

Assessment of public awareness and opinions toward waste minimization through a survey in the Kingdom of Bahrain

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Abstract

The Kingdom of Bahrain is a country of relatively small size, with a high population density, and a rapidly growing economy. The increasing population is escalating the growth rate of Municipal Solid Waste (MSW) generation. Sustainable management of MSW is an important mission for Bahrain's policymakers, urban planners, and concerned municipalities due to the rising population, increase MSW generation rate per capita, and limited availability of land for waste disposal. A questionnaire-based survey of 300 respondents has been conducted to determine their understanding of the environmental mindset of the people living in Bahrain and their willingness to participate in waste minimisation strategies in the form of waste reduction, reuse, and recycling. In addition, this survey explored the differences between the educational level, gender, age, nationality, and social class of the participants regarding their level of public awareness and attitude toward MSW management practices. Only 62% of the respondents knew that MSW has been disposed to a landfill site in Bahrain. This relatively low rate indicates the requirements for educational and awareness programmes in Bahrain. 78% of the respondents believe that improvement of waste management is the responsibility of all individuals, communities, companies, and governments. An additional 10% also consider that it is the accountability of the individuals only. Therefore 88% of the respondents showed awareness of their own responsibilities in waste management. Different age groups and levels of education did not show any statistical differences in the willingness of applying waste minimization practices although education showed a strong correlation with the knowledge of the disposal of the generated MSW in Bahrain.

Keywords: landfill, MSW, recycling, reuse, waste management, 3R

1. Introduction

The best practice of MSW management in developed countries emphasizes numerous strategies for reuse, recycle, and reduction of waste, with landfilling being the least preferred option, at the bottom of the waste management hierarchy (OECD, 2013). Diverting waste from landfills becomes imperative that has numerous social, economic, and environmental benefits, and it is in line with the global response to the climate challenge. Many economies aim for the "zero waste" concept, which is not an economic reality but rather an aim or a long-term ambition of companies to reduce waste from the complete chain of business activities, from production to the customer (Morgan, 2017). This would enable the development of a fluid circular economy, including waste in its cycle as a valuable resource, with its maximum value being extracted and reused.

There are a few waste-to-energy options in MSW management (Mutz et al, 2017), which simultaneously offer solutions to multiple problems: renewable energy generation, decreased greenhouse gas emissions, and limited land for landfilling and waste disposal. These methodologies include incineration, pyrolysis/gasification, anaerobic digestion (for the pre-separated organic fraction of MSW), and landfill gas collection as a post-disposal option. All these technologies not only significantly reduce pressure on landfill, but provide revenue, using waste as a valuable resource. Unfortunately, most of the above technologies have a high capital cost; for example, it has been estimated that anaerobic digestion costs 4 to 6 times more than landfilling (Clarke, 2018). To overcome this, in addition to renewable energy generation, revenue can be obtained from process by-products (e.g., the digestate from anaerobic digestion can be sold as fertiliser), and gate fees or subsidies are required to cover the full costs.

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The potential of landfill gas-to-energy options to generate electricity and reduce the carbon footprint in Bahrain from the MSW Askar landfill site has been recently investigated (Coskuner et al., 2020).

Even though historical incidents of uncontrolled land and sea dumping are now regulated by law, un-engineered landfilling poses an issue to be addressed. Bahrain's primary landfill site is nearing its extended capacity and there is a need to plan other waste management strategies. Up to less than a generation or so ago, as with neighbouring regions in the Gulf, its population lived in close equilibrium with this natural environment, producing domestic waste composed of predominantly date stones, palm fronds, and camel bones (Clarke and Almannai, 2014). However, Bahrain's socioeconomics has changed rapidly with the country using large revenues from fossil fuel exports to develop large urban conurbations coincident with rapid population increases which produce large volumes of post-consumer waste in the last few decades (Sillitoe, 2014).

The complex problem of waste management could present an opportunity for Bahrain to develop and implement a world-leading environmentally sound waste strategy. This could incorporate the new modern findings (as contained in papers such as by Van Ewijk and Stegemann, (2016) and contribute to the overall achievement of a circular economy, where waste is used and re-used as a valuable resource. Research has shown that a positive attitude toward recycling may not manifest itself in behaviour, particularly where there are real or perceived barriers (Clarke and Almannai, 2014). There are also scattered initiatives for waste recycling and positive signs that Government is realising the potential in developing a national waste management strategy.

Bahrain's economy is reported to have been the fastest growing of all Gulf Co-operation Council (GCC) countries in 2017 (Bridge, 2018). But, in terms of its adoption of environment-friendly renewable energy technologies, the country has simultaneously been described as a "laggard" (Atalay, et al., 2016). It has also recently been placed fifth in a global ranking of countries according to per capita carbon dioxide emissions, with these being 4.7 times greater than the Arab World average, 3.1 times greater than the Other Small States, and 2.4 times greater than the mean for all OECD nations (World Bank, 2018). Only Qatar and Kuwait ranked higher in the same report. In a recent study, it has been shown that total annual CO₂ emissions were strongly correlated with the annual amount of MSW disposed to Askar Landfill in Bahrain (Jassim et al., 2021).

In addition, the Kingdom of Bahrain also has a pronounced problem with MSW. Currently, and in contrast to best practice, as defined by the environmental waste hierarchy, it implements controlled but un-engineered landfilling of refuse (Al Sabbagh, et al., 2012; Abiad and Meho, 2018). The Kingdom of Bahrain's only landfill site is at the village of Askar. It started receiving MSW in February 1986 with an operational capacity of 250 hectares at a depth of 10m to 15m. By July 2016 it was full and had to be extended by a further 60 hectares at a depth of 15m. MSW is acknowledged as being one of the country's biggest challenges, with many reports stating that the volumes produced are not only too high but that the landfill site has surpassed its capacity (Unnikrishnan, R., 2018; Khalil and Suliman, 2017; Al Ansari, 2012). The implications of this to the environment are through the global environmental impact of methane greenhouse gas emissions, but locally the situation also represents an immediate danger to the country's unique habitats and wildlife (Al Ansari, 2012).

The problems of managing greenhouse gas emissions, protecting existing ecology, and attempting to manage the large volumes of waste produced by a consumerist society, are not restricted to the Kingdom of Bahrain (Priyadarshini, 2018, Hoornweg et al. 2013). These are major global challenges for which much has been written, with some authors questioning whether it is even possible to reconcile sustainability and environmental protection within the current paradigm of economic growth, and others asserting that "sustainable development" may be an oxymoron (Henfrey, 2014; Sillitoe, 2014). But the nation can perhaps be considered as representing an exemplar of these current global problems in microcosm: having a serious waste problem, being a small island state with a relatively large population, with a rapidly expanding economy, coincident with its unique and "blessed" ecology. Little has however been written about the reasons for the current waste problems in Bahrain, and fewer offer suggestions for either short- or long-term remedial options.

Research has shown that a positive attitude toward recycling may not manifest itself in behaviour, particularly where there are real or perceived barriers (Clarke and Almannai, 2014). There are also scattered initiatives for waste recycling and positive signs that the Bahraini Government is realising the potential of waste recycling in developing a national waste management strategy. Al Sabbagh, et al. (2012) mentions numerous recycling/landfill diversion strategies but also state that there is an overall lack of strong waste recycling, reduction, and prevention initiatives. A few small recycling companies are operating in Bahrain for collecting recyclables. For example, Al Majid Plastic and Metal Recycling Factory began its operation in 2013 and focuses on the recycling of paper and cartons, but also plastics and metal (www.recyclebahrain.net/). The company has recycling containers for waste sorting distributed around the country and contracts with three municipalities (Manama Municipality, Northern Municipality & Southern Municipality) and numerous markets and businesses.

Similarly, the Bahrain Recycling Plant (2019), located in Askar Industrial Area, is an aluminium recycling company with local and overseas partners (www.bahrainrecycling.com/). Although there are some small-scale initiatives for the provision of recycling practices in Bahrain, there are limited studies carried out for the assessment of public awareness of waste minimization practices. Attitudes and opinions of 384 people regarding public littering in the Kingdom of Bahrain were investigated and it was found that paper is the most frequently littered item followed by food wrappers and plastic (Freije et al, 2019). Another recent study focused on the public awareness of household waste management in the Muharraq Governorate in Bahrain. This study provides valuable insight into the perception and opinions of 300 respondents who live in the Muharraq Governorate (Abbas et al., 2020).

Public awareness is an important element for increasing public participation in sustainable waste management programs. In fact, public participation is one of the most critical factors for the success of recycling programs apart from appropriate legislation, strong technical support, and adequate funding. Therefore, this study investigated the perceptions and opinions of 300 respondents living in Bahrain from different ages, gender, educational level, nationality, and social class regarding their knowledge of MSW management and opinions on waste minimization practices.

2. Materials and Methods

2.1 Study Area

The Kingdom of Bahrain is an archipelago comprising a total land area of ca. 778 km², but the number and size of islands constantly changing due to land reclamation (Al-Joburi, 2018). The largest island is Bahrain, which has a predominantly flat, rocky, and bare topography, surrounded by a shallow continental shelf. The climate is arid sub-tropical, with low rainfall and high summer humidity. The latest statistics on the human population (2021) show 1.5 million inhabitants (Central Informatics Organisation, 2021). In addition to this, the Kingdom's tourism reportedly reached 12 million tourists visiting in 2018 (The World Bank, 2020).

The country is divided into four managerially and financially autonomous governorates: The Capital, Al Muharraq, Northern, and Southern as shown in Figure 1. The management of municipal waste is, however, the responsibility of three national governmental bodies: The Ministry of Works, Municipalities Affairs and Urban Planning (MoWMAUP), the Supreme Council for Environment (SCE), and the Ministry of Industry, Commerce, and Tourism (MICT). MoWMAUP is responsible for tendering, contracting, and supervising the cleaning, collection, and transporting services of domestic waste and street sweepings, along with also being responsible for landfill site operation. SCE is responsible for MSW legislation, which also includes licensing for hazardous and medical waste treatment. MICT is responsible for maintaining a register of the private companies contracted to manage the waste.

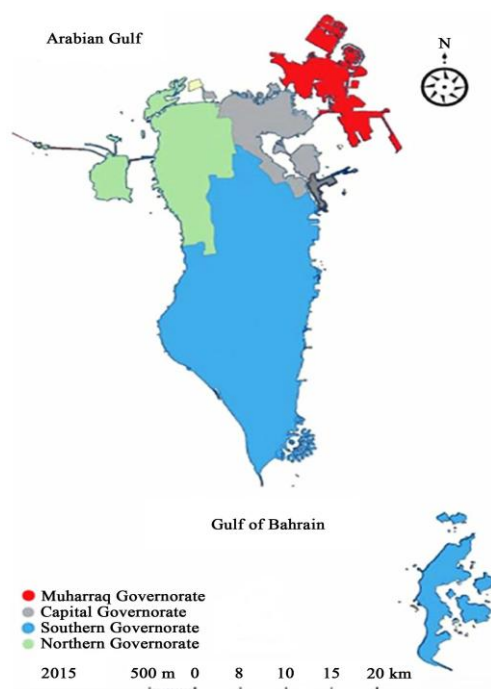


Figure 1. Bahrain map with the main four governorates (Source: The figure is licensed under a Creative Commons Attribution 4.0 International License)

2.2. Status of MSW Management in Bahrain

Since 2001, unsegregated domestic refuse has been collected by private companies, through communal 1100 L capacity bins distributed around public areas such as schools, bus stops, markets, roadsides, walkways, and public gardens. Some 250 L bins are also provided across the country. This waste, along with commercial and industrial waste plus road sweepings, is then transferred to the Askar Landfill site where nominal gate fees are applied. Incoming waste is audited at the Askar landfill site based on its origin, and with total volume determined using a weighing bridge. During maintenance periods, the amount of waste is estimated by the number of wheels or visible inspection methods. This results in the total record of received waste being a combination of real data and estimated amounts.

The Askar landfill site is approximately 25 kilometres from the capital city of Manama, and around 4 kilometres away from the Askar village residential area. The site currently does not operate best-practice civil engineering methods for land remediation (Cooper, 2010). Open tipping into a quarry in sections ca. 10 to 15m deep and ca. 100m² wide occur, rather than containment into smaller cells with geosynthetic clay liners, which is a common practice at engineered landfills (Al-Joburi, 2018). Waste is tipped within existing holes in the stone quarry area and covered by sand. As per MoWMAUP estimations, approximately 1.7 cubic meters is required for each ton of MSW (this 1.7m³ covers also the sand used for coverage). During a site visit, it was reported to the authors that lining was only applied to one section, this being for hazardous waste disposal. Though there was some compaction, this was accompanied by only very minimal sand covering (refuse could be seen protruding through it). There was the absence of a leachate draining system and a gas collection system. No monitoring boreholes were implemented, along with no analyses of air, groundwater, and sand/soil made at the site. A high incidence of fires was reported. The proximity of the residential areas to the Askar landfill makes these areas vulnerable to emissions of air pollutants, and nuisances such as odour pollution, in addition to nuisances from the passage of trucks delivering the wastes.

Values (on a weight percent basis) and categories of waste received at the Askar site in 2016 are shown in Figure 2. Of note is that these values exclude liquid waste and a category titled "expired foodstuffs", both of which are reported as zero tonnage but were assigned charge values for gate fees. It was reported to the authors that the liquid waste (of unknown composition) was poured over the sand at the Askar site, while the expired foodstuffs were landfilled.

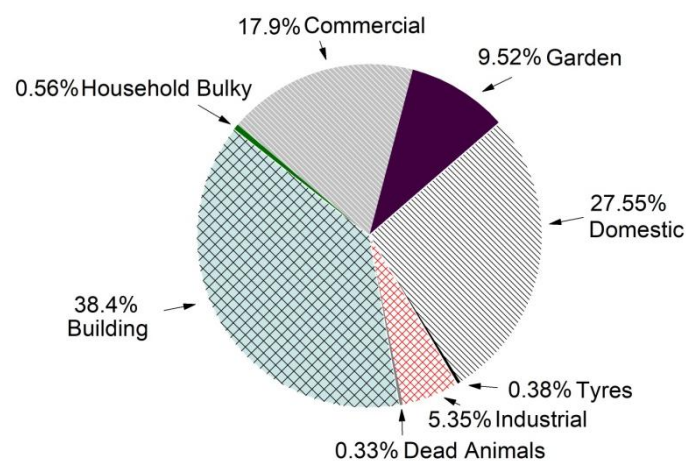


Figure 2. Categories of waste accepted at Askar Landfill Site, Bahrain in 2016. Numerical values represent the estimated percentage of the total received (on a weight basis). Commercial = commercial and institutional waste, Building = construction and demolition waste.

It has been reported that over the period from 1997 to 2016, the Kingdom of Bahrain witnessed a yearly average growth in municipal solid waste (MSW) disposal of 8.04% from 0.384 million tonnes in 1997 to 1.805 million tonnes in 2016. Additionally, it was observed that the minimum daily waste generation rate (WGR) was 1.69 kg/per capita.day in 1999 and the maximum WGR was 4.04 kg/per capita.day in 2008 during the period between 1997 and 2016 (Coskuner et.al, 2021).

2.3. Municipal Solid Waste Composition

It has previously been reported for some GCC countries that a lack of accurate and consistent data on MSW generation is due to an unwillingness by some parties to divulge the true nature and scale of the waste problem, a situation which has caused both disagreement and insufficient clarity on the true volumes of waste generated (Clarke and Almannai, 2014)

Such reticence was not apparent in this study, for both MoWMAUP and staff at the Askar site were freely transparent with the disclosure of information on the disposal rate of different waste streams on daily basis.

However, to assess how much of the waste can theoretically be diverted from the Askar landfill site, a greater resolution on waste composition is required. Unfortunately, the data on waste composition was not available at the Askar Landfill site as the investigation of composition requires tedious work with committed staff and equipment. The latest survey regarding the composition of MSW in Bahrain was carried out in 2017 and a total of 70 samples were physically sorted amounting to 7,000 kg of waste during this survey (Dowding, 2017). The mean percentage composition of MSW in Bahrain is provided in Table 1 as the outcome of this survey.

Materials Recovery Facilities (MRFs) can be used to recover the recyclable materials present within MSW. The MRFs recycle only four categories of materials which are metals, glass, plastic, and paper & cardboard. The main reason behind this recycling process trickling down to these four categories is mainly because of the higher economic value of those materials. Additionally, a significant amount of energy is consumed to make those materials therefore recycling these four categories of materials reduce the amount of MSW to be disposed to landfill site as well as reduce the CO₂ emissions caused by energy-intensive operations to produce them (Yaman et al, 2020). Based on the composition data presented in Table 1., approximately 48.2% of the MSW is occupied by recyclable materials (Paper & cardboard, all plastics, glass, and metals) in Bahrain. If a reasonable number of recyclable materials can be recovered, it will have a substantial positive impact on the environment, resources, and economy of the country.

Table 1: MSW Composition as mean percentage in Bahrain (Dowding, 2017).

Material Component	Percentage (%)
Paper & cardboard	11.6
Dense plastic	11.7
Plastic film & other plastics	18.4
Textile	4.1
Miscellaneous Combustibles	1.8
Miscellaneous Non-Combustibles	0.3
Glass	3.3
Ferrous Metals	0.4
Non-ferrous metals	2.8
Food Waste	35.2
Other Organics	2.8
Residual	7.6
Total	100

2.4. Survey Methodology

The present study was performed on a structured questionnaire developed in both Arabic and English based on the methodology used by Clarke, et al. (2017) for Qatar. This was considered both suitable and relevant due to its currency and demographic similarities between the two target populations living in Qatar and Bahrain. The survey aimed to assess the general public's awareness of waste management in the Kingdom of Bahrain and to solicit opinions that could be used to gauge the potential for public participation in more sustainable waste management practices. The first part of the questionnaire survey included details of the respondents regarding their nationality, gender, age group, educational level, and social class to find out the demographics of the respondents. The second part of the questionnaire survey contained the following seven questions to be answered by respondents:

- 1) What happens to the waste you generate?
- 2) How frequently do you throw food items into the garbage?
- 3) Who needs to be responsible to improve the waste management system in Bahrain?
- 4) Are you willing to give up plastic bottles for glass?
- 5) Are you willing to switch to using cloth bags instead of plastic for shopping?
- 6) Would you be willing to segregate recyclable material into separate bags for collection?
- 7) What is the biggest issue that prevents recycling?

The first question was designed to understand the perception of respondents on waste disposal, while the second question was asked to find out the behaviour of respondents regarding the disposal of food waste. The third question was structured for seeking the opinion of respondents regarding the responsible parties for waste management. The last four questions (4 -7) were intended to understand the perception of respondents regarding recycling practices. Initially, both English and Arabic version of the questionnaire was disseminated to a total of fifty members of staff and students at the University of Bahrain via electronic internet media. These recipients were, in turn, asked to forward it to their families and friends (distributed via email and social networks).

Statistical analysis was performed using the Statistical Package for Microsoft Excel. The test of independence was performed using Pearson's chi-squared test. For the test of independence, if the chi-squared probability value or the p-value is less than or equal to 0.05, it is considered just to dismiss any dependence of the variables being tested on each other. The p-value and the chi-squared values as indicated in parentheses can be read as significant or insignificant based on this principle. In other words, differences with p-value < 0.05 were considered statistically significant.

2.5. Respondent Demographics

A total of 300 people responded to the questionnaire (96 in English and 204 in Arabic) indicating a preference for answering the Arabic survey more than the English version. Therefore, we believe that it was useful to provide this questionnaire in both commonly used languages in Bahrain due to the mixed nature of the Bahraini and non-Bahraini population living in the country. The demographics of survey respondents are presented in Table 2.

Demographic analysis showed that 90.33% of the respondents were Bahraini, while only 2.66% were GCC citizens and 7.0% were expatriates (neither Bahraini nor GCC citizens). The very high participation of the Bahraini population in this survey indicates that findings can be more representative of the local population's awareness and attitudes toward solid waste management practices.

Participation in this survey by females of 55.33% was slightly higher than the males with 44.00%. The highest rate of participation in this survey was found to be between the ages of 0 to 24 with a 53.66% rate and this was somewhat expected as it was initially distributed between university students who were then asked to forward it to others. Similarly, the highest participation was found to be from university graduates with a rate of 65% which can show that the education level of the respondents was fairly high. Most of the respondents identified themselves as either lower-middle class or upper-middle-class with 35.66% and 54.33% respectively (total of 89.99%). Therefore, the survey results are dominated by the perception of the middle social class in this study.

Table 2. Demographics of survey respondents

Demographic	Variable	Responses (Arabic)	Responses (English)	Total No	(%)
Nationality	Bahraini	194	77	271	90.33
	Other GCC country	5	3	8	2.66
	Non-GCC country	5	16	21	7.00
Gender	Male	78	54	132	44.00
	Female	124	42	166	55.33
	Declined to say	2	0	2	0.66
Age Group	0 to 24	106	55	161	53.66
	25 to 44	68	24	92	30.66
	45 to 64	27	17	44	14.66
	65 to 74	3	0	3	1.00
	75+	0	0	0	0.00
Highest Education Level	Middle school	3	0	3	1.00
	High school	46	15	61	20.33
	Graduate	146	49	195	65.00
	Post-graduate	9	31	40	13.33
Social Class	Low income	13	9	22	7.33
	Lower middle-class	58	49	107	35.66
	Upper middle-class	127	36	163	54.33
	Affluent	6	2	8	2.66

3. Results

3.1. Survey Results of Perception on Waste Management

As explained earlier, the first three questions were related to the general awareness and behaviour of the respondents. Over one-third of the survey respondents exhibited a misconception on the question "What happens to the waste that you generate?" (Figure 3). Within this group, 9% believed that the waste was sold to other countries for profit. This response is nine times greater than when the same question was posed to residents of another GCC country (Clarke, et al., 2017), despite this practice not occurring in either country. It may be noted that about 30% of the respondents did not know or had not thought about where their waste is going once taken outside their homes. Additionally, it was observed that education only contributes significantly to knowledge of what happens to the generated waste. Undergrads and people with higher education seem to be more aware that most of the waste is landfilled (chi sq value: 16.34, p-value: 0.01).

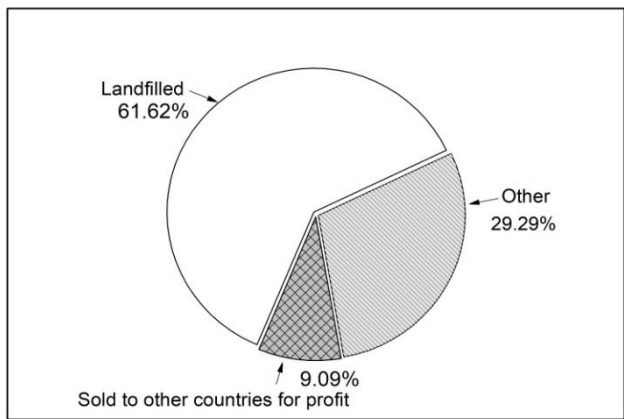


Figure 3. Perception of "What happens to the waste that you generate" among the survey population. Note that two respondents abstained from answering this question.

Figure 4 shows the results of how frequently the survey respondents disposed of food waste each week. More than 50% of respondents report daily disposal, 20% claim disposal three times a week, 14% of the respondents tell once a week, and only 14% claim never to dispose of food waste.

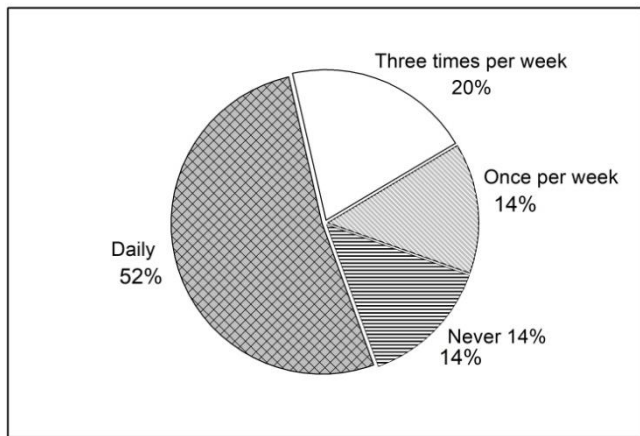


Figure 4. Survey responses to the question of how frequently food waste is thrown away.

Figure 5 illustrates the perceptions of the survey population on who it feels needs to be responsible for improving the waste management system in Bahrain.

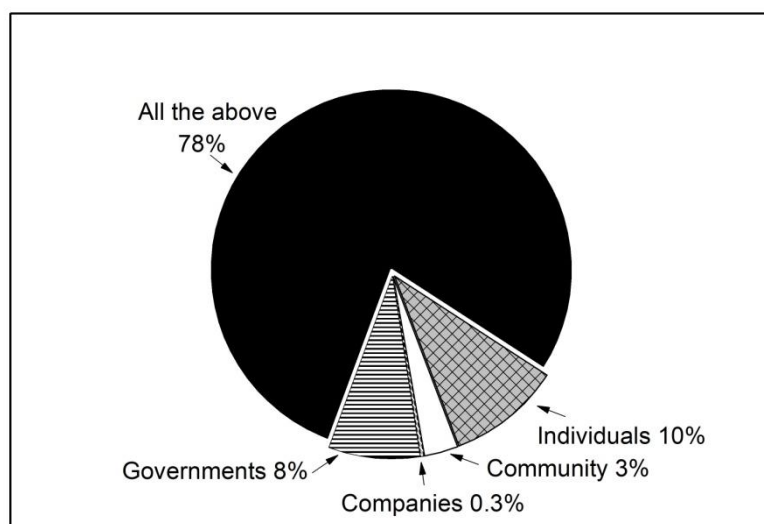


Figure 5. Perception of the sample population on who needs to be responsible for improving the waste management system in Bahrain.

In contrast to the observational evidence from surveys conducted in other GCC countries (around 4% of respondents), only one person in 300 believed that companies were wholly responsible. Also, far fewer respondents (8%) thought that the government was responsible (18% in contrast, for example, from the surveys conducted in the other GCC countries).

3.2. Survey Results of Perception on Waste Minimization Practices

Overall, the survey results revealed a desire to participate in recycling and waste reduction activities (Figure 6 - Figure 8). Gender seems to be a significant factor in willingness to switch plastic bottles out for glass (chi sq value: 11.58, p-value: 0.009). Age seems to play a significant role as well, individuals below the age of 44 seem to be significantly more willing to stop using plastic bottles than individuals over the age of 50 (chi sq value: 16.52, p-value: 0.11). Women (73%) showed a higher incidence of willingness to segregate recyclable material into separate bags for collection in comparison to men (64%); while only 5% of all respondents said that they would not be willing to do so. More women (39%) than men (23%) also expressed a willingness to give up plastic bottles in favour of using glass, regardless of circumstances. Gender seems to be a significant factor in willingness to switch plastic bottles out for glass (chi sq value: 11.58, p-value: 0.009). Interestingly however, across both English and Arabic respondents, an additional 30.5 (± 0.5)% of women said that they would stop using plastic bottles but only if they were cheap, in comparison to a greater number (48%) of men who expressed this same preference. The same trend for thrift was also evident in responses to waste segregation for recycling with 16% of men (in comparison to 11% of women) responding that there would have to be a financial incentive before they would participate in this activity. In addition, 51% of men, compared to 42% of women said that they would only be willing to stop using plastic bags if it was financially attractive for them to do so.

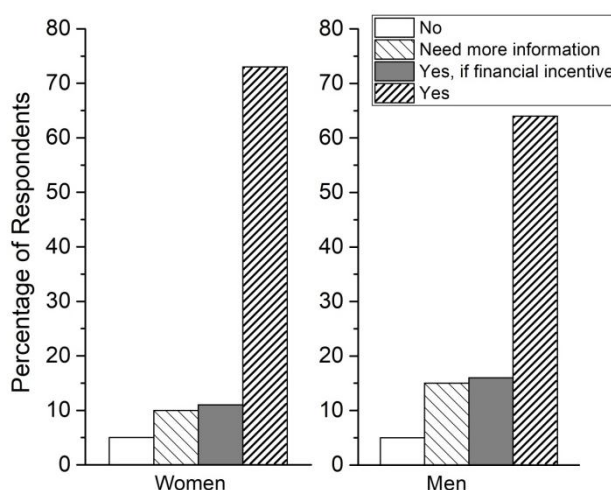


Figure 6. The willingness of respondents to segregate their refuse.

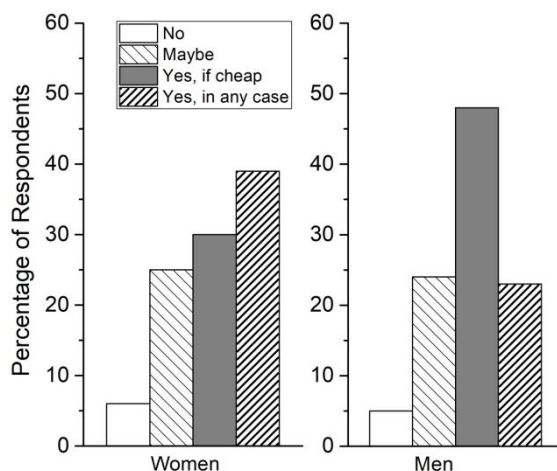


Figure 7. Responses to the question "Are you willing to give up plastic bottles for glass?"

Grouping the age ranges into two categories: 0-24 years, and ≥ 25 years, showed no significant differences on the questions of willingness to segregate their waste (chi sq value: 3.05, p-value: 0.80) and switching from plastic to cloth bags (chi sq value: 2.71, p-value: 0.84), hence showing age is, according to the data, not a contributor to a pro-environment mind-set.

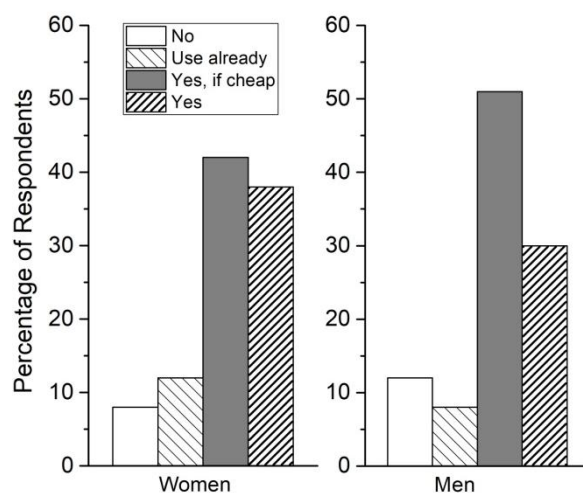


Figure 8. Responses to the question: "Are you willing to switch to using cloth bags instead of plastic for shopping?"

Education does not seem to have a significant impact on environmental behaviour like willingness to give up plastic bottles (chi sq value: 2.68, p-value: 0.97) or willingness to use cloth bags (chi sq value: 16.59, p-value: 0.05). A significant number of the population (chi Sq value: 12.84, p-value: 0.46) think that the lack of bins in neighbourhoods is the greatest barrier to recycling. This is an indication that these variables are dependent. The lack of bins is a significant deterrent to recycling behaviour.

4. Discussion

It is acknowledged that a strong correlation exists between excessive solid waste generation, urbanisation, and gross national income per capita (Hoornweg et al, 2013). Because of these factors, the Kingdom of Bahrain currently must manage large volumes of municipal refuse. However, the country still does not implement a more modern and sustainable waste management strategy as advocated by the waste hierarchy, in which landfill occupies the lowest tier (van Ewijk and Stegemann, 2016). As concluded by other authors, despite its economic status, the absence of a properly designed and maintained landfill site is representative of a developing country (Clarke and Almannai, 2014). Here landfill as a default waste management choice reflects both an absence of adequate infrastructure and planning for coping with the volumes of waste and a lack of awareness about its importance. This was considered by the authors of the study to be representative of limited education and public knowledge about environmental issues in general. This study has shown that there is a somewhat limited understanding of what happens to the country's refuse among what can be considered its most highly educated citizens.

For a target population comprising all citizens of the Kingdom of Bahrain, the survey results are only weakly representative of this group. Rather, they represent the higher end of the country's population in terms of education status. Though no comparable data on this demographic was available, the returned value of 78% of respondents with tertiary education was one-third higher than the current world maximum, and approximately three times higher than the only other GCC country for which data was obtainable - Saudi Arabia at 23% (OECD, 2020). The responses were also heavily skewed in favour of young people, with no respondents above 75 years old, only 1% of respondents between 65 and 74 years of age, and over half the sample population below 25 years. Both were undoubtedly due to the mode of dissemination – the target frame was restricted to internet users, and non-random selection via staff and students at the University of Bahrain. However, it also needs to be noted that Bahrain does have a very young population, with a total median age of 32.2 years (www.indexmundi.com). According to the published data, age groups of 15-24 and 25-54 combined contribute to more than 75% of the total population (15.65% and 65.04%, respectively). The survey responses were also skewed in favour of Bahraini nationals, at 90% of the group, in comparison to governmental data which shows that this group represents only 46% of the country's population.

The survey results show that there exists a latent desire for reuse and recycling practices. Women would seem to need less of a financial incentive to do so in contrast to men. Finally, the results of the survey presented in this work indicate that education of local communities and raising awareness of issues surrounding recycling and waste management is needed. This would provide wider participation in any future Governmental initiatives.

5. Conclusion and recommendations

The complex problem of waste management could present an opportunity for Bahrain to develop and implement a world-leading environmentally sound waste strategy. Waste minimization practices can potentially contribute to the overall improvement of MSW management with additional support for the circular economy as suggested by Van Ewijk and Stegemann (2016), particularly with the high content of recyclable materials in MSW in Bahrain.

Results of our survey showed that low waste auditing currently occurs, concurrent with limited incentives to divert waste from landfill. Survey respondents showed a clear latent to embrace waste reduction policies and recycling initiatives. This indicates that government initiatives to encourage and facilitate recycling opportunities would be welcomed and accepted. Avoiding waste to landfill requires a multifaceted approach involving cultural and political factors. Clarke and Almannai (2014) suggest that the required changes are further hindered where the population is culturally diverse and rapidly changing. We recommend an integrated approach for the application of waste minimization practices in Bahrain which might include the introduction of public policies, adaptation of educational and awareness programmes, provision of MRFs for recyclable materials, and increasing the number of recycle bins all around Bahrain.

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Conflict of Interest

All authors declare that they have no conflicts of interest.

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