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Research Article

Minab Urban Waste Management by WAGS Software

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ABSTRACT

The solid waste management in accordance with sustainable development is among new sciences in word. Therefore excessive consumption can be considered as one of the main sources of pollution sources that needs immediate attention in the processes of integrated solid waste management various aspects of wastes such as production, storage, transport, recovery and disposal would be analyzed. Such system should lead to better environmental protection.
However, the Minab city is 97000 population and the east of Bandar Abbas city, density, commercial and administrative buildings as well as health care centers. The waste collection is mechanized system in this city.In the present investigation the transport of waste has been carried out by WAGS software. The output of software provides us with necessary capital investment for a period of 15 years.
The result of study shows that the highest expenditure for collection and transport of waste belongs to man power and machineries. In general the following pattern can be noticed; 36% of total expenditures go to man power, 1% for buy machineries, 4% for maintenance, 10% for fuel charges and 49 %for others.The result of study shows that overall expenditure of waste collection is about 1401200 million Rials. Thus an amount of 538679 million Rials would be required as investment to the year 2029.

Keywords: *The Solid Waste Management, WAGS Software, Minab City, Fuel Charges, Environmental Protection.*

INTRODUCTION

Iran's growing urban population along with the creation of new population centers, the absence or weakness of policy making and the assessment of performance and various activities based on the national master plan (land use planning) as well as the constant wastewater disposal into the environment are the crisis factors that have endangered and put the natural environment and human especially urban citizens health at risk. In other words along with various problems of the cities in Iran, environmental hazards caused by the mismanagement of the country's waste is another major problem (Naghavi, 1997). Sohrabi and Shirzadi Gilani (2008) conducted a study titled "waste collecting management of the cities and villages of Chabahar area" and after the investigation concluded that in order to collect urban wastes steps should be taken to collect the urban wastes at two stages of optimization and automation based on separation at source and also provide facilities to collect dry waste recycling and processing for all villages. According to the calculations they recommended construction of a bio-compost unit for urban and rural household organic wastes (Sohrabi and Shirzadi Gilani, 2008). Maghsoudlou et al. (2008) conducted a study titled "Principles of planning spatial locating methodological process and local evaluating of

municipal solid waste disposal centers of Yazd". The results of studies included achieving an effective and efficient operation as a native methodological process to assess environmental feasibility of municipal waste landfills according to environmental conditions and the practical application of it in the national level (Maghsoudlou et al., 2008). Karimi et al. 2007 conducted a study titled "Assessment of the current status of the rural wastes in Mazandaran Province and the provision of solutions to improve waste disposal" and according to the conducted studies it was found that household waste collection system is a combination of traditional and mechanized methods and due to waste combination of these villages the recycling and composting methods are recommended as the best methods for disposal of waste (Karimi et al., 2007). In 2004 a study titled "Analyzing the municipal solid waste process and management in Golestan province" was conducted by Abbasvand that after an examination and the use of theoretical and experimental bases of planning and management of urban waste, as well as the assessment of the study results on functional elements, finding problems and internal and external factors by analytical method offered basic strategies and management suggestions for improving and optimizing urban waste management system in Golestan province (Abbasvand, 2004).

The area under study

Minab area is located in the northeast of Strait of Hormuz with a surface area of 5172.26 square kilometers in 27°08′48″N 57°04′48″E the center of which is Minab City. The city is limited by Roudan city in north and northeast, Sirik city in the south and Bandar Abbas city in the west and it height is 16 meters above sea level (Kalantari Khandani et al., 2008). According to the latest administrative divisions Minab has 4 parts, 3 towns and 10 villages the parts of which include: Markazi (central), Senderk, Gourband and Toukhour (Eghtedari, 2005). This study was conducted in the city of Minab.

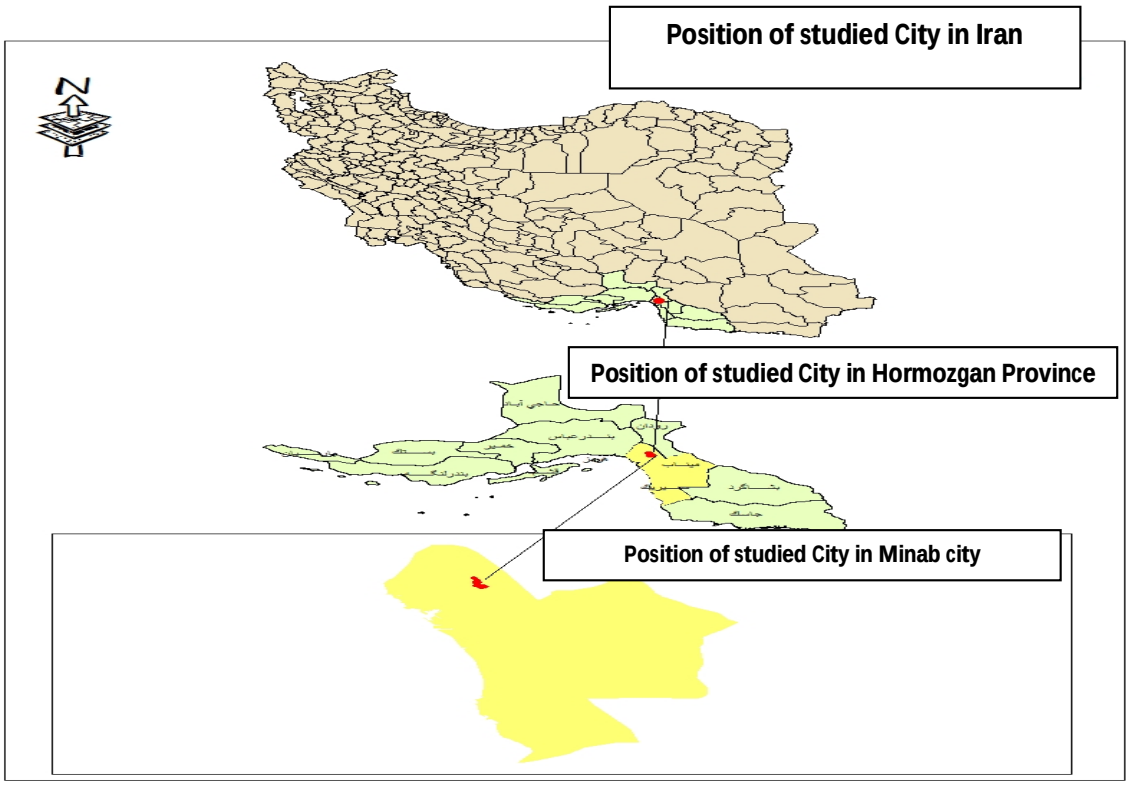

Figure1. Minab city position in Iran, Hormozgan and Minab area

Research Methodology

Method

Statistics and information were the main tools that have been used in this research computer analysis of the obtained data was performed by WAGS application is the most important part of this study which is described in detail below.

WAGS Software

WAGS software is designed in 1990 by the UN Human Settlements Center for a part of six elements required for solid waste management i.e. transport. Factors needed to implement WAGS program are as follows:

1- Population
2- The rate of population growth
3- The amount of produced waste
4- The growth rate of waste production
5- The density of the waste
6- The percentage of change in the density of the waste as a result of a change in culture
7- Waste acidity
8- Waste roughness
9- The position of the city compared to coastal areas
10- The method of garbage collection
11- Distance between collection area and disposal / landfill
12- The maximum allowed load to be transported through the roads
13- The width of the streets the wastes of which should be collected
14- The road factor
15- The number of working weeks
16- The number of working days
17- The number of shifts
18- The number of working hours per shift
19- The rate of productivity
20- Labor costs
21- Labor shadow factor
22- Driver cost
23- The driver shadow factor
24- The management overhead cost
25- Exchange rate
26- The shadow factor for exchange rate
27- The cost of fuel
28- The shadow factor for fuel
29- Taxes on imported vehicles
30- Sales Tax
31- The opportunities of investment costs
32- Taxes on the import of spare parts
33- Maintenance of vehicles
34- Distance from transfer station
35- Disposal intervals
36- Required extra capacity
37- Premium on larger vehicles
38- Premium on smaller vehicles
39- Road traffic taxes on large vehicles
40- Road traffic taxes on small vehicles

The results

The importance of qualitative and quantitative recognition of solid wastes

The growing volume of solid waste in terms of quantity and quality on the one hand and the need to control the adverse environmental and health effects on the other hand have caused solid waste management to be considered as a principal indicator of sustainable development.

Recognizing the importance of the sources of solid waste and its qualitative and quantitative process at all stages of solid waste management has led the designers and operators present appropriate solutions to determine the quantity and quality of solid wastes besides analyzing the parameters that affect this process. Later in this article we try to illustrate the importance of recognizing the quality and quantity of solid waste from different perspectives (Research Center for Energy and Environmental Studies, 2002).

The results of synthesized physical analysis of Minab waste

The results of synthesized physical analysis of Minab waste including corruptible materials, paper, rubber, plastic, [1]PET, textiles, glass, metal, construction waste and other materials percentage in spring , summer, autumn and winter are provided in Table (1).

[1] poly Ethylene Terephthalate.

Table1. The results of synthesized physical analysis of Minab waste

Parameter	Spring	Summer	Autumn	Winter	Mean
corruptible materials	55.65	53.56	68.7	77.3	63.8
Paper	5	4.17	1.38	1.52	3
Cardboard	5.07	4.48	4.93	3.72	4.55
Rubber	0.44	1.88	0.88	0.73	0.98
Plastic	9.49	8.61	9.12	7.93	8.78
PET	2.05	1.17	1.77	1	1.49
Textiles	3.7	2.42	3.6	2.34	3
Glass	4.63	5.18	0.89	0.67	2.84
Ferrous metals	0.53	3.33	1.09	0.27	1.3
Other metals	5.25	6.37	2.28	2.3	4
Construction waste	5.42	4.93	2.92	0.51	3.44
Other	2.7	3.1	2.11	1.7	2.4

(Municipality of Minab, 2014).

General information output

The time required for collecting waste and vehicle transportation to the disposal of waste location is 230 minutes. The volume of compressed waste in the vehicle is 15 cubic meters.

The maximum weight of compressed weight is about 7 tons.

The performance of the vehicles in collecting and transferring the waste to the landfill has 95% productivity. The useful life of a truck in Minab is 7.2 years.

Predicting the level of waste production

According to the 2011 census resident population of Minab is 97,000 people (Hormozgan Planning Department, 2011).

Per capita waste production in the region is about 1.3 kg daily also the amount of waste generated daily in the city is about 70 tons and the annual rate amount to 46026 tons in 2014 (Municipality of Minab, 2014).

Due to the high rate of population growth and increasing per capita waste production the amount of waste produced in the years 2014 and 2028 will be 46026 and 95146 tons per year respectively. The density increases because the economy and culture of the people is not changed significantly which increases the density.

Figures (2) to (7) present the of population growth, increasing per capita waste production, annual waste production and waste density changes.

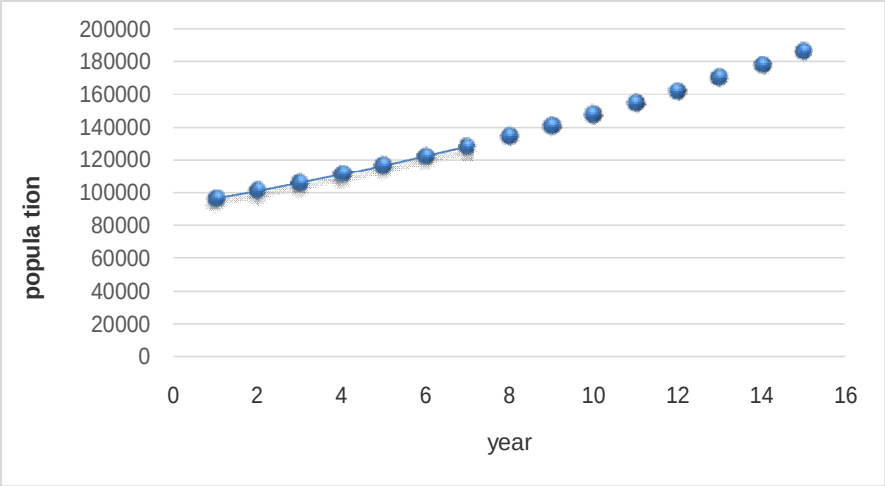

Figure2. The prediction of population growth

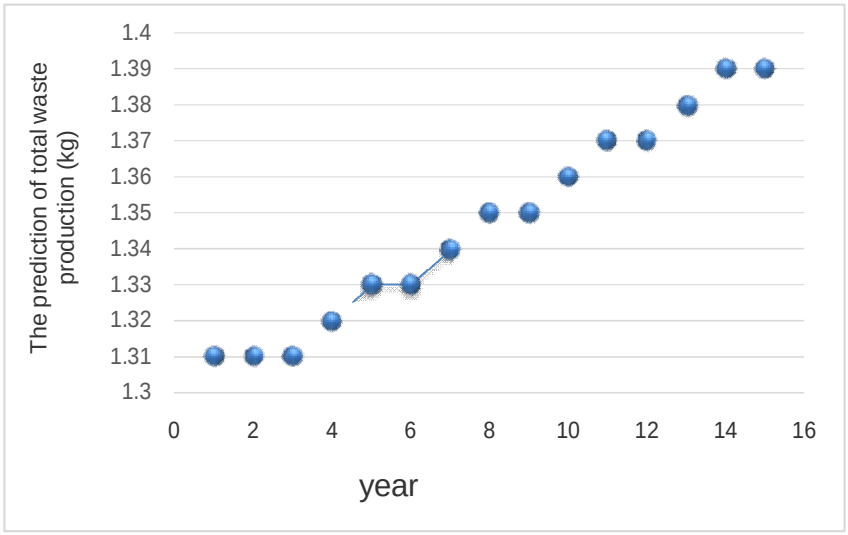

Figure3. The prediction of total waste production in Minab (Kg)

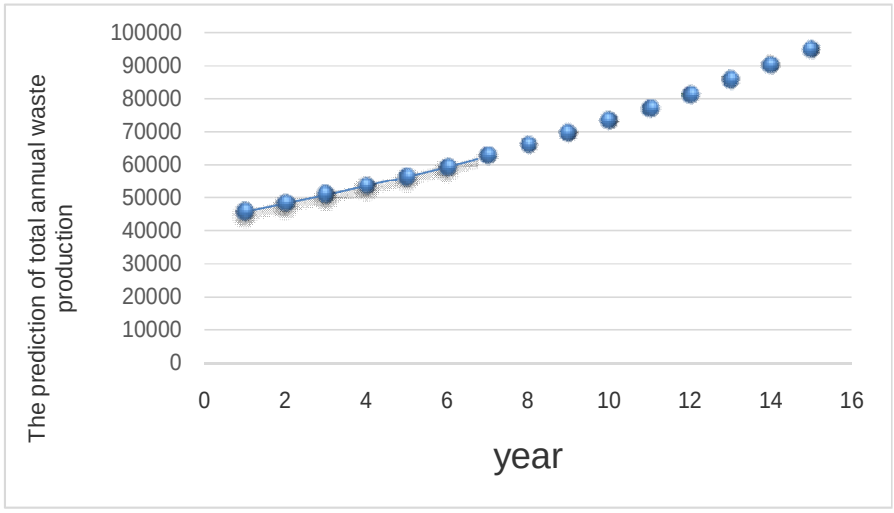

Figure4. The prediction of total annual waste production in Minab

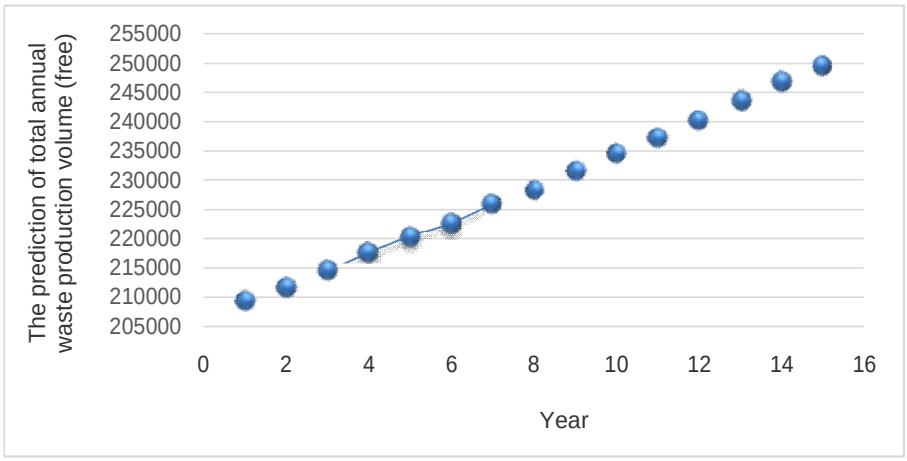

Figure5. The prediction of total annual waste production volume (free) in Minab

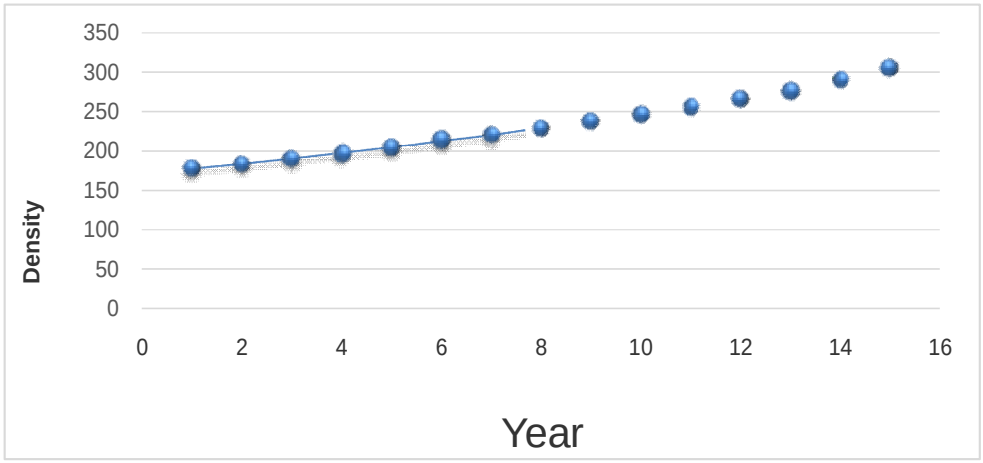

Figure6. The prediction of total annual waste production density (compressed) in Minab

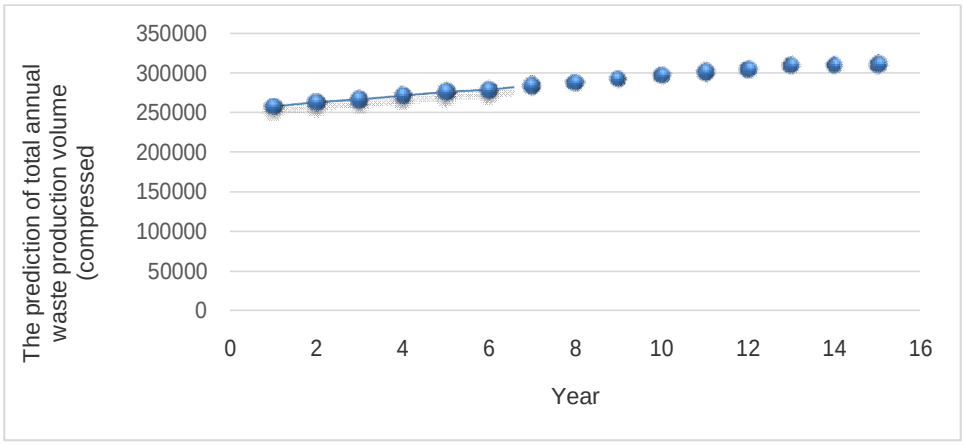

Figure7. The prediction of total annual waste production volume (compressed) in Minab

Anticipating the required vehicles

WAGS program shows that 10 trucks are essential to collect waste in 2014 which is consistent with the current situation in the region. The show Table (2) presents the required trucks within the years 2014–2028.

Table2. The required trucks within the years 2014–2028

Year	The number of required vehicles	The number of required new vehicles
2014	10	**0**
2015	10	**0**
2016	12	**2**
2017	13	**1**
2018	13	**0**
2019	15	**2**
2020	15	**0**
2021	16	**0**
2022	16	**1**

2023	17	**0**
2024	18	**1**
2025	19	**1**
2026	15	**1**
2027	16	**0**
2028	16	**1**

Table3. Minab municipality turnover

Year	Capital	Labour	Maintenance	Missed	Total (Million Rial)
2014	486750	443916	48675	337	**979678**
2015	9750	452808	48675	337	**979678**
2016	493500	458964	50325	349	**1003138**
2017	18000	466488	51150	355	**535993**
2018	502500	474696	52050	361	**1029607**
2019	22500	478800	52500	364	**554164**
2020	513000	488376	53550	371	**1055297**
2021	28500	493848	54150	375	**576874**
2022	522750	502740	55125	382	**1080997**
2023	36750	510264	55950	388	**603352**
2024	529500	516420	56625	393	**1102938**
2025	45000	523944	57450	398	**626792**
2026	537750	531468	58275	404	**1127897**
2027	46500	532836	58425	405	**638166**
2028	939250	534204	58575	406	**1132435**

DISCUSSION AND CONCLUSION

Our results based on WAGS outputs revealed that the population of Minab according to the 2011 census is 97,000 which will be 186,994 in the next 15 years (2028) also per capita waste production in Minab was 1.3 kg daily in 2014 that will be 1.39 kg in the next 15 years. The amount of daily waste production is 46,026 tons in the first year which will reach 95,146 tons in the fifteenth year. Given the population growth, the amount of produced waste within 2014 to 2028 will be doubled. The volume of free waste production will increase from 209,209 cubic meters in 2014 to 249,728 cubic meters in 2028 and volume of compressed waste production will increase from258, 573 cubic meters in 2014 to 310,935 cubic meters in the fifteenth year.

Since the mechanized vehicles are used to collect and transfer wastes to the landfill the required trucks and based on the on current trends is 10 vehicles in 2014 and will be 21 vehicles at the end of the fifteenth year and 11 vehicles should be purchased within 15 years the price of which amounts to 18,920 million rials. It should be noted that the truck's performance in waste transportation is 0.95 which is a very good performance. The cost of human resources including the cost of labor, management and driver in the first year is 443,916 million rials and it will be 534 204 million rials in the fifteenth year.

Minab municipal funds for waste management amounted to 979,678 million rials which will reach 132,435 million rials after 15 years (2028). These results show that about half of the credits required for waste management in the city of Minab should assigned to human resources.

Research previously conducted by Hekmatnia and Asgarabadi in 2008 in the city of Yazd and district 19-Tehran and Ghaznavi (2007) in district 3-Tehran indicated that the labor costs have the highest share which is consistent with the results of the present study and it has been indicated in the above studies that after labor costs the highest prices are spent to buy the vehicles while the results of this study showed that after labor costs the highest prices are spent on fuel which is due to the implementation of targeted subsidies in Iran which has increased the fuel price almost more than 10 times. The results are consistent with the study conducted by Kooshki et al (2004) in Kuwait and Chalkias et al (2009) in Greece because the results show that the highest prices are associated with the labor costs and fuel expenses. According to results it can be concluded that in order to reduce the labor costs the waste collection systems should be mechanized. Also the improvement of machinery and timely repair can reduce fuel costs. Research results conducted by Hekmatnia and Asgarabadi in 2008 in the city of Yazd and district 19-Tehran and Ghaznavi (2007) indicate that the cost of waste collection per month was 17.4 and 26 tomans monthly while it is 280 rials in this study which is due to increased price of fuel and labor payment. The average cost per ton of waste collection is nearly 60$. The studies conducted in different countries around the world show that the average costs of waste collection in Kuwait, USA, Thailand, Florida, Philadelphia, Mumbai-India and Chennai, India were 24, 5.3, 9.4, 16, 48, 33.33 and 33$ respectively. The comparison between these results and the results of the present study indicate that the waste collection system in Minab is traditional and inefficient which increases the costs of waste management.

Recommendations

- Performing comprehensive studies to recognize the abilities of waste collection systems and equipment in connection with the physical, social and economic structure of Minab to increase efficiency.
- Studying, designing and optimizing equipment and vehicles for mechanized and semi mechanized collection systems.
- Implementing programs to recycle vegetable waste from homes and public places such as fruit and vegetables to reduce the waste delivered to the collection system.
- Developing training programs for recycling and source separation for public officials and public associations.
- Specifying the location of waste resources based on appropriate criteria bins and taking into account issues such as, distance, amount of waste produced and…
- Including other rings such as marketing, recycling industries and selling recycled products in the municipal and Ministry's agenda along with source separation plans.
- Including source separation as the priority for the municipality plans and determining general goals at national, provincial and local levels
- Performing programs to create a culture of social responsibility and commitment to the management of solid waste by mass media like radio, television and newspapers
- Using the capacity of private and public sectors to recycle waste.

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