

Identifying the Barriers and Drivers towards Limiting the Single-Use Plastic Water Bottles at Universities in the UAE

Aysha AlKaabi¹, Nur H. Orak², Mohammad AlJaradin¹, Moetaz Elsergany^{1,*}

¹School of Sustainability and Green Economy, Hamdan Bin Mohammed Smart University, United Arab Emirates

²Department of Environmental Engineering, Marmara University, Türkiye

Received June 30, 2025; Revised October 11, 2025; Accepted November 3, 2025

Cite This Paper in the Following Citation Styles

(a): [1] Aysha AlKaabi, Nur H. Orak, Mohammad AlJaradin, Moetaz Elsergany, "Identifying the Barriers and Drivers towards Limiting the Single-Use Plastic Water Bottles at Universities in the UAE," *Environment and Ecology Research*, Vol. 13, No. 6, pp. 768 - 777, 2025. DOI: 10.13189/eer.2025.130602.

(b): Aysha AlKaabi, Nur H. Orak, Mohammad AlJaradin, Moetaz Elsergany (2025). *Identifying the Barriers and Drivers towards Limiting the Single-Use Plastic Water Bottles at Universities in the UAE*. *Environment and Ecology Research*, 13(6), 768 - 777. DOI: 10.13189/eer.2025.130602.

Copyright©2025 by authors, all rights reserved. Authors agree that this article remains permanently open access under the terms of the Creative Commons Attribution License 4.0 International License

Abstract Background: Higher education institutions worldwide face a major environmental issue from single-use plastic water bottles, because the UAE leads global plastic consumption per person at 285 Liters of bottled water annually. The UAE university sector faces ongoing challenges with plastic bottle reduction despite official sustainability programs, because evidence-based solutions must tackle the multiple behavioural, structural, and cultural elements that affect academic plastic usage. **Aim:** The research aims to investigate the factors affecting the high consumption rates of disposable plastic bottles across university campuses in the UAE, identify key barriers and drivers that influence stakeholder behaviour, and prioritize intervention strategies for effective plastic waste reduction in higher education environments. **Methodology:** The study followed a structured three-phase mixed-method approach, combining the Delphi technique with sustainability experts over two rounds to identify key factors, followed by a Likert-scale survey assessing perceptions of the campus users (n=384 students, faculty, and staff). Barriers and drivers were prioritized using the Weighted Scoring Method (WSM), with data collected through stratified random sampling across various UAE universities. **Results and Discussions:** The study established five main obstacles which may interfere with plastic reduction goals: Cultural habits favoring the use of plastic (mean=3.66), concerns about safety and health risks

from alternative products (mean=3.41), limited access to refill stations (mean=3.31), lack of environmental knowledge (mean=3.06), and high cost of reusable products (mean=2.99). The main factors that influence behavior include peer pressure (mean=3.58), convenient access to refill stations (mean=3.47), university leadership backing (mean=3.35), reward systems (mean=3.32), and environmental awareness programs (mean=3.31). The results show that stakeholders ranked all factors at similar levels, since no single element stood out as more important than others. Multiple factors need simultaneous attention for successful plastic reduction initiatives because single-point solutions prove ineffective. The study shows that successful implementation requires universities to create complete solutions that merge policy development with infrastructure enhancement, educational programs and behavioural modification approaches. The research delivers essential evidence-based recommendations for university administrators and policymakers. The research findings indicate that universities need to create diverse programs which tackle cultural aspects, build infrastructure, and deliver educational content to reduce plastic bottle use effectively.

Keywords Waste Management, Delphi Technique, Barriers, Drivers, Single-Use Plastics, Behavioral Change, UAE, Campus Sustainability

1. Introduction

Excessive plastic use and improper disposal can lead to plastic pollution, presenting a very serious ecological and environmental challenge. Global plastic waste generation has reached approximately 353 million metric tons in 2019, more than doubling since 2000. An estimated 19-23 million metric tons of plastic waste leak into aquatic ecosystems annually, polluting lakes, rivers, and oceans [1], [2]. The plastic pollution issue is intensified with the excessive use of disposable plastics with a shorter life cycle, leading to waste accumulation and many negative environmental problems associated with it. Single-use plastic bottles carry several adverse environmental consequences; one of the most significant issues is the microplastic pollution which directly forms a threat to the wildlife [3]. Considering the life cycle of the single plastic bottle manufacturing, the process of manufacturing and disposal of plastic bottles involves energy-intensive processes generating greenhouse gas emissions, contributing to the climate change challenges. Regulating plastic water bottles has become increasingly urgent as their environmental footprint extends beyond visible pollution to include resource depletion, energy consumption, and long-term ecosystem damage.

The worldwide consumption of plastic bottles has reached dangerous levels. The worldwide plastic bottle market consumes 1 million bottles each minute, while the yearly bottle consumption exceeds 500 billion units [4]. The recycling rate of plastic bottles stands at less than 30%, which leads to substantial waste accumulation in landfills, waterways, and oceans. Plastic bottles persist in the environment for 450 years before decomposing, which extends their harmful effects across multiple generations. The increasing use of disposable plastic water bottles has become a major environmental issue, because universities demonstrate similar consumption patterns to those of the general population [5]. The widespread adoption of single-use plastics in educational institutions undermines sustainability efforts because these institutions face challenges in implementing successful reduction plans despite their environmental leadership stance [6].

The environmental impact of single-use plastic bottles extends beyond the generated plastic waste and landfill issues. Actually, the more significant impact of single-use plastic is the carbon footprint associated with the production, transportation, and disposal process of the plastics. Bottled water production is energy-intensive process where it requires up to 2,000 times the energy cost needed for the production of tap water [5]. Accordingly, limiting single-use plastic bottles in high-demand sectors can directly contribute to efforts to reduce the carbon footprint and hence, support the commitments towards

climate change agreements. Furthermore, the UAE still has limited recycling infrastructure across its emirates, where most of the waste is collected without prior separation. This means that a substantial portion of plastic bottles eventually ends up in landfills or is disposed of through other unsustainable conventional methods.

In the Gulf Cooperation Council (GCC), all member countries in the region are classified as water-stressed countries due to their arid climate, low rain fall, elevated temperatures, and limited freshwater resources. This situation has led to a significant increase in the use of single-use plastic water bottles, particularly in some places that may lack the supply of potable tap water. The UAE is one of the GCC countries that exhibits one of the world's highest per capita plastic consumption rates, using approximately 4 billion plastic bottles annually (WAM, 2024). Individual consumption exceeds 285 liters of bottled water per person annually, significantly above global averages [7]. It has been found that 68% of UAE university students prefer bottled water over other refillable options [8]. The main drivers behind this preference were safety (43.80%), followed by convenience (16.88%) and taste (15.60%). Similar patterns are observed in neighbouring countries like Qatar, where institutional campuses show comparable bottled water preferences driven by similar factors, emphasizing the regional nature of this challenge. In the UAE, the plastic bottles constitute a significant portion of the plastic waste stream. For instance, the Abu Dhabi's 2020 single-use plastics policy identified plastic bottles among 16 priority single-use items requiring urgent intervention [3]. Despite various government initiatives in the country to promote the use of reusable bottles, universities are still struggling with plastic bottle reduction, highlighting the need to examine the challenges and explore alternative effective minimization strategies.

Educational campuses, like universities, act as critical hubs for learning and innovation and they have the opportunity to lead sustainability efforts by promoting sustainable practices among their faculty and students [9]. Although higher education institutions strive to shift toward more eco-friendly transitions, various barriers hinder the successful adoption of reusable alternatives [10]. Despite efforts by higher education institutions to adopt greener alternatives, numerous obstacles may hold them back, such as behavioural inertia, infrastructure limitations, and persistent concerns about water quality and convenience [10]. Globally, educational institutions have implemented many strategies to reduce the use of single-use plastic bottles. Studies show that institutions that combine policy interventions with awareness campaigns and infrastructure improvements achieve more substantial plastic waste reductions [11], where successful approaches typically address both supply and demand aspects of plastic bottle consumption. One of the solutions to address the increased volumes of single-use bottles is to consider installing high-quality water refill stations that meet user

expectations in terms of temperature, accessibility, and availability. In warm climates like the UAE, providing cooled refill stations with frequent sanitization, cleaning and filter changes can encourage the use of refillable bottles [12]. This approach could be strengthened with a proper institutional policy that limits or minimizes the sales of single-use bottles on campus. The enforcement of policy should be integrated with other technical and infrastructural approaches. Furthermore, running awareness campaigns addressing the environmental impacts and raising awareness about the safety of the campus water refill stations, such as the frequency of cleaning and sanitization, can reduce user hesitation. These campaigns may also help to reduce the misconception often associated with using refillable bottles by promoting them as socially and environmentally conscious choices. Incentive programs, such as providing free or subsidized reusable water bottles to new students and creating reward systems for consistent refill station use, can further motivate behavioral change. Additionally, peer influence programs leveraging social norms have demonstrated effectiveness in promoting sustainable behaviours within university communities [13].

The implications of this study extend beyond campus boundaries. While the focus of the study is on higher education institutions, the challenges associated with single-use plastic water bottles are relevant to a wide range of institutional and public buildings across the UAE. By engaging university stakeholders, we can gain a better understanding and more insights that could help in shaping policies and strategies for reducing plastic consumption, not only on university campuses but also in other similar institutions. By understanding the key factors influencing consumption patterns in academic settings, this research can support the development of evidence-based policies and scalable interventions applicable to other sectors. Ultimately, the study aims to identify and prioritize the primary barriers and drivers affecting single-use plastic water bottle reduction across the UAE university campuses, thereby contributing to the advancement of more sustainable consumption practices within the higher education sector and beyond by providing evidence-based recommendations for policymakers and university administrators.

2. Methodology

This study used a structured, three-phase mixed-methods approach to identify and prioritize factors affecting the reduction of single-use plastic water bottles in UAE universities.

- **Phase 1: Delphi Method with Sustainability Experts**

The Delphi method was selected for this study due to its

well-established effectiveness in achieving consensus among experts on complex issues, particularly in the absence of complete or certain information [5], [6], [14], [15]. This iterative and structured approach allows for the collection and aggregation of anonymous expert opinions, which minimizes the influence of dominant individuals and reduces the potential for groupthink, thereby leading to more reliable and objective outcomes than a single expert's opinion [7], [16]. In this study, a panel of 4 sustainability experts participated in the Delphi study. While some Delphi Studies are based on a larger number of panels, the literature suggests that the proper number of experts can vary [17] depending on the objectives of the study and the degree of homogeneity of the experts group. For this study, we opted for a small, yet highly specialized panel to ensure a high level of engagement and to facilitate a rich in-depth discussion of the various barriers and drivers to reducing single-use plastic bottle consumption in the context of UAE universities. Having such a specialized panel with the UAE context in large numbers was not practical during conducting this study. The goal was to benefit from the deep knowledge of a focused group of experts rather than seeking consensus from a larger, more diverse group of experts.

Compared to other consensus-building methods, such as nominal group technique or focus groups, the Delphi method offers the advantage of allowing experts to participate remotely and anonymously, which is particularly beneficial when experts are geographically dispersed or when sensitive topics are being discussed. The iterative nature of the Delphi method, with its multiple rounds of questioning and feedback, provides a structured process for experts to refine their opinions and move towards a consensus [9], [18]. This method has been widely used in environmental and sustainability research to identify key factors, forecast trends, and develop policy recommendations [19]. The expert panel consisted of environmental researchers and sustainability experts with expertise in waste management, chemistry, and higher education sustainability initiatives. In the first round of Delphi, the experts were asked open-ended questions to identify the key barriers and drivers influencing the reduction of reliance on single-use plastic water bottles in the UAE universities. Their responses were analyzed using qualitative coding techniques, which are commonly used for interpreting textual data. This process involved labelling and categorizing experts' responses to identify frequently listed factors [20].

In the second Delphi round, a refined list of drivers and barriers was sent back to the experts, who were requested to rank the priority factors using a Likert-scale ranking system. Responses were collected and analyzed to be used in the stakeholder survey. Experts' ranking provided a benchmark for the survey rankings since the Weighted Scoring Method (WSM) analysis was applied only to the stakeholder survey results.

- **Phase 2: Stakeholder Survey Development and Implementation**

The primary stakeholders in this study are the students, faculty, and staff of universities in the UAE. These groups were chosen because they are the main consumers of single-use plastic bottles on campus and are directly impacted by any policies or interventions aimed at reducing plastic waste. Students are considered the largest group of consumers, and accordingly, their behaviour may have a great impact on the success of any plastic reduction initiatives. The second category of the stakeholders is the faculty members, and their importance comes from not only their consumption habits but also their role as educators who can influence students' attitudes and behaviours. The last category of the stakeholders is the staff who play a role in the implementation of university policies, where their interests include the practical feasibility of new initiatives and the overall sustainability performance, in addition to their consumption habits.

After the completion of the two Delphi rounds, the outcomes of the expert reviews helped to identify the barriers and drivers. This has been converted into survey items where each preidentified barrier and driver by the experts has been transformed into a Likert scale question. This helped to ensure that the survey directly reflects the expert consensus from the first phase.

The survey was created to evaluate stakeholder perceptions (students, faculty, and staff) regarding the key barriers and drivers influencing the reduction of single-use plastic water bottles in the UAE universities. The survey was designed to ensure stakeholder engagement and that the study findings represented the broader university community and presented real-world behavioural and institutional challenges. The survey (appendix 1) included questions on demographics, the ranking barriers and drivers, in addition to an optional section about plastic bottle usage and collection.

The survey was carefully prepared before distribution to increase the responses' reliability. Questions were written to align with the study's objectives, concentrating on key barriers and drivers influencing the reduction of single-use plastic water bottles in the UAE institutes. Ranking questions were demanded due to their high relativity to the research's goal. Nevertheless, optional questions were written to further understand the respondents' behaviours while ensuring flexibility to reduce response bias. A pilot test (n=5) was conducted with students and professors to refine questions for clarity and determine how long it takes to complete the survey. A random sampling method was used to ensure representation across different university roles. Incomplete responses were excluded to maintain the quality of the results. Additionally, the survey was distributed after receiving the relevant research ethical approval from the research committee.

- **Phase 3: Data Analysis Using Weighted Scoring Method**

The Weighted Scoring Method (WSM) was used to analyze and prioritize barriers and drivers based on stakeholder responses. This multi-criteria decision analysis technique enabled a quantitative assessment of factors according to stakeholder perceptions [21].

The WSM was employed to rank the barriers and drivers based on stakeholder responses. The first step was calculating the Mean (M), Standard Deviation (SD), and Median for each factor to evaluate the factor's significance and to measure the spread or variability of responses. The survey used a 5-point Likert scale (1 = Not Important, 5 = Extremely Important), permitting participants to rate the importance of each element independently. The mean and standard deviation were calculated using proper statistical tools. To enable comparison and ranking of drivers and barriers, the mean scores were normalized to sum the total weight to 100% (or 1.0). Normalization ensured that the weighted values reflected the relative importance of each factor rather than absolute differences in ratings. The normalized score for each factor was calculated using the following formula:

$$W_i = \frac{M_i}{\sum M} \quad (1)$$

Where W_i is the normalized weight for factor i , M_i is the mean score for factor i , and $\sum M$ is the sum of mean scores within the same category (barriers or drivers).

The study population consisted of students, faculty, and staff from various universities across the United Arab Emirates. To ensure a diverse and representative sample, a random sampling approach was employed. The survey was distributed electronically, and participation was voluntary and anonymous. While the specific universities were not recorded as a variable in this study to maintain the anonymity of the participants and their institutions, the recruitment process targeted a mix of public and private universities to capture a broad range of perspectives within the UAE's higher education sector. A total of 384 complete and valid responses were collected and included in the final data analysis. The sample consisted of 250 students, 84 faculty members, and 50 staff members.

3. Results and Discussion

Barriers and Drivers: Expert and Stakeholder Perspectives

The findings of this study revealed the factors affecting the single-use plastic water bottle reduction in the UAE universities. A survey with sustainability experts identified some barriers, such as the lack of awareness about environmental impact, cost of reusable bottles and refill stations, limited access to refill stations on campus and ease

of access to plastic bottles, preference for bottled water due to health/safety concerns, and cultural habits favoring plastic use. Analyzing the responses received from the experts showed that the major barriers can follow this order: environmental awareness, limited access to refill stations, and the convenience of disposable bottles. Furthermore, cultural factors and water quality perceptions also emerged as significant obstacles to minimizing the utilization of single-use plastic bottles. The findings of this survey are summarized in Table 1, which summarizes the key barriers and drivers documented by experts during Delphi Round 1. The repetition of certain items, such as lack of awareness and incentives, across multiple responses indicates early consensus on the institutional impact. These findings directly informed the development of structured items used in Delphi Round 2, where participants were asked to rate and prioritize these factors quantitatively. The emphasis on behavioural and systemic issues also aligns with existing literature on adopting sustainability in higher education.

On the other hand, the survey revealed that the most impactful drivers, as ranked by experts, were university leadership, awareness campaigns, and refill station accessibility, with minimal variation across expert responses. In contrast, notable discrepancies emerged in expert ratings for peer influence and incentives. This suggests that their perceived effectiveness may depend on contextual or campus-specific factors, such as student culture, resource availability, or implementation strategies. These results support the need for top-down leadership and bottom-up behavioural change, laying a solid foundation for designing stakeholder surveys and institutional action plans.

The stakeholder survey was distributed among students, faculty members, and staff to collect different campus viewpoints on barriers and drivers influencing single-use

plastic bottle reduction. A total of 100 responses were received, and the data were analysed using descriptive statistics to assess the perceived importance of each factor. Demographic data showed that the majority of respondents were students (88%), followed by faculty members (7%) and staff (5%). In terms of gender, 64% of the participants were female. Over half of respondents (54%) had been at the university for 1–3 years, 22% for less than 1 year, 15% for 4–6 years, and 9% for more than 6 years. The results indicated that 66% of respondents reported utilizing plastic water bottles daily, stressing the deep-rooted reliance on bottled water. Likewise, only 47% reported disposing of plastic bottles in recycling bins, while 41% admitted using general waste bins, indicating a recycling behavior gap despite infrastructure access. However, 42% stated that recycling bins are available and easy to find in their colleges, 11% were unaware of recycling bins in their universities, and a combined 45% noted that bins are either limited or not easily accessible in their study areas. These supplementary data points offer valuable behavioural insights to support institutional decision-making. The environmental implications of these consumption patterns are significant. Based on our survey data and university population estimates, we assume a university campus with 10,000 students generates approximately 15,000 plastic bottles weekly. This translates to roughly 600,000 bottles annually from a single campus, contributing substantially to the country's plastic waste challenge.

The results of the survey are presented in Table 2 showing the stakeholder ratings for key barriers and drivers. Scores were derived employing descriptive statistics and normalized through the Weighted Scoring Method (WSM). The mean scores were expressed as percentages to allow for the proportional ranking of each barrier and driver based on their relative importance.

Table 1. Experts' list of main barriers and drivers

Expert No	Barriers	Drivers
Expert 1	Lack of suitable alternative, use of single-use plastic is more convenient to students; some students think it is more hygienic	Incentives and recognition Positive image to those who are using reusable plastic Enact bans on the use of single-use plastic
Expert 2	Lack of awareness and resistance to change Limited availability of refill stations Existing contracts with bottled water suppliers Absence of enforcement mechanisms	Awareness and Education Campaigns Policy Mandates Incentives and Rewards Collaborations and Partnerships
Expert 3	A glass bottles is more costly than a plastic bottle Lack of awareness	Universities can encourage or implement a refill station Campuses can request a governmental support for shifting to glass bottles The universities can make an incentive program for the students to encourage them to avoid single-use plastic bottles
Expert 4	Awareness on the importance of recycling	More education, campaigns Discuss the topic in the curriculum

Table 2. Summary of the ranking of barriers and drivers for minimizing single-use plastic bottles in a university campus (n=100)

Criteria	Mean score	SD	Wi
Barriers			
Lack of awareness	3.06	1.36	18.6%
High cost of reusable bottles and refill stations	2.99	1.29	18.2%
Refill station limitation and plastic bottle convenience	3.31	1.15	20.1%
Health & safety concerns	3.41	1.05	20.8%
Cultural habits favoring the use of plastic	3.66	1.26	22.3%
Drivers			
Awareness and educational campaigns promoting plastic reduction	3.31	1.30	19.4%
University leadership actively promoting sustainability	3.35	1.20	19.7%
Accessibility of water refill stations on campus	3.47	1.15	20.4%
Incentives	3.32	1.09	19.5%
Peer influence	3.58	1.18	21.0%

The mean scores and standard deviations for each of the identified barriers and drivers are presented in Figure 1 and Figure 2. The highest-weight barrier was cultural habits favoring plastic use, with a mean of 3.66, and a normalized weight of 22.28%. The standard deviation ($SD = 1.26$) still reveals that most respondents viewed this factor as "very important," emphasizing a strong agreement on the behavioural roots of plastic consumption. The findings of this study are in alignment with the study done by Boca et al. [22], where the cultural factors are found to significantly influence plastic waste perceptions among university students. Also, the recycling behaviours and environmental responsibility showed notable differences across different cultural contexts.

The health and safety concerns followed cultural habits, with a mean of 3.41 and an SD of 1.05, showing consistent responses. The weight of 20.75% shows that it is perceived as a top barrier. This finding reflects persistent perceptions about tap water quality and safety in the UAE context. Despite the existing evidence of water safety, users may have some concern about tap water, where this can be avoided through proper communication and water safety campaigns on campus. The lower standard deviation (1.05) compared to other barriers suggests more consistent agreement among stakeholders regarding this concern. This aligns well with regional water consumption patterns where bottled water is often perceived as cleaner or safer than tap alternatives. Yoo [23] found that hygiene concerns related to water quality were the primary hindrance to tap water consumption among university students, even in areas with high-quality municipal water. The third-ranked barrier was refill station limitation and plastic bottle convenience (20.15%), which reflects infrastructure and perception-based barriers. Nguyen et al. [24] reported similar findings, where limitations of infrastructure have significantly impacted the plastic bottle consumption

patterns on university campuses, with accessibility of alternatives being a critical factor in behaviour change. The lowest-rated barrier was the high cost of reusable bottles which can be explained since UAE is classified as one of the high-income countries.

With respect to the key drivers, peer influence ranked highest, with a mean score of 3.58, and a weight of 21.02%. A previous study has demonstrated that social comparison information can significantly influence intentions to reduce single-use plastic water bottle consumption among university students, confirming the powerful role of peer influence in motivating sustainable behaviours [4]. This study also revealed that the accessibility of water refill stations on campus ($M = 3.47$, $SD = 1.15$, $W_i = 20.38\%$) ranked second, emphasizing the dual role of social impact and practical availability in promoting sustainable behaviour. These findings align with research conducted by Nguyen et al. [24], which suggests that the strategic placement and accessibility of refill stations are critical factors in reducing plastic bottle consumption on university campuses.

University leadership actively promoting sustainability was the third highest-rated driver ($M = 3.35$, $SD=1.2$, $W_i = 19.67\%$). Although still considered relevant, its moderate ranking may be due to the perception of the respondents who see the leadership efforts as less directly influencing the shift to reusable bottles. This finding underlines the need for more consistent and visible engagement from educational institute leadership to reinforce sustainability goals. The awareness and educational campaigns promoting plastic reduction were the lowest-rated drivers, with a mean score of 3.31, and a normalized weight of 19.44%. Although still considered relevant, its lower ranking relative to other drivers may indicate that respondents' perceptions towards awareness efforts alone are insufficient to drive behaviour change unless paired

with infrastructure or incentives. This may also reflect past experiences in which environmental messaging failed to translate into behavioural change. An earlier study found that while 39.79% of university students participated in environmental conferences, the effectiveness of awareness campaigns showed a significant variation among students due to lack of practical engagement in such activities. The practical engagement opportunities showed greater impact than passive information delivery [22]. Ultimately, this analysis supports the qualitative insights from Delphi rounds 1 and 2, where experts identified the same high-impact factors and affirmed their relevance across different respondent groups.

The means and normalized weights representing stakeholders' views showed balanced variations, with no single factor dramatically outweighing other barriers or drivers in the ranking. This suggests that effective plastic

reduction strategies must address multiple factors simultaneously rather than focusing on isolated interventions. In other words, minimizing the amount and utilization of single-use plastic bottles in the UAE universities will not be achieved through a single approach but requires a holistic approach that addresses all the drivers and barriers together in one single plan. Furthermore, the mean scores for drivers ranged from 3.21 to 3.58, generally higher than those for barriers, which ranged from 2.99 to 3.66, except for cultural habits. This suggests that campus users may perceive positive motivators as potentially more impactful than obstacles where this optimism will provide a foundation for constructive intervention strategies. This optimistic outlook provides a foundation for constructive intervention strategies.

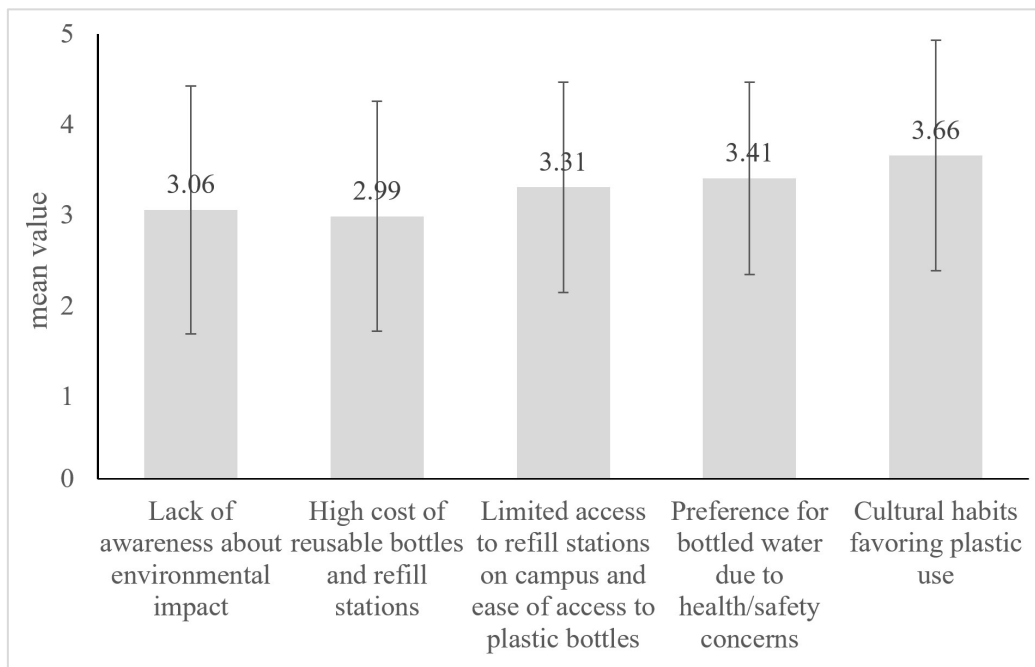


Figure 1. The mean score and standard deviation for each identified barrier in the study

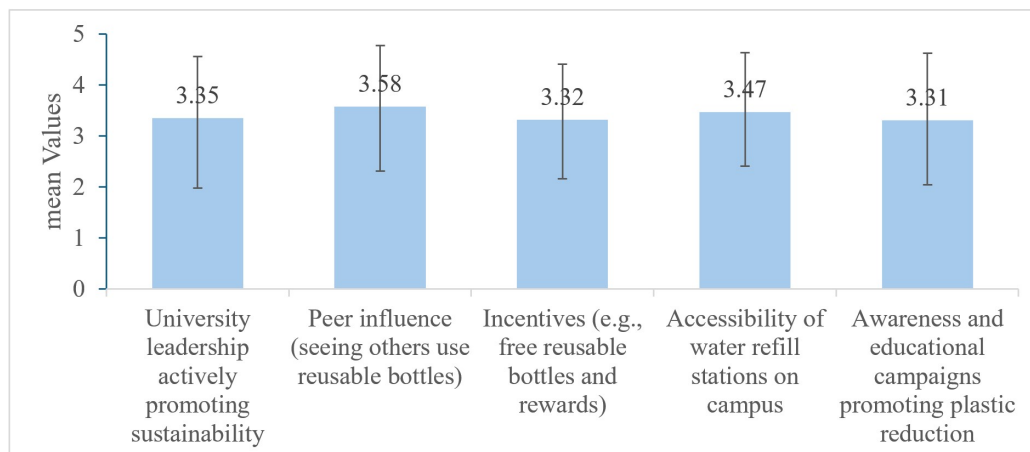


Figure 2. The mean score and standard deviation for each identified drivers in the study

Contextual Factors Influencing Intervention Effectiveness

- Theoretical Framework for Contextual Influences

The impact of contextual variables on the pro-environmental behaviour can be explained through the consideration of the social cognitive theory and the planned behaviour theory. These theories emphasize the interaction between individual factors, environmental conditions, and behavioural outcomes [25]. Earlier studies showed that contextual factors can operate through various pathways to influence behaviour change, which includes direct and indirect effects on behaviour through attitudes, social norms, and perceived behavioural control. The proper understanding of these mechanisms is very important for designing effective sustainability interventions in the university or any relevant organization.

- Campus Culture and Social Environment Mechanisms

Universities with established sustainability cultures demonstrated higher responses to plastic reduction initiatives than other universities lacking this culture. This is mainly because the existence of the of environmental awareness in the institutional culture and student expectations [26]. In this case, the peer influence becomes more effective through the social proof mechanisms, where sustainability behaviours are considered normal rather than exceptional. Earlier studies on social norms in environmental behaviour showed that personal norms serve as the strongest predictors of the good environmental behaviour; however the social norms promote such behaviour through their influence on personal norm development [27].

- Implementation Strategy Variables and Their Mechanisms

The approach to implementing the plastic reduction strategies significantly affects the success of those strategies. There are several psychological and practical mechanisms rooted in behaviour change theory. The top-down policy implementation without the engagement of stakeholders often resulted in resistance because of fail to address the underlying motivations and concerns of stakeholders. This approach violates the basic principle of self-determination theory that emphasizes autonomy and competence [28]. To achieve successful implementations, a combination of policy measures with educational approaches supported by infrastructure enhancement and incentive systems, is needed to address multiple barriers simultaneously.

- Stakeholder-Specific Contextual Influences

Different Stakeholder groups may respond differently based on their roles, motivations and constraints that they may face within the university environment. For example, students who are considered the largest consumer group are

mainly influenced by peer behaviour, convenience, and cost considerations due to their developmental stage and social environment background [29]. On the other hand, faculty members, as educators and role models may be influenced by their professional identity and their commitment to the institutional values which makes them responsive to the environmental acts that align with their educational role. Finally, staff members may be more influenced by the policy consistency and their commitment to support the university's sustainable practices.

4. Conclusions

Based on the results obtained from this study, the authors identified several practical implications for the UAE universities seeking to reduce single-use plastic bottle consumption. Universities can leverage social dynamics by enhancing peer-led sustainability initiatives that encourage reusable bottle usage and challenge cultural habits favoring the disposable plastic bottles. Additionally, investing in high-quality, accessible water refill stations, coupled with proper communication to address any possible safety concerns, is essential. There is a critical need to ensure better visibility of university leadership commitments through explicit policy changes, proper policy enforcement, and clear institutional prioritization of sustainability goals. Awareness programs that address specific misconceptions among campus users, such as water safety and environmental impact of single-use plastics, can be impactful rather than relying on generic environmental topics.

Appendix

Appendix 1: Survey on Identifying the barriers and drivers towards limiting the Single-Use Plastic Water Bottles at Universities in the UAE.

Section 1: Introduction

Dear Participant,

Thank you for taking the time to participate in this survey. This study aims to explore the barriers and enablers influencing the reduction of single-use plastic water bottles in UAE universities. Your insights will help identify the key factors affecting sustainability initiatives and provide valuable input for improving plastic reduction strategies on university campuses.

The survey consists of ranking questions where you will evaluate various barriers and drivers based on their importance. Please read each question carefully and provide your responses based on your experience and perspective. Your participation is voluntary and anonymous, and all responses will remain anonymous and will be used solely for research purposes.

Thank you for your valuable contribution!

Aysha Alkaabi

Section 2: Demographic Questions

* Indicates required question

1. Role at the University Role at the University *
Mark only one oval.
 - Student
 - Faculty Member
 - Staff
2. Gender *
Mark only one oval.
 - Male
 - Female
 - Prefer not to say
3. How long have you been affiliated with this university?
 - Less than 1 year
 - 1–3 years
 - 4–6 years
 - More than 6 years

Section 3: Barriers to Reducing Single-Use Plastic Bottles

Rate how much each of the following barriers prevents UAE universities from reducing plastic bottle use.
(1 = Not Important, 5 = Extremely Important)

1. Lack of awareness about environmental impact
2. High cost of reusable bottles and refill stations
3. Limited access to refill stations on campus and ease of access to plastic bottles
4. Preference for bottled water due to health/safety concerns
5. Cultural habits favoring plastic use

Section 4: Drivers for Reducing Single-Use Plastic Bottles

Rate the importance of each of the following factors in encouraging plastic bottle reduction in UAE universities.

1. University leadership actively promoting sustainability
2. Peer influence (seeing others use reusable bottles)
3. Incentives (e.g., free reusable bottles and rewards)
4. Accessibility of water refill stations on campus
5. Awareness and educational campaigns promoting plastic reduction

Section 5: Usage & Collection of Plastic Bottles
OPTIONAL

1. How often do you use single-use plastic water bottles on campus?
 - Daily
 - A few times per week
 - Once a week
 - Rarely
 - Never

2. How do you typically dispose of plastic water bottles on campus?
 - In general waste bins
 - In recycling bins
 - I take them home for reuse or recycling
 - I rarely use plastic bottles
3. Are recycling bins for plastic bottles easily accessible on your campus?
 - Yes, they are available and easy to find
 - Yes, but they are limited in number
 - No, they are not easily available
 - I am not aware of recycling bins on campus

REFERENCES

- [1] OECD, “Global Plastics Outlook: Economic Drivers, Environmental Impacts and Policy Options,” OECD Publishing, Paris, Feb. 2022. doi: 10.1787/de747aef-en.
- [2] J. C. Prata, J. P. da Costa, I. Lopes, A. C. Duarte, and T. Rocha-Santos, “Environmental exposure to microplastics: An overview on possible human health effects,” *Science of The Total Environment*, vol. 702, p. 134455, 2020, doi: 10.1016/j.scitotenv.2019.134455.
- [3] R. Rajput, A. Hussain, and S. Sharma, “Environmental impacts of single-use plastics and sustainable alternatives,” *Environmental Science and Pollution Research*, vol. 29, no. 10, pp. 14234–14253, 2022, doi:10.1007/s11356-021-17426-3.
- [4] K. Bruchmann, S. M. Chue, K. Dillon, J. K. Lucas, K. Neumann, and C. Parque, “Social Comparison Information Influences Intentions to Reduce Single-Use Plastic Water Bottle Consumption,” *Frontiers in Psychology*, vol. 12, p. 612662, 2021, doi: 10.3389/fpsyg.2021.612662.
- [5] A. Mohammadi, N. Mehrabi, and M. Nasiri, “Plastic pollution on university campuses: A global review,” *Environmental Science and Pollution Research*, vol. 30, no. 5, pp. 10789–10805, 2023, doi:10.1007/s11356-022-24589-3.
- [6] M. T. Seblosa, H. M. Ramos, and D. Guillen, “Sustainable alternatives to single-use plastics in educational institutions,” *Journal of Cleaner Production*, vol. 401, p. 136594, 2023, doi: 10.1016/j.jclepro.2023.136594.
- [7] UAE MOCCA, “National Climate Change Plan of the United Arab Emirates 2017-2050.” UAE Ministry of Climate change, 2017. [Online]. Available: <https://www.moccae.gov.ae/assets/30e58e2e/national-climate-change-plan-for-the-united-arab-emirates-2017-2050.aspx>
- [8] H. Mahmood, A. Salam, and M. Khan, “Bottled water consumption patterns among university students in the UAE,” *Journal of Environmental Management*, vol. 331, p. 117271, 2024, doi: 10.1016/j.jenvman.2023.117271.
- [9] J. K. Singh and P. Blessinger, “The role of higher education in promoting sustainable development goals,” *International Journal of Sustainability in Higher Education*, vol. 24, no.

- I, pp. 1–15, 2023, doi: 10.1108/IJSHE-01-2022-0018.
- [10] L. Romdhane, R. Razzouk, and F. Hmaied, “Barriers to sustainability transitions in higher education institutions: A systematic review,” *International Journal of Sustainability in Higher Education*, vol. 24, no. 2, pp. 367–386, 2023, doi: 10.1108/IJSHE-06-2022-0189.
- [11] J. M. Santiago, N. Veiga, and J. Peixoto, “Effectiveness of plastic reduction initiatives in higher education: A comparative analysis,” *Sustainability*, vol. 16, no. 3, p. 1289, 2024, doi: 10.3390/su16031289.
- [12] A. Emad, M. Kamal, and M. Nazzal, “Sustainable water consumption in higher education institutions: A case study from the Middle East,” *Journal of Cleaner Production*, vol. 382, p. 135211, 2023, doi: 10.1016/j.jclepro.2022.135211.
- [13] O. O. Oludoye and N. Supakata, “Awareness campaigns and pro-environmental behavior: A study of university students,” *Journal of Cleaner Production*, vol. 425, p. 138721, 2024, doi: 10.1016/j.jclepro.2023.138721.
- [14] F. Hasson and S. Keeney, “Enhancing rigour in the Delphi technique research,” *Technological Forecasting and Social Change*, vol. 78, no. 9, pp. 1695–1704, Nov. 2011, doi: 10.1016/j.techfore.2011.04.005.
- [15] N. Mukherjee *et al.*, “The Delphi technique in ecology and biological conservation: applications and guidelines,” *Methods Ecol Evol*, vol. 6, no. 9, pp. 1097–1109, Sept. 2015, doi: 10.1111/2041-210X.12387.
- [16] D. Khodyakov, “Generating Evidence Using the Delphi Method,” Oct. 2023. Accessed: Sept. 27, 2025. [Online]. Available: <https://www.rand.org/pubs/commentary/2023/10/generating-evidence-using-the-delphi-method.html>
- [17] D. Beiderbeck, N. Frevel, H. A. Von Der Gracht, S. L. Schmidt, and V. M. Schweitzer, “Preparing, conducting, and analyzing Delphi surveys: Cross-disciplinary practices, new directions, and advancements,” *MethodsX*, vol. 8, p. 101401, 2021, doi: 10.1016/j.mex.2021.101401.
- [18] P. Nasa, R. Jain, and D. Juneja, “Delphi methodology in healthcare research: How to decide its appropriateness,” *World J Methodol*, vol. 11, no. 4, pp. 116–129, July 2021, doi: 10.5662/wjm.v11.i4.116.
- [19] [L. Furtado, F. Coelho, S. Pina, C. Ganito, B. Araújo, and C. Ferrito, “Delphi Technique on Nursing Competence Studies: A Scoping review,” *Healthcare*, vol. 12, no. 17, p. 1757, 2024, doi: 10.3390/healthcare12171757.
- [20] A. Triantafyllou *et al.*, “Developing a questionnaire on Knowledge, Perceptions and Application of Vascular-Aging Measurements,” *Journal of Cardiovascular Development and Disease*, vol. 10, no. 2, p. 80, 2023, doi: 10.3390/jcdd10020080.
- [21] H. Taherdoost and M. Madanchian, “Weighted scoring method: A comprehensive review of multi-criteria decision-making techniques,” *Decision Analytics Journal*, vol. 6, p. 100136, 2023, doi: 10.1016/j.dajour.2022.100136.
- [22] G. D. Boca, A. Işitan, E. Çağlarer, and S. Saraçlı, “A Cross-Cultural Analysis for Plastic Waste Perception of Students from Romania and Turkey,” *Sustainability*, vol. 15, no. 24, p. 16594, 2023, doi: 10.3390/su152416594.
- [23] J. H. Yoo, “Motivators and Hindrances of Consuming Reusable Water Bottles: An Exploratory Case Study at Columbia University,” *Consilience*, no. 27, 2025, doi: 10.52214/consilience.vi27.12156.
- [24] X. C. Nguyen *et al.*, “Generation patterns and consumer behavior of single-use plastic towards plastic-free university campuses,” *Chemosphere*, vol. 291, no. 3, p. 133059, 2022, doi: 10.1016/j.chemosphere.2021.133059.
- [25] M. Helferich, J. Thøgersen, and M. Bergquist, “Direct and mediated impacts of social norms on pro-environmental behavior,” *Global Environmental Change*, vol. 80, p. 102680, May 2023, doi: 10.1016/j.gloenvcha.2023.102680.
- [26] M. A. Budihardjo, B. S. Ramadan, S. A. Putri, I. F. S. Wahyuningrum, and F. I. Muhammad, “Towards Sustainability in Higher-Education Institutions: Analysis of Contributing Factors and Appropriate Strategies,” *Sustainability*, vol. 13, no. 12, p. 6562, June 2021, doi: 10.3390/su13126562.
- [27] N. Niu, W. Fan, M. Ren, M. Li, and Y. Zhong, “The Role of Social Norms and Personal Costs on Pro-Environmental Behavior: The Mediating Role of Personal Norms,” *PRBM*, vol. 16, pp. 2059–2069, June 2023, doi: 10.2147/PRBM.S411640.
- [28] C. M. Baum and C. Gross, “Sustainability policy as if people mattered: developing a framework for environmentally significant behavioral change,” *J Bioecon*, vol. 19, no. 1, pp. 53–95, Apr. 2017, doi: 10.1007/s10818-016-9238-3.
- [29] A. Y. J. Tsai and A. Y. K. Tan, “The Expanded Theory of Planned Behavior in the Context of Environmental Protection Behaviors for Undergraduates: Roles of Moral Norms and University Class Standings,” *IJERPH*, vol. 19, no. 15, p. 9256, July 2022, doi: 10.3390/ijerph19159256.