies

Figure 1 depicts the distribution of respondent knowledge of portable water and wastewater treatment terms in Guyana. The percentage of respondents that were well informed about wastewater, potable water, wastewater reuse and treated wastewater effluent were 66%, 63%, 61% and 40% respectively. The lower familiarity with treated wastewater effluent could be absence of a functioning municipal WWTP in Guyana. The percentages are significantly higher than respondents' knowledge to wastewater and wastewater treatment in a study conducted by Baawain et al. (2020) which shows that only 32.4% of the respondents were aware of wastewater and wastewater treatment. According to Po et al. (2003) the success of any reuse project is linked to the acceptance and knowledge of the public, hence before embarking on wastewater reuse project, it is necessary to educate them about wastewater reuse.

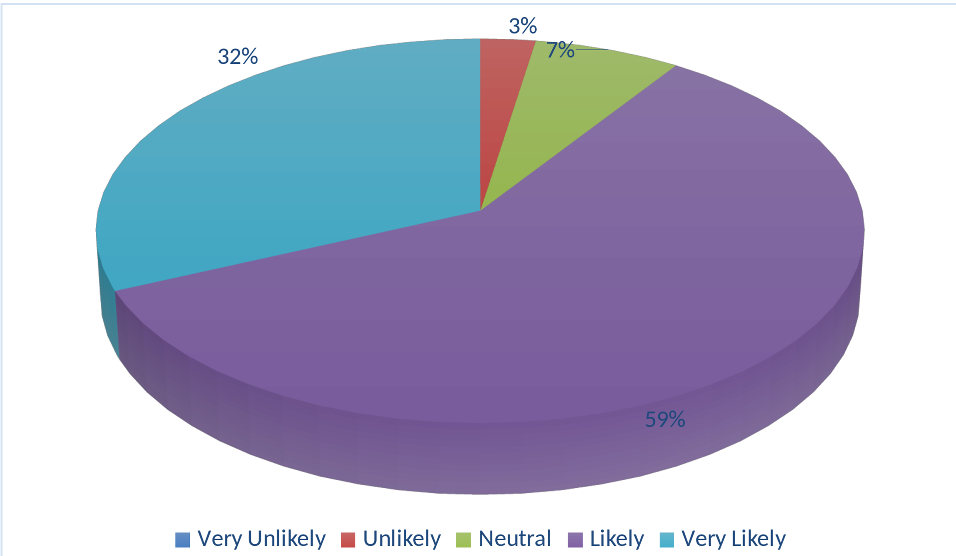
Figure 1: Respondents' Knowledge of Water and Wastewater Terminologies



Respondents' Level of Support on Treating Wastewater Suitable for Reuse

Figure 2 below shows that a total of 91% of the respondents are very likely to support any initiative to treat wastewater to high effluent quality suitable for reuse.

Figure 2: Respondents' Level of Support on Treating Wastewater Suitable for Reuse



Preferred Hypothetical Options for Wastewater Reuse

Figure 3 depicts the level of support for the different wastewater reuse options. Some of reuse options were adapted from Baawain et al. (2020) and Friedler and Lahav (2006). Wastewater reuse for irrigation of agricultural crops, public park irrigation, sidewalk landscape irrigation, cooling purpose in industries and firefighting received the highest support ranging from 73% to 84%. With the exception of wastewater reuse for irrigation of agricultural crops, participants generally preferred low-contact reuse options. Friedler and Lahav (2006) mentions that public perception may differ from specialists' "conventional thinking." Hence, the high support in the instance of reuse for irrigation of agricultural crops could be due to the fact that the perceptions of the degree of contact of the author differs from that of the public as it relates to reuse for irrigation of agricultural crops.

Another reason for the high support of wastewater reuse for sidewalk landscape irrigation, public park irrigation and irrigation of agricultural crops could be the high nutrient benefit to plants as wastewater has phosphorous and nitrogen which are essential for plant growth. This findings are similar to Choudri and Charabi's (2019) study in the Apulian region of Italy which revealed Farmers and consumers demonstrated a high degree of acceptance to wastewater reuse for agriculture. In Queensland, the Eli Creek Irrigation Project at Hervey Bay was established to lessen the requirement for an ocean outfall due to population expansion (Heron, 1998 as cited in Po et. al., 2003).

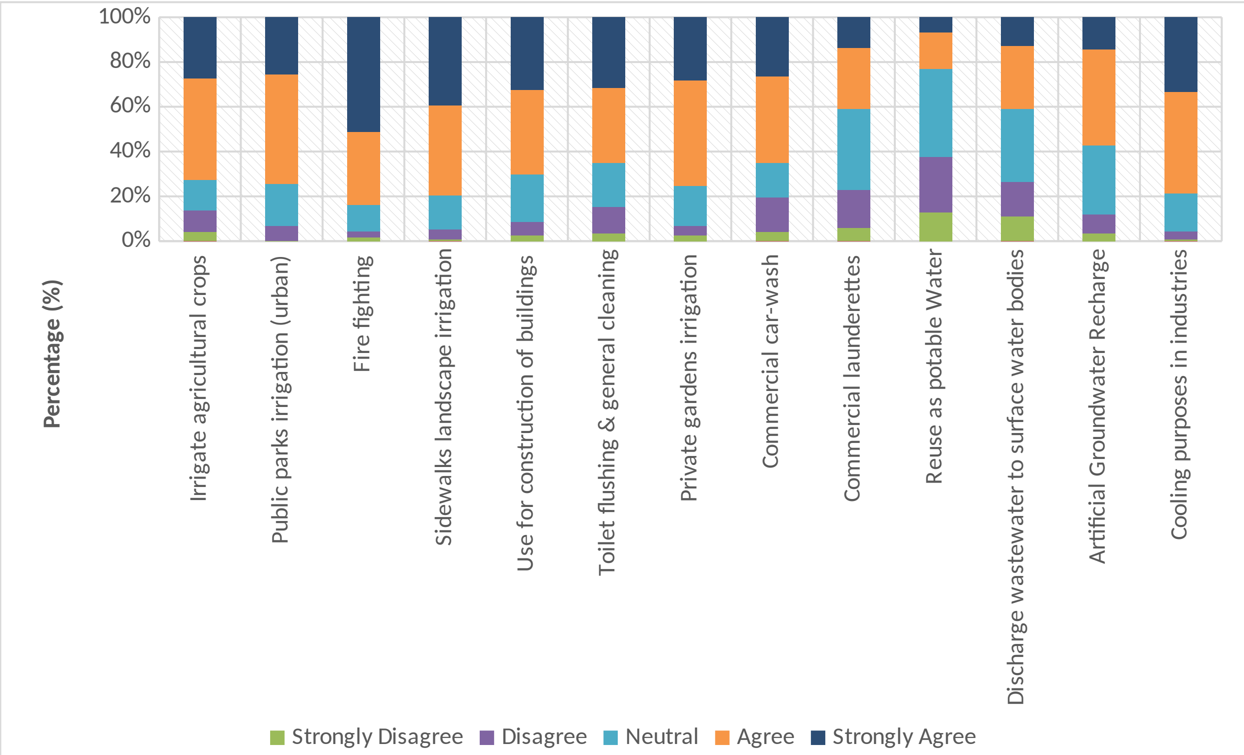
When compared with studies conducted by Baawain et al. (2018) the support for the different reuse options correspond closely with wastewater reuse for irrigation of landscapes in business areas, use as fire hydrants, cooling building, irrigation of golf courses, irrigation of public parks, irrigation of school grounds, use as toilette flushing, and use for car washing and in the range of 64.2–78.7%. Friedler and Lahav (2006) found that reuse alternatives viewed as "minimal contact" obtained above 90% support in their studies (e.g. firefighting and reuse in construction of buildings).

The high support for firefighting is understandable in Guyana because of the many instances water is not accessible to extinguish fires. Reuse of treated wastewater can also be beneficial to breweries such as Banks DIH Limited where the water to beer ratio for beer production is currently 17:1 which is way above the internationally accepted industry standard of finished water – to – beer ratio of 4.5: 1. CBMC (2002) list the largest consuming processes as mashing and sparging, cleaning of packaging material (e.g. bottle washing), pasteurisation (tunnel), rinsing and cleaning of process equipment (CIP), cleaning of floors, soap lubrication of conveyors in the packaging area, vacuum pump for filler, flushing of filler and keg washing. The wastewater from bottle washing is of the highest volume and consist mostly of chemicals such as sodium hydroxide and phosphoric acid and contains a very minor percentage of total organics discharged from brewery processes.

Findings from the studies showed that wastewater reuse for potable water, commercial launderette and discharge to surface water bodies received the lowest support ranging from 23% to 41%. This corresponds well with Friedler and Lahav (2006) who found that reuse options with "high contact" garnered relatively less support in their studies (e.g. 60% for commercial launderettes). Baawain et al. (2018) found that over 50% of the respondents were against reusing wastewater as drinking water, discharging wastewater into the marine environment, and irrigating agricultural crops. Baghapour et al. (2016) found only 8.9% of respondents supported reuse of wastewater reuse for drinking and cooking.

The public, in general, may be hesitant to accept any wastewater reuse that is directly or indirectly tied to humans. People avoid consuming treated wastewater for two primary reasons, according to Buyukkamaci and Alkan (2013) as cited in Baawain et al.(2020): (a) the presence of pathogens and/or harmful compounds, and (b) their fear about the safety of using treated water and its uncertain long-term health impacts (Baawain Mahad, 2020).

Figure 3: Preferred Reuse Options of Guyanese for Treated Wastewater



Respondents Trust in GWI to Treat Wastewater to High Enough Effluent Quality for Reuse

Table 2 depicts the level of trust respondents have in the utility company to treat wastewater to high enough effluent quality for reuse. The findings revealed a widespread lack of trust in GWI to treat wastewater to high enough effluent quality for reuse with 23% having no trust, 64% limited trust and 13% trust in treating. This might be due to the fact that respondents are not knowledgeable about wastewater reuse projects, as none in present in Guyana. If the Government of Guyana wishes to implement a wastewater reuse project serious efforts would have to be made to enlighten the public about the project benefits.

Table 2: Trust in GWI to Treat Wastewater to High Enough Effluent Quality for Reuse

No trust	Limited Trust	Trust
23%	64%	13%

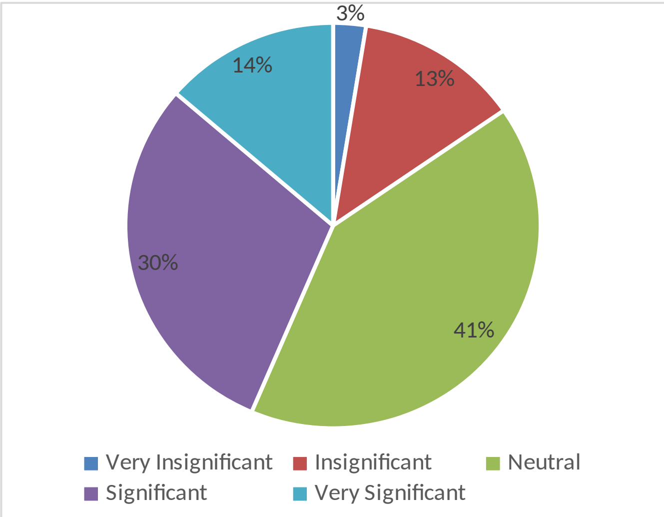
Respondents' View on Health Risk Associated with Wastewater Reuse

The view of respondents on health risk associated with wastewater reuse is represented in figure 4. 44% (very significant 14%; significant 30%) of respondents viewed the health risk associated with wastewater reuse as significant, 41% neutral and 16% (very insignificant 3%; 13% insignificant) insignificant. This explains why wastewater reuse for potable use only received a support of 23%. It also agrees with research undertaken by Baghapour et al. (2016), who found that 74.9% of respondents were opposed to utilizing reclaimed wastewater for cooking and drinking, while just 8.9% agreed.

Choudri and Charabi (2019) reviewed several studies on the health effects associated with wastewater treatment, reuse, and disposal which revealed the presence of pharmaceuticals (acetaminophen including antibiotics such as azithromycin, ciprofloxacin, and norfloxacin) , personal care products containing phenylbenzimidazole sulfonic acid, benzophenone-3, benzophenone-4, 4 methyl-benzilidine-camphor, and two antibacterial agents triclosan and triclocarban, heavy metal risk indices for food crops, raising concerns about public health in the area. Also, effluents from wastewater treatment introduce considerable environmental antibiotic resistance into reservoirs. Based on the present treatment technologies, the scientists concluded that improvements were required to eliminate antibioticresistant microorganisms as well as solids and minerals.

To reduce the health risk connected with the practice of wastewater reuse for vegetable irrigation, locally appropriate wastewater irrigation rules based on quantifiable and verifiable health hazards must be developed (Drechsel et al. 2002; WHO 2006 as cited in Seidu et. al, 2008).

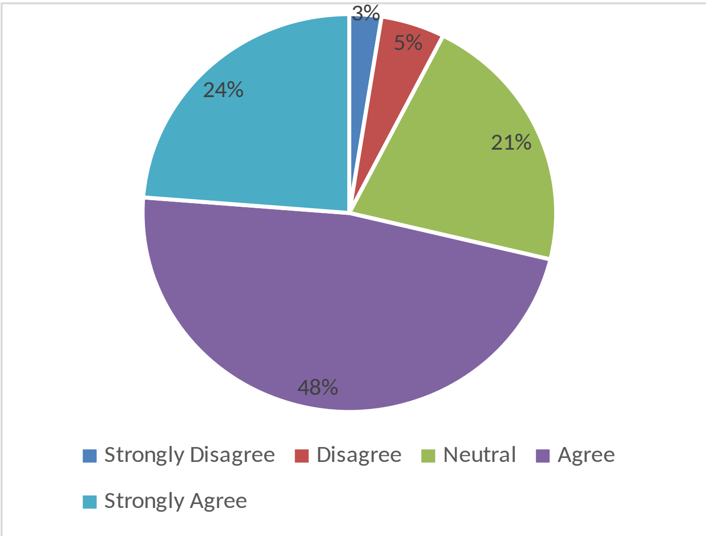
Figure 4: Respondents' View on Health Risk Associated with Wastewater Reuse



Respondents' View on whether Wastewater Reuse is an Environmentally Responsible Activity

Figure 5 shows respondents view on whether wastewater reuse is an environmentally responsible activity. The findings revealed 71% (strongly agree 24%; agree 48%) agree, 21% neutral and 8% (strongly disagree 3%; 5% disagree) disagree. According to the findings of research done by Molinos-Senante, Hernández-Sancho, and Sala-Garrido (2011), the largest environmental advantage is the avoidance of nitrogen and phosphorus discharge, as these elements are predominantly responsible for eutrophication problems in inland water bodies. Arena, Genco, and Mario (2020) stated that urban wastewater reuse initiatives can also have a positive environmental impact by diverting wastewater away from receiving bodies and improving water quality. This is a classic win-win situation in which enormous synergies may be established between the agricultural sectors, as well as the environment.

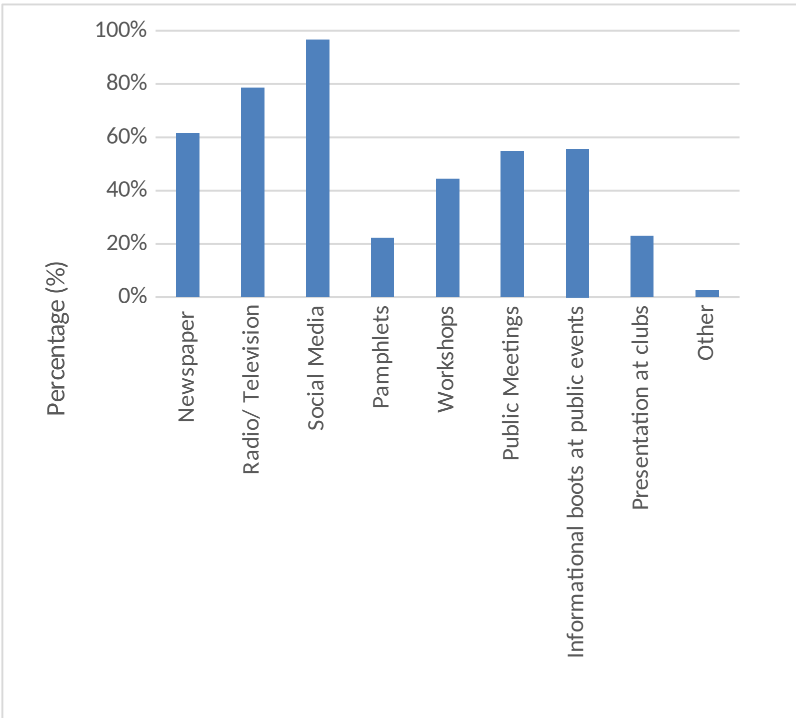
Figure 5: Respondents' View on whether Wastewater Reuse is an Environmentally Responsible Activity



Best Ways to Communicate to the Public about Wastewater Reuse and its Importance

To guarantee optimum societal acceptance, awareness programs promoting water reuse projects at the national level should be formulated. The perception and attitude of the public towards treatment and wastewater reuse may be influenced by a knowledge gap (Baawain Mahad, 2020). From the survey, wastewater reuse for drinking water, commercial laundries, and discharge to surface water bodies received the least support. The ideal ways to convey to the public about wastewater reuse and its relevance are through a variety of information sharing platforms. As shown in figure 6 below, social media television/ radio, and newspapers are the best means of informing the public; nevertheless, the quantity of instructional programs should be increased.

Figure 6: Best Ways to Communicate to the Public about Wastewater Reuse and its Importance



4. Conclusion

Generally, the study revealed an overwhelming support for the implementation of wastewater reuse initiative in Guyana. However, a widespread lack of trust is discovered in the water authority to treat wastewater to high enough effluent quality for reuse with 23% of the respondents having no trust, 64% limited trust and merely 13% trusting the water authority. Wastewater reuse for drinkable purposes received only 23% support from the respondents. 44% of respondents view the health risks associated with wastewater reuse as significant. A high percentage (71%) of respondents believe that wastewater reuse is an environmentally responsible activity.

When the Government of Guyana decides to proceed with the wastewater reuse project, significant efforts must be made to educate the public about the benefits. Education and awareness may be transferred through the media and advertising initiatives to boost public trust to increase the likelihood of the planned wastewater reuse project being successfully implemented.

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