

Economic evaluation of household waste recycling of Birjand in 2013 (Iran)

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Abstract

Recently, the problem of municipal solid waste is one of the most important issues. The aim of the present study is to investigate and analyze obtained information and data, and also to study the amount of waste in city of Birjand in 2013 and focus on the economic and environmental aspects. Data were collected from Municipal Waste Management of Birjand and then statistical analysis were performed. The results showed that with a population of 197,896 in the city of Birjand in 2013, 4/33727 tonnes of household waste were collected. The maximum amount is related to organic waste with amount of 25970 tons and minimum related to related to textiles with amount of 6/168 tons. . Based on calculations, the highest rates of economic value is related to biogas with the value of \$ 3376112. with The economic value of waste in the city of Birjand, lots of activities can be done including create advanced recycling site and employment, generate income and protect the environment and urban landscaping.

Keywords: household waste, Economic Assessment

Introduction

According on article 2 in waste management law, all solid, liquid or gas (non-sewage) material that is directly the result of human activities for which the initial user has no further use in terms of his/her own purposes of production, is called waste (Adineh Nia and et al, 2010). The household waste is classified as normal waste. Experiences show that if the manufacturing wastes including household, industrial, medical, agricultural, etc (Emami Heydari, and Mazinani, 2011). are not given the proper management and also are not changed to low risk materials by the help of scientific and technical methods or disposed, may cause dangerous and serious harms to community (Jamali Zavareh, 2011). There are some methods to reduce the environmental hazards of waste including reduction in origin, production of recyclable materials, separation of wet and dry waste, recycling, recovery and proper disposal. Environmentally friendly products, increasing efficiency and reducing waste material, recovery and reuse of waste, is economically justifiable and generally increase the economic benefit to society at all levels. Identifying sources of municipal waste and knowledge of its physical composition, per capita population and per capita production effect the waste collection methods, transportation, recycling and recovery of materials and energy. There are some problems that are caused by not paying enough attention to collection and disposal of municipal solid materials because of various quality and quantity of materials, these could be solved only through good management and coordination of knowledge and experience (Herbert and Lund 2001). In terms of environment waste and its management is so important Birjand city with a population of 197896 persons in the year 2013 (Department of utilities, municipalities Birjand, 2013) that is prevalent in South Khorasan also has numerous universities and training army and police garrisons, has a high potential of waste production. In this regard, this study focuses specifically on household waste and we have a comparison with other parts of the country and the world in terms of quality and quantity to achieve the general welfare of Birjand.

The amount of household waste in the city of Birjand

According to the law on waste management, approved by the Islamic Consultative Assembly of Iran on 20/2/1383, wastes are divided into five main categories that involve: normal, medical, industrial, hazardous and agricultural (The office of water and soil, 2010). Household waste is considered as normal wastes. The amount of household waste in the city of Birjand in 2010 to 2013 are given in Table 1. As indicated in this table per capita production of household waste have been rising which can be seen in Figure 1.

Table 1: per capita waste production in Birjand (14)

Total weight (tons per year)	Total weight in kg	Per Capita waste production (kg)	Population	Year
29426/6	80620/8	0/440	183229	2010
30795/5	84371/2	0/449	187993	2011
32228/1	88296/2	0.458	192881	2012
33727/4	92403/7	0.467	197896	2013

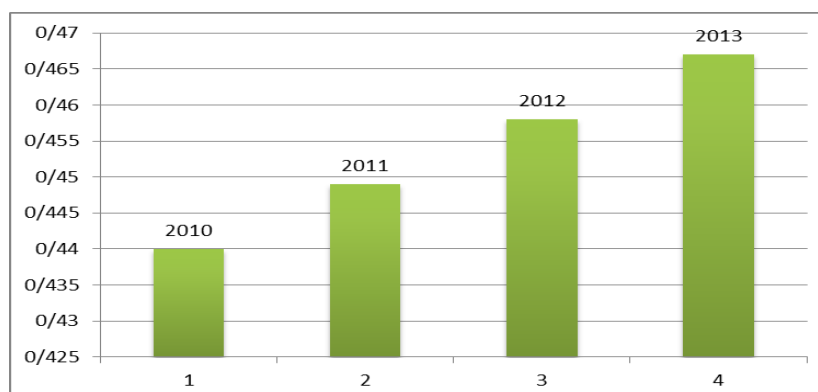


Figure 1- per capita waste production in the city of Birjand in different years (kg)

According to statistics obtained from field studies in Iran, the amount of waste generated per capita in urban areas varies from about 292 to 820 g. In total, about 50,000 tons of waste is produced per day in the cities of country. However, the amount of this is much higher in developing countries. For example, per capita waste production in Tokyo is around 1340 to 1380 mg per day. This is higher than the total waste generated per capita in Japan (1106 grams per person per day) (Mansouri, 1390). This amount is lower than the maximum level of it in Iran so it indicates less level of welfare in this city. In table 2, there is a comparison among different cities in Iran and other parts of world.

Table2- Per capita waste generation in different places

Total weight (tons per year)	Per capita waste production	Population	Location
18250000	820-292	-	[15] Iran
33727	467	197896	[14] Birjand
384996	595	1771484	[3] Isfahan
321930	640	1377450	[5] Karaj
4033	699	15736	[5] Hashtgerd
-	956	-	[12] Rasht
-	1380-1340	-	[15] Tokyo
-	1106	-	[15] Japan

Municipal waste bring lots of environmental problems in many societies that depend on the quality and quantity of waste. Environmental pollution of wastes is mainly caused by physical composition of wastes. These compounds include putrescible materials, paper and cardboard, plastics, fabrics and textiles, metals, glass and other materials that their amounts varies according to The customs, the level of well-being of society and different parts of the world. To reduce environmental hazards of household waste of Birjand understanding physical composition is required, the physical analysis of household waste in 4 season in 1392 are given in table 3.

Table3- Physical analysis of household waste in Birjand in 2013 (percentage)

other	cardboard	plastic	textiles	Glass	metals	paper	PET	Putrescible	Season
5	3	5	-	2	1	5	2	77	Spring
6	3	4	-	3	1	3	2	78	Summer
8	3	4	1	2	2	5	2	73	Fall
4	4	4	1	2	1	3	1	80	Winter

As is apparent from Table 3, most of the ingredients of household waste in Birjand is putrescible materials that reflects the ability of the waste to produce organic fertilizers and between 15 to 18 percent of the ingredients are recyclable. As it is shown in table 4, the amount of organic materials is high in the cities, but the same parameter for developed countries such as Germany is 42/4%, Netherlands 50/5%, UK 30.6 percent apparently it may cause by the cultural underdevelopment in the field of waste produced in Iran.

Table4- Physical analysis of household waste in different parts of the world

Iran [9]	Damasc [15]us	England [15]	Netherlands [15]	Germany [15]	Persian [15] Gulf	North Africa [15]	Mashhad [1]	Tehran [15]	Birjand [14]	Compounds
62/64	50	30/6	50/5	42/4	40-35	70-60	66/17	70/73	77	Organic materials
10	11	31/2	22/8	19/9	30-24	20-10	7/7	10/33	7/25	Paper, paperboard, corrugated
10/28	5	5/2	6/8	6/1	15-10	2-1	18/26	2/76	6	Plastic
4/24	3	3/8	7/2	11/6	6-5	3-2	2/05	2/83	2/25	Glass
3/24	3	5/3	4/4	3/9	5-2	3-2	1/03	1/43	1/25	Metals
4/08	4	1/4	1/4	1/5	6-5	3-2	3/28	2/78	0/5	Textiles
5/52	21	19/8	-	-	3-2	10-5	1/51	6/12	5/75	Other
100	100	100	100	100	100	100	100	100	100	Total

Reference: (The office of water and soil, 2010).

According to the statistics, it is hard to restore the recyclable wastes in later stages of waste management if they are not separated at the origin. So there is a need to get people involved with the separation of waste at the origin of generation.

Economic Assessment of household waste recycling in Birjand

The amount of household waste in 2013 was 33,727,400 kilograms in Birjand. The ingredients of this is shown in table5.

Table 5- the amount of household waste of Birjand in 2013

total	other	textiles	metals	Glass	plastic	paper and cardboard	Putrescible	Type
33727400	1939326	168637	421592	758867	2023644	2445236	25970098	Amount

Putrescible waste

1-Compost

It is organic matter that has been decomposed and recycled as a fertilizer and soil amendment. Compost is a key ingredient in organic farming. As concern about landfill space increases, worldwide

interest in recycling by means of composting is growing, since composting is a process for converting decomposable organic materials into useful stable products. Turning food waste into a valuable soil amendment. Municipal and household waste and food waste are converted into compost after separation by aerobic fermentation process. Unlike conventional composting, the compost is free of foreign substances is called Bio-composting (Abedini Torghabeh, 2010). The amount of wet waste that was collected in the city of Birjand in the year 2013 was 25970098 kg, of which about 60%, it means 15,582,058 kg of compost that can be achieved. That is equivalent to \$ 2648950 gross profit income for the city.

Table 6- The economic estimation of the production of compost from wet household waste in 2013

The total financial value of collected wet waste (dollars)	Unit price (cents/kg)	The amount collected (kg)	Index
2648950	17	15582058	Compost

2- Biogas

Due to population growth and the high consumption of energy resources and not paying enough attention to renew it today, we face with the problem of energy supply and Excessive use of fossil fuels also causes other problems such as air pollution, water and soil pollution. More than 25,970,098 kg of wet waste was generated in Birjand in 1392, when considering that between 21/0 to 65/0 cubic meters of methane gas can be obtained from the analysis of per kilogram of wet biodegradable waste. Now, due to the amount of waste produced in the city between 5,453,720.58 to 16,880,563.7 cubic meters of biogas can be produced. With this amount of gas can be used in the consumption of energy-saving, which has a large economic cost as well.

Table 7- Estimation of economic value of gross production of biogas in 2013

The total economic value (\$)	Unit price (cents/kg)	The amount of biogas production (cubic meters)	Index
337611 to 1090744	20	16880563 to 5453720	Biogas

Dry household waste

1-paper and cardboard

Paper industry is located fifth ranks in terms of energy consumption in the world. Two tons of wood is needed in order to produce one tone of paper that means 13 tre3es. Moreover, as research has shown that recycling one ton of paper will save 31,609 liters of water and Each ton of recycled paper saves 4,000 kilowatt of energy (Barimani et al, 2013). One ton of recycled paper saves 463 gallons of oil and reduce air pollution to 587 units (Karimi Shrvdany, 2010).

Table8- Estimating the economic value and saving of energy, oil and water from recycling paper and cardboard collected in the city of Birjand in2013.

Water (liters)	Energy (kWh)	Stored oil (gallons)	The total economic value (\$)	Unit price (cents / kg)	The amount collected (kg)	Index
77291465	9780944	1132144	611309	25	2445236	paper and cardboard

2- Plastic

More than a third of the packaging are made of plastic. Today, more than 50 types of plastics are made from renewable raw materials such as oil (Alkyngtvn et al, 2001). Nearly a third of household waste is made up of thrown packaging material. One third of all produced plastics are formed more from polyethylene phthalate, for the manufacture of disposable plastic canister Poly Clamshell packaging Poly chloro ethane and ethane are used to create tote bag by Burberry (Winfield, 1381.). On the other hand, by recycling of every 5 bottle of 2-liter of pet, we could fill a ski jacket and 35 of this bottle is enough to fill the inside of a sleeping bag (Abdoli, 2005).

Table9- Gross economic value of plastics in the city of Birjand in 2013

The total economic value (\$)	Unit price (cents / kg)	Amount of collected (kg)	Index
222600	11	2023644	plastics

3-Glass

In addition to the shortage of raw materials that is a good reason to recycle there is another reason that says Second hand using glass (broken glass) is also economically very affordable Because the melting point of glass particles is lower than raw materials and reduces energy consumption. Cost reduction, the balance at the time and reduce the pollution, are other advantages of using glass chips. Melting furnaces used for glass containers usually have a 5 year old when they are necessary to rebuild. In order to melt the recycled glass only 40 to 60 percent of energy is needed that is essential for preparing the raw glass. Thus, in practice, by 15 to 20 percent of additional retail glass are added to Melting furnaces. By doing so, one-fifth of air pollution reduced in Japan, Europe and America that have standard clean air regulations (The Civil Service Management, 1385). 9 gallons of oil are saved per ton of recycled glass with the same amount of storage is 50 percent water and 1600 kWh of electricity would be saved in the production process (Abdoli, 2005). 758867 kg glass was collected in Birjand in 1392 of which 682980 was recyclable.

Table 10- Estimating the economic value and the energy of the glass recycling in 2013

The stored oil (gallon)	Stored energy (kW/h)	The total economic value (U.S. \$)	Price per Unit (cents)	The amount of recycled glass (kg)	Index
6147	1092768	20489	3	682980	Glass

4- Metals

Recycling ferrous metals, is considered part of iron and steel industry. And iron have been always with waste recycling. Abandoned objects containing iron in different shape and sizes of houses and factories as worn objects to be thrown away. Nonferrous metals is not usually seen compared to other materials in the waste. The only of this kind is aluminum that is found in municipal waste that is used in packaging industries (Moghaddam, Mkhtarany, (2007).

Table 11- The estimated gross economic value of recycled metals in household waste of Birjand in 2013

The total economic value (U.S. \$)	Unit price (cents / kg)	The amount of recyclable metal (kg)	Index
248739	59	421592	Metals

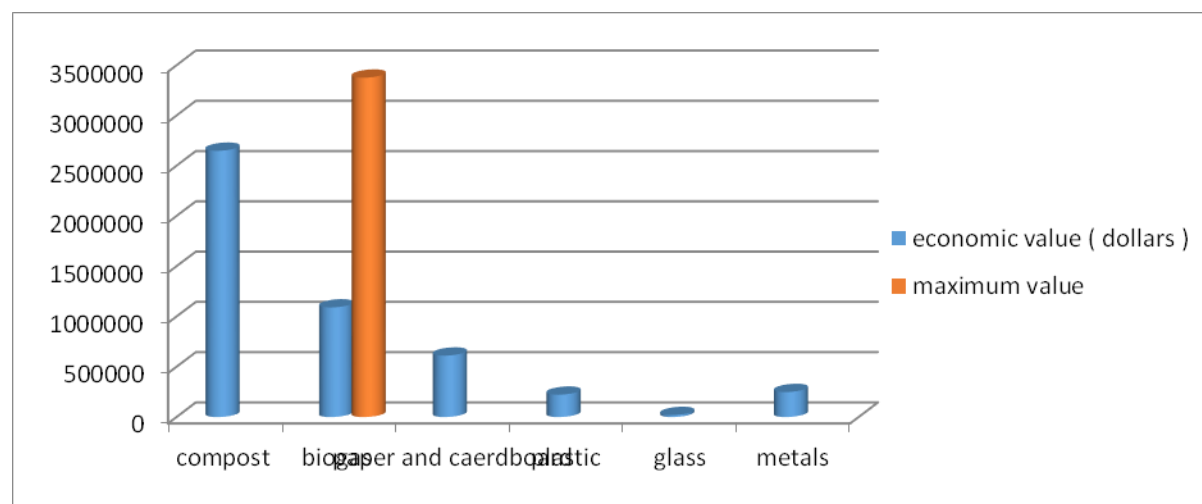


Figure 2 - The economic value of recycling household waste types in Birjand

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