POLITECNICO DI MILANO

CIVIL, ENVIRONMENTAL AND LAND PLANNING ENGINEERING

Course of Solid Waste Management and Treatment - 057728

WASTE PREVENTION PRACTICES FOR DRINKING WATER AND SPICE CONSUMPTION IN INDIA

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AY 2024-2025

Abstract

Plastic pollution is causing significant environmental and health-related problems in India, arising due to issues such as the widespread use of single-use plastics and insufficient waste management. Focusing on the consumption of plastic packaging in drinking water and spices in the Indian city of Delhi, this study makes a case for waste prevention.

A qualitative research approach was used in order to analyze the waste generation patterns. Considering the population of Delhi, the spice and water consumption by each person was calculated to estimate the amount of waste generated. Data about the weight of different components of the single-use and reusable containers was collected through various web sources, governmental reports and studies, whereas assumptions had to be made regarding the specific materials used, due to lack of data.. The collected data was then analyzed to understand and evaluate the impact of PET, PP, glass and refillable methods on overall waste generation.

The qualitative method shows substantial differences in the consumption patterns using stainless-steel bottles and reusable spice containers from PET, PP, or glass. This has important implications, emphasizing that waste minimization becomes a tangible solution to reducing adverse environmental challenges through promoting sustainable consumerism and effective waste management.As an instance, the adoption of refillable methods showed a noticeable reduction in the total waste footprint, facilitating a sustainable way of life.

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1. Introduction

The initial step for the study of waste prevention practices for drinking water and spice consumption in India was done by a background study of existing literature regarding the subject and to find the relevance of the subject as shown in section 1.1 and 1.2.

1.1. Background

India is currently facing major challenges of plastic pollution, with problems originating from several issues regarding plastic consumption and waste management. One of the key issues causing plastic pollution in India is the high plastic waste generation, reaching a number of almost 35 million tonnes of plastic waste annually, of which a large share is not properly disposed of (Akaash et al., 2024). This phenomena can be related to the extensive use of single-use products, and the consequences of the improper management include plastic pollution of oceans and marine areas surrounding the country (Singh et al., 2019), as well as air pollution of plastic particles (Hussain et al., 2019).

Waste prevention is one of the most important parts of sustainable management. It is a pure prevention strategy that does not allow creating waste by targeting products and actions that cause waste creation. Waste prevention strategies furthermore create a sense of responsibility on the consumers and producers to alter their usual methods of consumption and production strategies. Single-use water bottles as well as single-use plastic food packaging are two examples of areas of improvement when it comes to waste prevention (Yan and Chaudhary Awais Salman, 2023).

The use of plastic items has expanded widely due to its convenience as a material, and is commonly found in single-use products such as bottles and plastic bags. The increasing plastic consumption for water bottle purposes is also driven by growing health concerns, increasing disposable incomes and a lack of access to safe drinking water in many areas. The western region of India accounts for around 40 % of the market, with Gujarat being a major hub for bottled water manufacturing. Delhi is a significant example for studying the bottled water market and usage patterns for several reasons such as large growing population, urbanization and lifestyle changes, water scarcity and quality issues. Considering earlier research, it becomes evident that plastic pollution is an addressed issue in India, including commitments to decrease the use of single-use plastics (Singh & Mathur, 2019). The efforts to minimize plastic waste can be partly explained by the problem of pollution of microplastics in marine areas of the country (Sunitha et al., 2021). Hereby, preventing waste can mean encouraging the reuse of bottles, increasing the availability of tap water and raising awareness of the unlawful disposal of plastics.

India is referred to as the "home of spices" due to the vast variety and volume of spices it produces. Approximately sixty-three different types of spices are cultivated in India, with around 94% of the total production consumed domestically. A variety of plant parts, including leaves, bark, fruit, flower buds, stems, roots, seeds, and more, are used to make spices, which are aromatic compounds of vegetable origin. Because they contribute flavor, taste, and color,

spices are used as seasonings and condiments and are a necessary component of food preparation. The packing material to be used must be carefully chosen, taking into account both the functional and marketing needs, in order to preserve the quality of the spices during handling, transit, storage, and distribution. Due to properties such as lighter weight, easier availability, compatibility, hygienic nature, machinability, printability, heat sealability and selective barrier properties, plastics are often a preferred packaging material for spices. (A. R. Indiramma, n.d)

However, despite the value of spices in the country, the improper way of utilisation of these spices in households leads to the generation of unnecessary waste. Several factors such as buying excessive quantities and improper storage practices add up to the waste generation. Of course, spices are a different category of the ingredients that are also a rather overlooked area in food waste. Over time, this results in a lot of spices becoming stale, moldy or unwanted and being disposed of in the bin. Food waste such as these could be reduced by better purchasing practices, efficient storage and better utilization of the barbarians in our cooking for using up old spices. Focusing on this issue, several reusable and durable methods of packaging as well as awareness among customers regarding optimal storage methods is crucial for the prevention of waste generation.

This means that by utilizing an additional layer of a waste avoidance strategy that focuses on the lifespan of water bottles and spices, helps one to conserve many resources while reducing the pressure on crowded landfill sites, as well as fostering a more circular economy. Also this will not only feed into other environmental goals but they also reintroduce the issue of sustainable consumption.

1.2. Delimitations

The current study focuses on the waste generated from usage of single-use plastic in Delhi, India, more specifically focusing on the scenarios of drinking water and spices consumption. Delhi was chosen as a target area since this is the most densely populated and urbanized city in India as well as the national capital (Vikash et al, 2008) , additionally motivated by the fact that the spice consumption in urban areas is proved to be higher compared to rural areas in India (Bhathal et al., 2020).

2. Aims & Objectives

In order to suggest waste prevention strategies that can lead to a higher environmental performance for Delhi, India, objectives 2.1.-2.2 are set for this study. The objectives are related to the consumption of drinking water and spices. The aim is also to analyse the current usage patterns, waste management practices and environmental impacts of plastic bottles. By exploring the intersection of plastic bottle waste and consumer behaviour, this research seeks to inform effective strategies for reducing plastic waste, promoting sustainable practices and mitigating the environmental consequences of plastic bottle pollution in India.

Additionally, this study aims to analyze the usage patterns, waste management practices and the environmental impacts caused by spice packaging. It also focuses on several strategies in order to reduce spice related waste. The objective is to promote sustainability and reduce the environmental impact caused by the usual pattern of spice consumption.

2.1. Evaluating Waste Prevention for Drinking Water Consumption

The first objective is to evaluate options for water consumption by quantitatively comparing the waste generation of water consumption through the business-as-usual (BAU) case, which is the purchase of bottled water, to consumption through refilling reusable bottles. Based on this evaluation the objective of this study is to present an option that could reduce the pollution caused by plastic water bottle consumption, and induce a shift to use of more long-lasting products.

2.2. Evaluating Waste Prevention for Spice Consumption

The second objective is to evaluate the waste generation due to spice consumption in Delhi, India by quantitatively comparing the waste generated by plastic spice packets in conventional scenarios to the waste generated by refillable containers for spices. The approach is to evaluate options for the reduction of single use plastics as spice containers in order to reduce its impact on the environment, hence leading to a sustainable waste management practice.

3. Method

The method of the study conducted for the waste prevention scenarios for drinking water and spice consumption in Delhi, India is discussed in detail below, in sections 3.1 and 3.2.

3.1. Waste from Consumption of Drinking Water

A quantitative comparison of the waste generation of different materials was carried out, based on the functional unit of consumption of drinking water for one person in Delhi for one year. As described in chapters 3.1.1.-3.1.2., the initial step was to collect data and make assumptions when data was not obtainable, after which the calculations were performed.

3.1.1. Data Collection and Assumptions

The method of assessing the possibilities of waste prevention in the water bottle case relies heavily on data collection, as this was necessary in order to make the calculations for comparison of the reference (BAU) scenario and the waste prevention scenario, consisting of the use of refillable bottles.

Delhi being the capital of India has been selected as the focal point for this study. As a megacity with a population of over 30 million, major key players in the Indian bottled water market include Bisleri, Aquafina, Kinley & Himalayan. Out of these, Kinley was considered for the

data collection. For the BAU scenario, the weight of water bottle components represented the properties of the one liter bottle of Kinley, since this was found to be the most sold product in India (Ray, 2012; Sharma & Giri, 2012). Regarding the waste prevention case, Newell brands was described as one of the potential leading actors of a transition to a more reuse-based drinking water consumption (Credence Research, 2024). Considering that the most sold product by Newell is a bottle made of stainless steel with a plastic cap (newellmerch.com), this model was selected to represent the waste prevention scenario. However, due to the relatively high cost per item for a Newell bottle (91,95 EUR), a similar product by the brand Caspian was surveyed for calculations. Resemblant to the most sold Newell product, the assessed Caspian bottle has a body consisting of stainless steel and a cap made of high-density polyethylene (HDPE) (amazon.in).

Table 1 displays the data findings and the sources of reference, retrieved by browsing *Google Scholar* and searching for specific data on *statista.com*. Common search terms in the data collection process *include consumption of water in India, weight of water bottle components and properties of metallic water bottles. The desired data findings were obtained from either product descriptions of retailers or scientific papers.*

Table 1. Summary of data collection for the water bottle case study.

INFORMATION		**FINDING**	**UNIT**	**SOURCE**
Population of Delhi		33 807 000	-	statista.com (1)
Bottled water consumption in Delhi		1 036 000 000	liters (l)	statista.com (2)
Weight of plastic bottle components	Bottle	2,4	grams (g)	indiamart.com
	Cap	1,3	grams (g)	indiamart.com
	Label	1 % of the total weight	%	Foolmaun & Ramjeawon, 2012
Cost of plastic bottle		125	rupees (₹)	indiamart.com
Weight of reusable bottle components	Bottle	435	grams (g)	Amazon.in
	Cap	25	grams (g)	Amazon.in
Cost of reusable bottle		294	rupees (₹)	Amazon.in

Due to the lack of available data, a number of assumptions were necessary to make in order to make the calculations and compare the two options. One of these was related to the materials of the plastic bottle components, where specific information about the properties of Kinley's water bottles was not found. Hence, the assumption is that the materials of the different components correspond to the most common composition, which is polyethylene terephthalate (PET) for the body (Tsironi et al., 2022), high-density polyethylene (HDPE) for the cap and low-density polyethylene (HDPE) for the label (Barletta et al., 2019).

A second parameter that had to be estimated by using general data of the product was the lifetime of the reusable bottle. According to Tamburini et al. (2021), the lifetime of a metallic water bottle is typically 2,5 years. Addressing the uncertainty of this parameter, a sensitivity analysis is carried and described in section 4.1.2.

3.1.2. Calculations

The consumption of drinking water in Delhi per person and year was calculated as a first measure, by dividing the total consumption of bottled water by the population of the city, according to equation 1 below:

$$\text{□□□ □□□□□□ □□□□□□□□□□□□/□□□□} = \frac{\text{□□□□□ □□□□□□□□□□□□/□□□□}}{\text{□□□□□□□□□□}} \quad (1)$$

Subsequently, the weight of waste material generated per person and year in the BAU scenario ($□_{□,□□□}$) was calculated by multiplying the per capita consumption achieved from equation 1 with the weight of the specific material in one item, as per equation 2:

$$□_{□,□□□} = \text{□□□ □□□□□□ □□□□□□□□□□□□/□□□□} \times \text{□□□□}h\text{□ □□ □□□□□□□□ □□□ □□□□} \quad (2)$$

Correspondingly, the weight of waste material generated per person and year in the waste prevention scenario ($□_{□,□□}$) was calculated according to equation 3, by dividing the weight of the specific material per item with the expected lifetime of the product.

$$□_{□,□□} = \frac{\text{□□□□}h\text{□ □□ □□□□□□□□ □□□ □□□□}}{\text{□□□□□□□□ □□□□□□□□}} \quad (3)$$

Although the economic side of the different cases of water was not the main focus of the study, a comparison was made, using equations 4 and 5.

In the BAU scenario, the cost of one item is multiplied by the per capita consumption of drinking water per year, to obtain the cost of consumption per year (equation 4).

□□□□ = □□□□□,□□□ × □□□ □□□□□□ □□□□□□□□□□□□/□□□□
(4)

In evaluating the cost of consumption per year in the scenario of the reusable bottle, the cost per item was instead divided by the expected lifetime of one product (equation 5).

$$\square_{\square\square} = \frac{\square_{\square\square\square\square,\square\square}}{\square\square\square\square\square\square\square\square\ \square\square\square\square\square\square\square\square}$$
(5)

3.2. Waste from Consumption of Spices

Based on the functional unit of consumption of spices for an individual in Delhi over the course of a year, a quantitative comparison of the waste generated by various packing solutions was conducted As described in chapters 3.2.1.-3.2.2., the initial step was to collect data and make assumptions when data was not obtainable, after which the calculations could be performed.

3.2.1. Data Collection and Assumptions

Analyzing the possibilities of waste prevention in the case of single use plastic spice packets, it was necessary to find data in a place where spices are used very prominently, which is ultimately India, one of the leading consumers of spices around the world (Cobb, 2024). Being the capital of India, we chose Delhi as the basis of our research. Apart from being the capital, Delhi is a city of various cuisines and tastes and has one of Asia's biggest spice markets namely "Khari Baoli" which plays an important role in the development and sustenance of spice trade in India (Fraser, 2024).

The major Indian spice brands in Delhi include MTR, Everest, Goldiee, catch, MDH. Out of which MDH and Everest have been under lawsuits due to the presence of hazardous substances in them (Biswas, 2024). 'Catch' is the most popular product among the locals from personal experieneces, so we chose this brand as the basis for our research. 'Catch' uses various types of packaging for the spices, but the most sought after packaging is the single use plastic sachet made of Low Density Polyethylene (LDPE) as it is cheaper and convenient to carry for the average Indian consumer (Catch foods, 2024). For the waste prevention scenario we are using the comparison of refillable spice containers namely made of durable plastic and glass to single use plastic sachets. Plastic containers made of PET or PP are durable, light weight, less corrosive, cheaper and keep the spice fresh for a longer period of time. Hence, a more environmentally friendly and sustainable option (A. R. Indiramma, n.d). Similarly, glass containers are non reactive and have a longer lifespan than a single use plastic spice container unless and until it is mishandled to break. Glass retains its structural integrity, allowing for indefinite recycling without compromising on quality, in contrast to plastic, which tends to deteriorate with each recycling cycle (Lee, 2023).

Typically, from personal experiences, locals prefer a 200g capacity sachet/refillable container for household cooking purposes, hence further calculations were carried out using this quantity as the basis. Firstly we started with the data collection that was available on the trusted web sources for the total population and consumption of spices in India in the year 2024. Furthermore, we also obtained data for the total population of the city of Delhi. The different types of spice containers(200g) considered in the project were personally weighed with help of friends and family in India and some others by a comparison with similar Italian product packagings to further refine the data.

Table 2. Collected data from existing sources.

Available Existing data (year 2024)	**Value**
Total consumption of spices in India (statista.com(3))	28,84 million kg
Total population of India (worldometers.info)	1 455 684 748
Total population in Delhi (India Population, 2024)	33 807 400

Table 3. Weights of spice containers in the conventional and refillable scenarios.

Weight Refillable Scenario								**Weight Conventional Scenario**	
Plastic(200g)				**Glass(200g)**				**Plastic(200g)**	
Container		**Cap**		**Container**		**Cap**		**Container**	
M	**W**	**M**	**W**	**M**	**W**	**M**	**W**	**M**	**W**
PET/ PP	30g	PET/ HDPE	12g	Glass	105g	HDPE	7g	LDPE	5g

Acronyms used: PP-Polypropylene, PET- Polyethylene Terephthalate,LDPE-Low Density Polyethylene, HDPE- High Density Polyethylene, M-Material, W-Weight

3.2.2. Calculations

The consumption of spices in India per person in a year (C_i) was calculated firstly, by dividing the total consumption of spices of the country by the population of the country in a year (2024), according to equation-6 below:

□□ = □□□□□ □□□□□□□□□□□□ □□ □□□□□ □□ □ □□□□
□□□□□□□□□□ □□ □□□□□ □□ □ □□□□

(6)

Subsequently, the consumption of spices in Delhi in a year(C_d) was calculated, by multiplying the per capita consumption in India in a year achieved from equation-6 with the total population in Delhi in the same year, according to equation-7 below:

□□ = □□ × □□□□□ □□□□□□□□□□ □□ □□□*h*□ □□ □ □□□□

(7)

The next step was to calculate the number of spice containers used in a year in Delhi (N_d), for the conventional and refillable scenario, which was found by dividing the total consumption of spices in Delhi per person in a year (C_d) found from equation-7 by the capacity of the container considered, according to equation-8 below:

□□ = □□ / □□□□□□□□ □□ □*h*□ □□□□□□□□□

(8)

Then the waste generated in Delhi in a year (W_d) from the use of the spice containers for the conventional and refillable scenarios were calculated, by multiplying the number of spice containers used in a year in Delhi, formed from equation-8, with the weight of the respective material of the container considered, according to the equation-9 below :

□□ = □□ ×
□□□□*h*□ □□ □*h*□ □□□□□□□□ □□ □*h*□ □□□□□□□□□ □□□□□□□□□□

(9)

Correspondingly, a sensitivity analysis was carried out to find the weight of waste material generated with a variation of 1,2,3,4,5 years of expected lifetime in the waste prevention scenario, which was calculated according to equation-10, by dividing the weight of the material of the container considered in a year with the expected lifetime of the product.

□□□□□ □□□□□□□□□□ = □□□□h□ □□ □□□□□□□□□ □□ □h□ □□□□□□□□□□ □□□□□□□□□□
□□□□□□□□ □□□□□□□□□

(10)

4. Results & Discussion

In this chapter, 4.1. presents results and discussion points for the drinking water case, and 4.2. regards the waste from spice consumption.

4.1. Water

The quantitative results from data findings and calculations can be found in section 4.1.1. Thereupon, a sensitivity analysis is carried out in section 4.1.2, modifying the lifetime of the bottle in the waste prevention scenario. Further aspects of the comparison are lastly described in chapter 4.1.3.

4.1.1. Quantitative Results and Comparison

Table 4 displays the results of generated waste material for each inhabitant of Delhi and year, related to the drinking water consumption. The table also reveals the corresponding waste generation in the waste prevention case, more precisely using the reusable bottle from Caspian.

Table 4. Weight of waste generated per year for the two different types of bottles.

Type of bottle	Material	Weight of waste [g]
Plastic bottle (BAU scenario)	PET	45,5
	HDPE	84
	LDPE	1,295
Reusable bottle (waste prevention scenario)	Stainless steel	174,5
	HDPE	10

Making this comparison, there appears to be a higher total mass of waste created for the reusable bottle. However, the majority of the weight consists of the body of the bottle, made of stainless steel. Regarding types of plastics, more waste is created in the BAU scenario of consuming drinking water only from single-use plastic bottles.

In addition to the results of weight of waste created in the two scenarios, an economic comparison was made according to the description in section 3.1.2. Calculations, whose results are displayed in Table 5 below.

Table 5. Results from the economic analysis.

Scenario	Cost per person and year [₹]
BAU (single-use plastic bottles)	4375
Waste Prevention (reusable metallic bottle)	117,6

4.1.2. Sensitivity Analysis

Because the data acquired on the lifetime of the reusable product was relatively general and considered to be variable, a sensitivity analysis with regard to this parameter was performed. The generated waste per each for each assumption of lifetime was calculated using equation 3, described in section 3.1.2. Table 6 presents the results of plastic and metallic waste generated per year, spanning from an expected lifetime of 1-4 years.

Table 6. Results of the sensitivity analysis with regards to the lifetime of the reusable bottle.

		Weight per year [g]						
Type of material	Weight per item [g]	1 year's lifetime	1,5 years' lifetime	2 years' lifetime	2,5 years' lifetime	3 years' lifetime	3,5 years' lifetime	4 years' lifetime
Stainless steel	435	435	290	217,5	174	145	124,286	108,75
HDPE	25	25	16,6667	12,5	10	8,33333	7,14286	6,25

Comparing the results of the sensitivity analysis, it can be concluded that especially the weight of metallic material is very dependent on this factor, seeing that there is a difference of more than 300 grams per year between the most extreme cases (1 year respectively 4 years' lifetime). As the total weight of waste per year for the BAU scenario is 130,795 grams per year (45,5 + 84 + 1,295), it can be calculated that the weight of total waste in the reusable case falls short of this somewhere in between 3,5 and 4 years of expected lifetime (124,286 + 7,14286 = 131,42886 and 108,75 + 6,25 = 115).

It should moreover be mentioned that a similar analysis could have been made with regards to the economical aspect of the two consumption cases, assessing the cost of consumption per year depending on lifetime of the metallic bottle. As the economic perspective was not the focus of this study, this analysis was however not carried out.

4.1.3. Discussion

As a comment on the results of the weight of waste produced in the two different scenarios, as presented in Table 4, it can be mentioned that the recycling process of metal and plastic have

different characteristics. One parameter that differs between the two processes is that both PET and HDPE recycling have a higher energy saving compared to the primary production, relative to the same comparison made within the recycling of steel. Another noteworthy divergence is that steel is considered a permanent material, which means that it is not downgraded with each recycling process, while plastics are progressively downgraded (Grosso, 2024).

The availability of drinkable water for refilling can also be discussed since tap water in Delhi needs to be filtered before drinking (Chauhan et al., 2017). The filtering process in homes would generate organic sewage waste, so for a more complete comparison, this waste stream should also be taken into account. Related to the social aspect of the two scenarios, it can also be pointed out that reusable bottles have a lower cost per year and per person compared to the single-use options (see Table 5), which can motivate this alternative for the population of Delhi.

4.2. Spices

The quantitative results from data findings and calculations can be found in section 4.2.1. Thereupon, a sensitivity analysis is carried out in section 4.2.2, modifying the lifetime of the spice container in the waste prevention scenario.

4.2.1. Quantitative Results and Comparison

Table 7, shows the values for the total consumption of spices in India per person and total consumption of spices in Delhi for the year 2024, which were calculated following equations-6 & 7 under section 3.2.2.

Table 7. Results for the consumption of spices for year 2024

Calculated Data for year 2024	Value
Total consumption of spices in India per person in a year(C_i)	19,8g
Total consumption of spices in Delhi in a year(C_d)	669 792 000g

Table 8 shows the results of the waste generated from spice consumption in Delhi for the year 2024 as well as the number of containers used for both conventional and refillable scenarios of spice containers of capacity 200g. The results were found using the equation-8 & 9 under section 3.2.2.

Table 8. Results of the waste generated due to spice consumption in Delhi in 2024

Spice container type (200 g capacity)	Material	Waste generated in Delhi in 2024 (Wd)	Number of (200g)containers used in Delhi in 2024 (N_d)

Conventional containers	LDPE		16 745 kg of LDPE	3 348 960
Refillable containers	Body	PET/PP	100 469 kg of PET/PP	
	Cap	PET/HDPE	40 188 kg of PET/HDPE	
	Body	Glass	351 641 kg of glass	
	Cap	HDPE	23 443 kg of HDPE	

In Table 9. and Figure 1. Below, a comparison of the weights of waste produced by the use of spice containers in the conventional and refillable scenarios were made.

Table 9. Results of the difference in weights of containers between conventional and refillable scenarios.

Weight Refillable Scenario				**Weight Conventional Scenario**
Plastic		Glass		Plastic
Container	Cap	Container	Cap	Container
100 469 kg	40 188 kg	351 641 kg	23 443 kg	16 745 kg

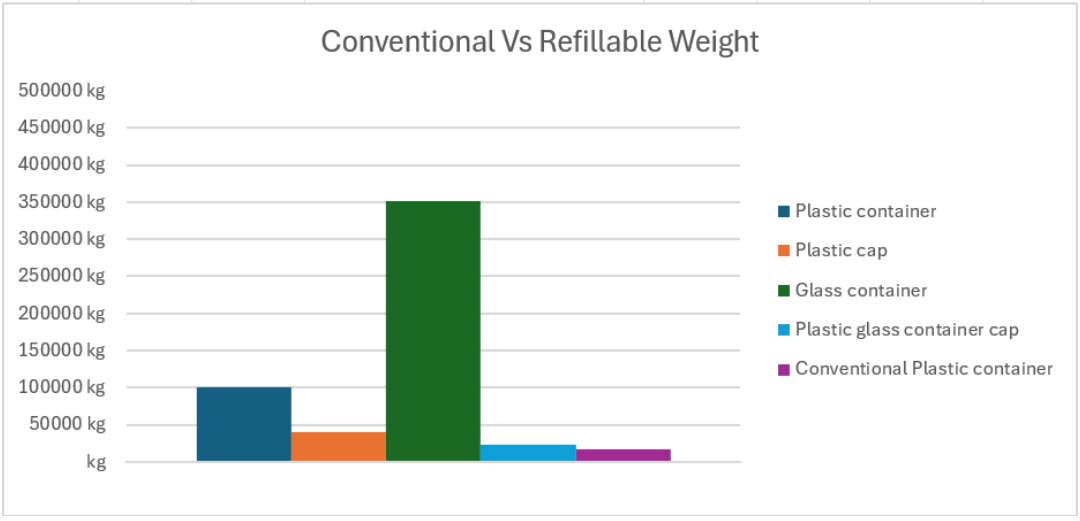

Figure 1. Graphical representation of the results of difference in weights of containers between conventional and refillable scenarios.

The weight share of materials used in conventional and refillable packaging scenarios for spices are demonstrated in Figure 1. From the analysis of this graph the following discussions were made:

Plastic packaging (containers and caps) weighs less than most other materials. Glass containers have the heaviest weight of all types, almost double that of plastic because glass falls under the category of heavy goods. The cap being made of plastic helps reduce the overall weight of the glass container. Additionally, glass is heavier than plastic, but that weight may be more forgivable in a reusable or refillable system, since conventional systems of single use plastics are typically of lower weight and often produce more waste that has more negative impact on the environment. Regarding refillable plastic containers**,** they are of extra weight compared to the conventional scenario of single use plastic packaging , but more durable and recyclable than them and also much lighter here than on glass.

4.2.2. Sensitivity Analysis

Because the data acquired on the lifetime of the reusable product was relatively general and considered to be variable, a sensitivity analysis with regard to this parameter was performed. In Table -10 and Figure 2, the results of sensitivity analysis with regards to the lifetime of the reusable container are shown and a discussion is included regarding the key observations made from the analysis.

Table 10. Results of the sensitivity analysis with regards to the lifetime of the reusable container.

Expected lifetime	**Plastic Containers & cap (200g)**		**Glass Containers with plastic caps (200g)**	
-	**Container PET/PP (30g)**	**Cap PET/HDPE (12g)**	**Container glass (105g)**	**Cap HDPE (7g)**
5	20 Ton	8 Ton	70 Ton	5 Ton
4	25 Ton	10 Ton	88 Ton	6 Ton
3	33 Ton	13 Ton	117 Ton	8 Ton
2	50 Ton	20 Ton	176 Ton	12 Ton

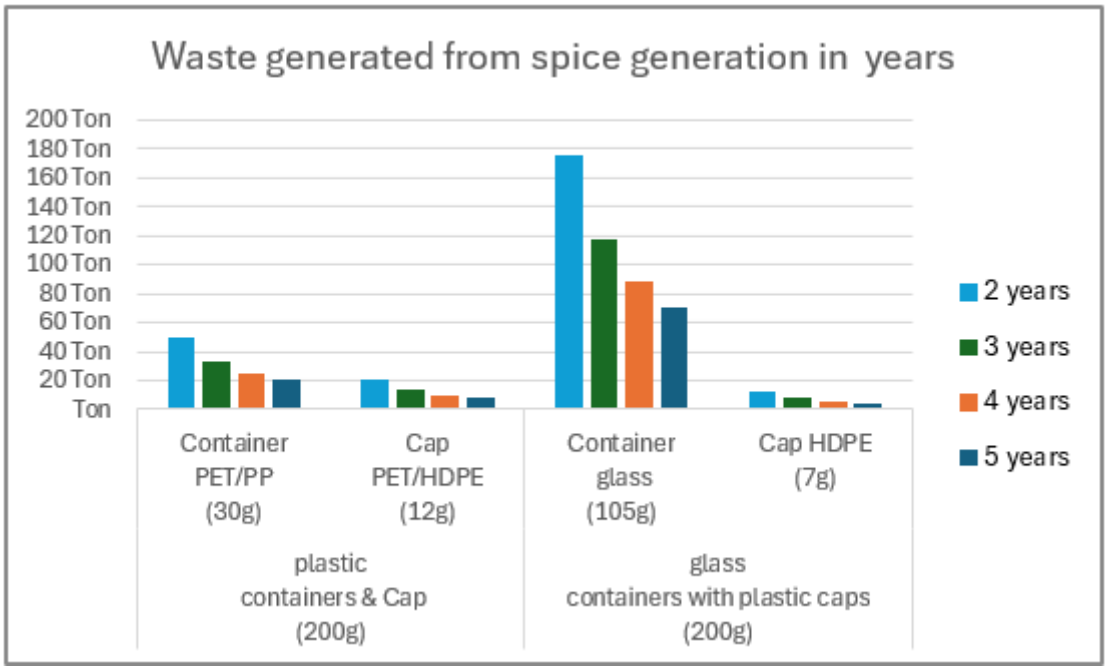

Figure 2. Graphical representation of the sensitivity analysis results with regard to the lifetime of the reusable container.

Waste generated from spice consumption in a year varies depending on the type of packaging and expected lifetime assumed, as illustrated above in the comparison of plastic containers with plastic caps and glass containers with plastic caps over expected lifetimes of 2, 3, 4, and 5 years.

Plastic containers with plastic caps are typically made of PET / PP for the body and PET / HDPE for the caps. Each plastic container generates 30 grams of waste from the body and an additional 12 grams from the cap. The waste accumulated on a yearly basis decreases when the expected lifetime of the container is increased, due to durability. Overall in the different expected lifetimes, plastic containers produce less total waste weight compared to glass containers. However, offer a significant advantage over single-use plastic containers, as their reusability reduces overall waste generation.

Glass containers with plastic caps, made of a 105-gram glass body and a 7-gram HDPE cap, also show a reduction in waste on a yearly basis as the expected lifetime is increased. Most of the waste from these containers comes from the glass body, while the plastic cap contributes a relatively minor portion. Although glass is heavier than plastic, the total volume of non-recyclable waste from glass containers is significantly lower than that of plastic containers, making glass containers more eco-friendly in terms of waste disposal.

5. Conclusion

In conclusion, this study focuses on the importance of waste prevention practices in order to address environmental challenges caused by single use plastic water bottles as well as spice packaging in Delhi, India. Using alternatives like refillable bottles and spice containers made of materials like PET, PP and glass are major steps towards reducing waste at its source. The results from this study are suggesting that reusable water bottles, as an option to single-use plastic, leads to a total reduction of waste by weight, by reducing plastic weight at the same time as increasing metallic waste. Similarly, the reusable packaging options for spices show a noticeable potential of waste prevention by lifecycle and weight.

6. Author's Statement

A mixed methods approach was used analyzing existing literature, industry trends and consumer behaviours. As a group of five members namely Lina, Sisira, Mugtaba, Sania and Reeta, the research work was split into two parts. The former two (Lina and Sisira) focused on drinking water and the latter three (Mugtaba, Sania and Reeta) on the spice consumption waste prevention scenario. The writing of the different parts of the report was divided correspondingly. Additionally, the peer-reviewing of group 6's report was assigned to Lina, Mugtaba and Sania, while the responsibility of the oral presentation was entrusted to Sisira and Reeta. Regarding the received peer-review feedback, the correction work was divided in the same two cases as earlier. Lina made changes in formatting, abstract as well as in chapters 1 and 2, while Sania corrected grammatical errors and incorporated the changes suggested by the peer review group.

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