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Solving the Plastic Waste Crisis with the participation of People in Developing Countries, Case Study of Iran

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Abstract

Background: *Iran is one of the top 10 countries in the world in terms of plastic consumption. This study aimed to solving the plastic waste crisis with the participation of people in Iran.*
Methods: *The study is a descriptive-analytical one that has been done from 2019 to 2022. The plastic waste produced in 9 provinces (out of 31 provinces) was sampled once a week for 12 months to determine the total weight and per capita per day. Also, the method of collecting and disposing of plastic waste was determined in different cities of the provinces. After that, a training program regarding the in-source separation of plastic and other municipal wastes was implemented in Semnan city to teach people how to reduce and separate their plastic wastes. Finally, a plastic recycling factory was designed and constructed in Semnan.*
Results: *The study indicates that the plastic waste per capita per day is about 56gr in the studied provinces. Also, currently, only 5% of the total plastic waste is collected separately and more than 95% of it is disposed of as mixed with other wastes. By carrying out an in-source separation and reduction program, the amount of plastic waste produced in this province decreased by 10% in two years, and also a plastic recycling plant with a capacity of 30 tons per day was constructed in Semnan city (the capital of Semnan province) which prevents disposing of 1050 Ton of plastic annually, resulting in environmental pollution preventing.*
Conclusions: *Based on the results, the implementation of a training program to reduce plastic production and the construction of plastic recycling factories can greatly decrease the plastic crisis in developing countries such as Iran.*

Keywords: Plastic, Crisis, Iran, Management, Recycling.
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Introduction

Nowadays, human beings are facing the biggest crisis of plastic waste and its pollution[1]. According to statistics, the consumption of plastic products by the end of 2020 has reached 368 million tons[2].

Plastics are more resistant to natural decomposition than other materials because the chemical bonds that hold plastic molecules together are stronger than natural powers[3]. In other words, soil microorganisms that can easily decompose materials such as wood and other organic waste cannot destroy most plastics[4]. Plastic decomposition in nature begins after a long period of time (about 100 to 500 years), and plastic debris kills millions of birds and thousands of mammals[5]. Also by interfering in the balance of air and water in soil layers, especially in areas adjacent to cities, soil fertility is lost[6].

Alabi et al., study showed that since 1950 to 2018, about 6.3 billion tons of plastics have been produced worldwide, 9% and 12% of which have been recycled and incinerated, respectively[7].

Environmental pollution by plastic wastes is now recognized widely to be a major environmental burden[8], especially in the aquatic environment where there is prolong biophysical breakdown of plastics[9], detrimental negative effects on wildlife[10], and limited plastic removal options[11,12], Due to the potential side-effect on the environment, plastic waste incineration is less employed for waste management in comparison to other disposal methods such as land filling or recycling.

Recycling of plastics is a major aspect of the worldwide efforts in minimizing the yearly 8 million tons of plastics entering the oceans[13]. Distribution of plastic waste is related to the populations. Increase in population has led to increased demands for plastics and plastic products. Indiscriminate disposal of wastes from plastics and plastic products can lead to environmental pollution from several ways such as natural beauty deterioration[14], death of aquatic organisms[13], sewage system blockage in towns and cities especially in developing countries[14], resulting in creating conducive environment for breeding mosquitoes and other disease causing vectors and production of foul smells[10], reduction in water percolation and normal agricultural soils aeration thus causing reduced productivity in such lands[11].

Iran is also one of the top 10 countries that produce high amounts of plastic[15]. According to current statistics, the amount of plastic produced in Iran is more than 17,000 tons per year (50 tons per day) and each citizen enters 3 plastics into the environment[16].

Currently, plastic waste is collected with other mixed waste in Iran. Households still dump their waste in a mixed container and deliver it to the municipal waste collection system. The collected waste is then disposed of, and enters a daily large amount of plastic into the environment. Also, lightweight plastics are usually spread in the surrounding fields and water sources and cause various adverse environmental consequences.

Despite the existence of a comprehensive law on waste management in Iran and its emphasis on the in-source waste separation, no effective action has been taken yet to separate waste in Iran.

To design a comprehensive program to solve the plastic waste crisis in Iran, the study was conducted in 9 provinces (out of 31 provinces) to collect the required data and then take the necessary action to reduce plastic waste.

Materials and Methods

This is a descriptive-analytical study and has been carried out for three years in 9 provinces of Iran (Semnan, Hamedan, Mazandaran, Tehran, Qazvin, West Azerbaijan, Razavi Khorasan, Isfahan, and Golestan). The figure 1 shows the location of the above provinces on the map of Iran.

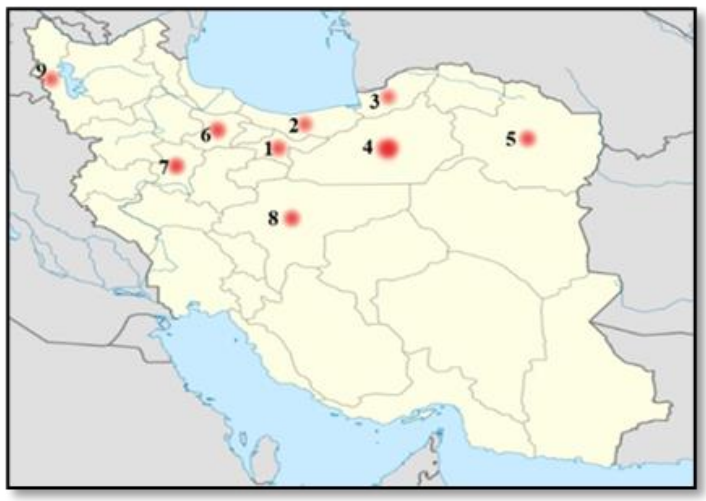

Figure 1. Location of the studied provinces in Iran

1- Tehran. 2- Mazandaran. 3- Golestan. 4- Semnan. 5- Razavi Khorasan. 6- Ghazvin 7- Hamdan. 8- Isfahan. 9- West Azerbaijan.

The population of these 9 provinces in 2020 was about 30 million people (47% of the population of Iran). At First, the waste produced in all cities located in the studied provinces was sampled once a week for 12 months and the amount of plastic in them was determined. To do this, several citizens were given bags and asked to put their one day's production waste in a bag, and the next day the bags were collected. Finally, by weighing bags and dividing it by the number of people, the municipal and plastic wastes per capita per day were determined. Also, the method of collecting and final disposal of plastics in each city was determined by field observation and interviews with municipal service officials. Then, a waste separation and reduction training program was implemented in Semnan province to determine its effect on the separation of plastic waste from other wastes (Figure 2). Also based on the results obtained for the Semnan city, a plastic recycling factory was designed and constructed (Figure 3).

Semnan is located 200 km east of Tehran, (the capital of Iran) and has a population of 200,000. This city has a large industrial and a recycling town (the only one in the country) where the designed plastic recycling factory is located inside this recycling town.

Figure 2. Training program at school

Figure 3. Plastic recycling factory in Semnan

Results

Table 1 shows the population of the studied provinces.

Table 1. Population of the studied provinces

Province	Population	Proportion of the total country population
Tehran	13267637	17%
Mazandaran	3283582	4.1%
Semnan	702000	0.9%
Hamedan	1758268	2.2%
Qazvin	1873761	2.4%
Golestan	1868819	2.33%
Isfahan	5120850	6.4%
West Azerbaijan	3265219	4.1%
Khorasan Razavi	6434501	8%

Table 2 shows the total weight and per capita production waste in the studied provinces.

Table 2. Average amount of waste production in different provinces

Province	Population	Total waste generated Kg/d	Per capita per day, gr/d
Tehran	13267637	10826392	816
Mazandaran	3283582	2649851	807
Semnan	702000	476658	679
Hamedan	1758268	1206172	686
Qazvin	1873761	1204829	643
Golestan	1868819	1156799	619
Isfahan	5120850	3651166	713
West Azerbaijan	3265219	2027701	621
Khorasan Razavi	6434501	4304681	669

Table 3 shows the average of plastic waste produced in different provinces.

Table 3. The average of plastic waste produced in different provinces

Province	Population	Total plastic waste generated Kg/d	Per capita per day, gr/d
Tehran	13267637	809326	61
Mazandaran	3283582	180597	55
Semnan	702000	35802	51
Hamedan	1758268	89672	50
Qazvin	1873761	95562	51
Golestan	1868819	99037	53
Isfahan	5120850	297009	58
West Azerbaijan	3265219	163261	50

Khorasan Razavi	6434501	341029	53

Table 4 shows the disposal method of municipal and plastic waste in different province

Table 4. Disposal method of municipal and plastic waste in different province

Province	Population	Method
Tehran	13267637	19% Recycling, 74% landfilling 7% Incineration
Mazandaran	3283582	8% Recycling, 84% landfilling 8% Incineration
Semnan	702000	13% Recycling, 77% landfilling 10% Incineration
Hamedan	1758268	6% Recycling, 82%landfilling 12% Incineration
Qazvin	1873761	6% Recycling, 81%landfilling 13%Incineration
Golestan	1868819	5% Recycling, 82% landfilling 13% Incineration
Isfahan	5120850	9% Recycling, 83% landfilling 8% Incineration
West Azerbaijan	3265219	5% Recycling, 81% landfilling 14% Incineration
Khorasan Razavi	6434501	6% Recycling, 82% landfilling 12% Incineration

Table 5 shows the rate of plastic recycle after implementation of the in-source separation program in Semnan City.

Table 5. The rate of plastic recycle after implementation of the in-source separation program in Semnan City*

Year	First year	Sec year	Third year
Plastic recycling rate (%)	21	37	42
Weight of recycled plastic waste (kg/Year)	653595	1151572	13707189

*** The population of Semnan is 167,200 person**

Discussion

The main goal of the study was to investigate the plastic waste management status in Iran and provide solutions to it. For this, the status of production and management of plastic waste in 9 provinces of Iran (out of 31 provinces) were evaluated, which constitute 47% of the total country population. According to Table 1, Tehran province has the highest, and Semnan province has the lowest population among the evaluated provinces. Also, according to Figure 1, the studied provinces were from different parts of Iran. Table 2 shows the total weight and per capita production waste in the studied provinces.

Based on per capita production (Table 2), Tehran province with 816 grams per person per day has the highest, and Golestan province with 619 grams per person per day has the lowest plastic production rate.

The reason for the difference in waste production in provinces is the difference in income, geographical location, and different cultures[17].

The waste per capita per day varies in different countries. For example, it is 2000 grams in the United States, 800 grams in the United Kingdom, and 1050 grams in Malaysia[18,19].

Some reasons cause differences in waste per capita in different countries. The difference in the income, the existence or non-existence of payment rules for waste collection (tipping fee), cultural differences, and the presence or absence of training programs are the most important reasons. Table 3 shows the total plastic production and per capita in each province. Accordingly, each citizen in Iran produces an average of 55 grams of plastic waste per day and enters the environment.

Tehran city with 61 grams has the highest level and Hamedan and West Azerbaijan with 50 grams have the lowest plastic waste per capita. Considering 55 grams as the average plastic waste per capita and considering that the population of Iran is 79926280 people, 17945400 kg of plastic is produced daily in the country.

The amount of plastic waste is different around the world and usually, it depends on the income level, laws that banned the production of plastics, tax on plastic production, and the level of its recycling[20]. The plastic waste per capita per day is 160 grams in China, 110 grams in South Korea, 95 grams in Turkey, 55 grams in Iran, and less than 30 grams in the European Union.

Table 5 shows the plastic waste disposal methods in different provinces. Accordingly, 82% of plastic waste is disposed of, 10% is incinerated and only 8% is recycled. In other words, out of the collection of 1794540044 kg of plastic waste produced daily in Iran, only 353435632 kg is recycled and the rest is left in the environment.

Even in the capital (Tehran), about 75% of plastic waste is disposed of and only 19% is recycled. Plastic recycling rates vary from country to country. Plastic prices, laws, and taxes are the main reasons for the difference in plastic recycling rates. In Japan, approximately 78% of plastics are recycled. The rate is 56, 43, 72, and 83 percent in China, Turkey, France, and Iran, respectively[21,22]. Therefore, more effective actions should be taken to develop plastic recycling in Iran such as developing laws and training citizens.

Due to the large volume of plastic waste produced in Iran and considering that there was no factory to recycle plastic from this waste in provinces, Semnan Municipality decided to provide training programs to reduce production and teach people how to separate plastic in source, as well as design and construct a plastic recycling factory.

At first, 6 educated women went to the houses, schools, universities, offices, and commercial departments of Semnan city to make them aware of how to produce less plastic and collect them separately (Figure 2). On the other hand, a plastic recycling factory with a capacity of 30 tons per day and consisting of the following units were designed and constructed (Figure 3).

1- Waste packaging

2- Milling and grinding

3- Dehydration and drying

4- Making plastic granules

Table 5 shows the effect of the training program on the amount of plastic recycling in the city of Semnan. By comparing Tables 4 and 5, it is clear that the training program can increase the amount of plastic recycling by about 29%. In other words, if required and enough information is given to Persian citizens, 1274824 kg of plastic can be recycled daily and prevent them from entering the environment.

The results of the study indicate that despite the adoption of the Waste Management Law in 2004 and its emphasis on waste separation in Iran, the plastic waste management status is not suitable in Iran. Scavengers steal valuable waste from bins that are installed on the streets. Also, currently, 17000 tons of plastic are produced daily in Iran and only 5 percent is separated in the source of production. More than 25% of plastics are removed from collection tanks by scavengers, and more than 70% of plastics are disposed of in landfills.

The construction of a plastic recycling factory with a capacity of 30 tons per day prevented the disposal of 30 Tons of plastic in Semnan province and also produced30 tons of plastic granules for use in industry. Therefore, it is suggested to set up plastic recycling factories in different provinces to produce enough raw material for industries while preventing plastic landfills.

Based on the results, the implementation of a training program to reduce plastic production and the construction of plastic recycling factories can greatly decrease the plastic crisis in developing countries such as Iran.

Ethical Considerations

This study has been done upon solid wastes and follows the ethical considerations. The picture of trainer also showed with her permission.

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Conflict of Interest

The authors declare that they have no competing interests.

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