

original article

# Investigation on the solid waste recovery in the industrial unites of Isfahan, Iran

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## ABSTRACT

**Aims:** The purpose of this study was to investigate the professional attraction rates on solid waste recovery area, current recovery market in the study area, and to determine their activity index.

**Materials and Methods:** The recovery of materials in the active industrial units of Isfahan industrial parks, central area of Iran, were classified and analyzed. The quantitative and experimental studies were used. In each recovery area, employment, investment rate, and production capacity of industrial units were specified and the activity index was prescribed.

**Results:** The highest activity index in the province relates to paper and metal with 17 and 16 units, respectively. In the study area, no study has been carried out about electronic waste and old cars recovery. Also employment in paper and metal recovery industrials are more than another with 385 and 221 persons per year, respectively.

**Conclusion:** The recovery of solid waste and distribution of solid waste production in Isfahan showed that planning of solid waste recovery industry can be developed in future.

**Key words:** Activity index, industrial parks, recovery market, solid waste

## INTRODUCTION

Developments in this century go along with the population growth, and technology advances have followed a new period in environmental destruction. Environmental pollution due to release of smoke, gases, effluents, and solid wastes from industries is one of the major issues of global concern.<sup>[1]</sup> Solid waste is one of the main polluting

materials. Increasing population and consequently increase in waste materials have made worries on resources decrement. Pollution and depletion of natural resources led experts to replace waste solid recovery with waste disposal programs.<sup>[2]</sup> According to scholarly resources, the recovery process is located on top of solid waste management programs after rubbish production decrease.<sup>[3]</sup> Recovery not only saves environment but also carries many economical advantages. In all initial feasibility studies, the recovery plans of different materials of existing units, consumption process, price, market condition, and their share in export and import market were assessed.<sup>[4]</sup> For instance, for recovering plastic bottles (PET), it is expected that a growing and suitable market exist in future.<sup>[5]</sup> To consider the alloy recovery, steel market is prosperous.<sup>[6]</sup> Thus, if exporters be able to present required price and

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quality, export in high volume practically is possible. The hospital wastes in Shandong China proceed to assess in 2009. After estimation of the waste level in the region and deciding on zoning of hospital waste, the waste management elements were measured. The result was the necessity of infrastructures establishment by government and private sector activation in this area.<sup>[7]</sup> In 2009, the Market Research Institute measured the electronic waste recovery market in Swedish. The obtained result suggested the creation of 500 companies with 200 work subjects.<sup>[8]</sup>

In Isfahan province, the active units in recovery are divided into two groups. They consist of active industrial units inside and outside the industrial estates. Each of these industrial units is working on recovery of a certain type of materials.

Recovery waste of industrial units in the Isfahan province was assessed on the base of amount of flow and use of wastes and the rate and volume of goods, financial and economic exchanges in recovering. This assessment was in terms number, employment, investment, and production capacity.

## MATERIALS AND METHODS

To evaluate the recovery market in the province, at first the recovery materials are divided into 10 categories. These recovery materials including wood, metal and nonmetal materials, paper and carton, glass, rubber and plastic, nonmetal mineral, clothing, electronic waste, old cars, and others. Then the industrial operations were assessed on the bases of the location of industrial units in the industrial parks or out of them.

Data were collected from mines and industries organization (MIO) and industrial parks company (ITC). The quantitative studies and experimental investigations were used as the method.

## RESULTS

The studies showed that 87 active industrial units, organizations, or person were working on the recovery or recycling materials transformation. The extracted statistics of established permitted units and those are active in recovery showed that from these 87 active industrial units approximately 51 units were recovering wastes inside and remaining 36 units worked out of industrial parks. Based on the MIO data, the number of establishment permitted recovery units outside industrial parks is 71 and in of them 36 units are active. Also, the number, investment, production capacity in active industries, and recovery of materials inside and outside of industries are assessed in the province at the same time. The resulted data about studies on recovery industry are presented in Figures 1-8. Figures 1 and 2 show

the active industrial units in recovery in and out of industrial parks of Isfahan province with different classification. The investment rate for active industrial units in recovery in and out the industrial parks in different categories has been shown in Figures 3 and 4. Figures 5 and 6 show the created jobs for active industrial units in recovery, in and out of industrial parks of the province in different recovery groups. Figure 6 presents that the highest employment level is in metals and

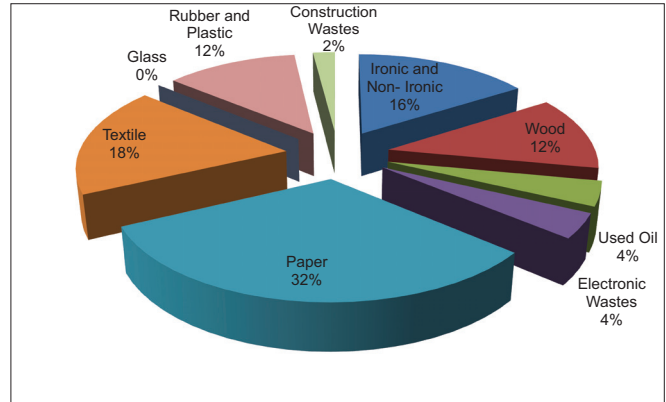


Figure 1: Number of active industrial units in recovery inside the industrial parks

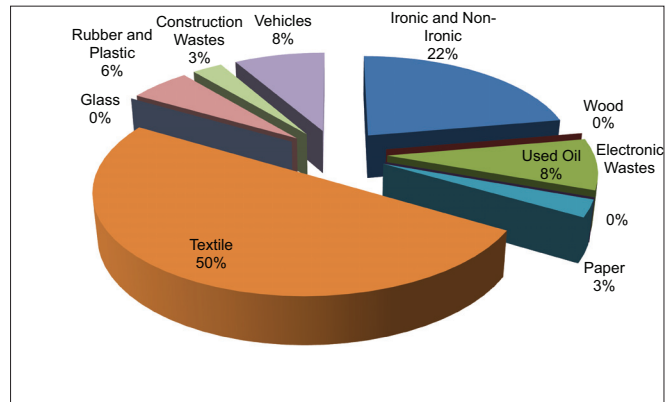


Figure 2: Number of active recovery units in dispersed industries of the province

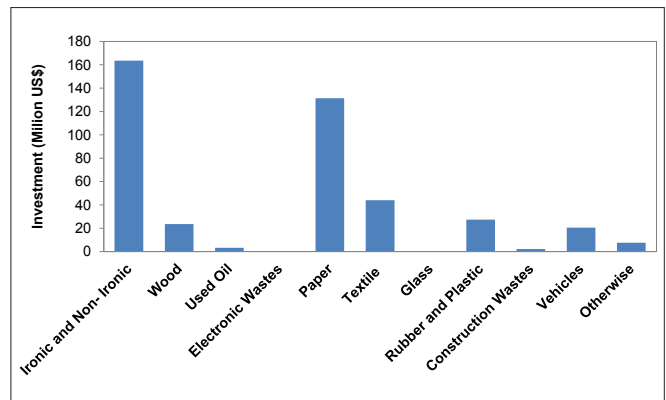
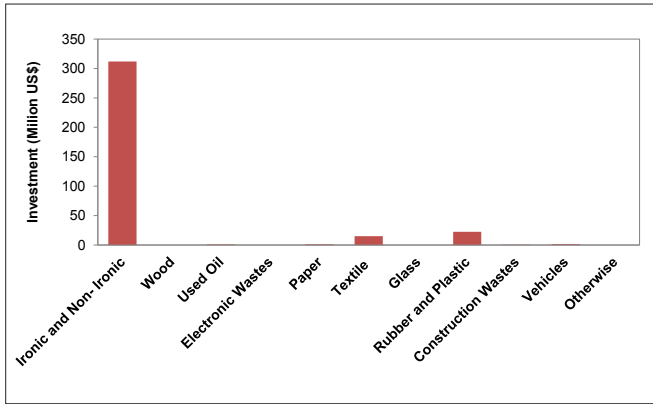


Figure 3: Evaluation of the investment rate in different recovery groups in and out the industrial parks

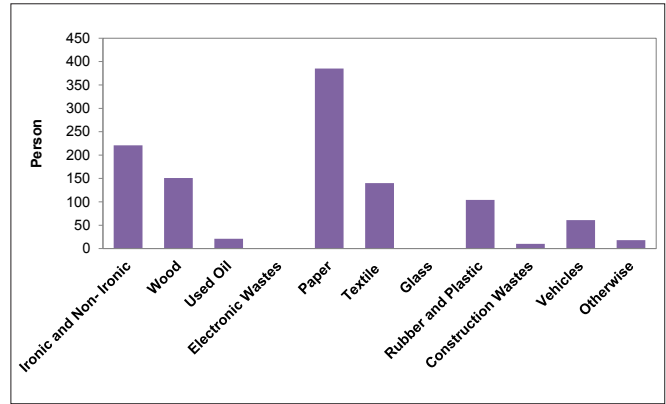
in electronic, glass and no job has been created in wood waste. Figures 7 and 8 show the created production capacities for active industrial unit's recovery in and out of the province for different recovery groups. Figure 9 shows the falling activity index for recovery industries. Table 1 shows the amounts and activity index for each group of recovery.

## DISCUSSION

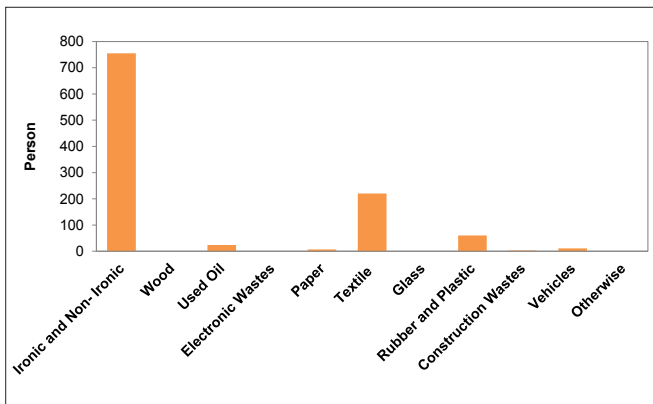
Environmental hazards as a consequence of material mass consumption and waste dispose remain largely, besides resource embodied in waste remains unconsidered in developing countries.<sup>[3]</sup>



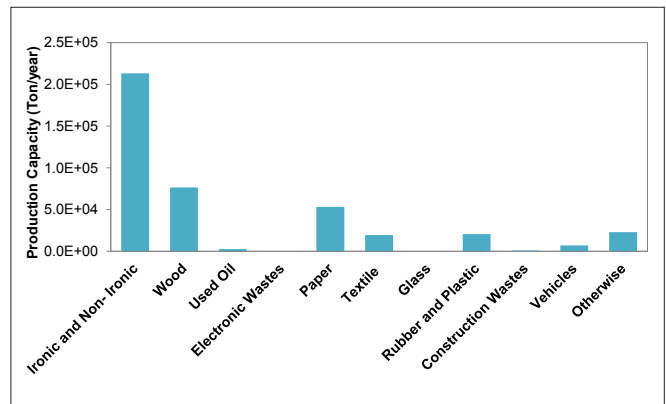
**Figure 4:** Evaluation of investment in different recovery groups of dispersed industries in the province



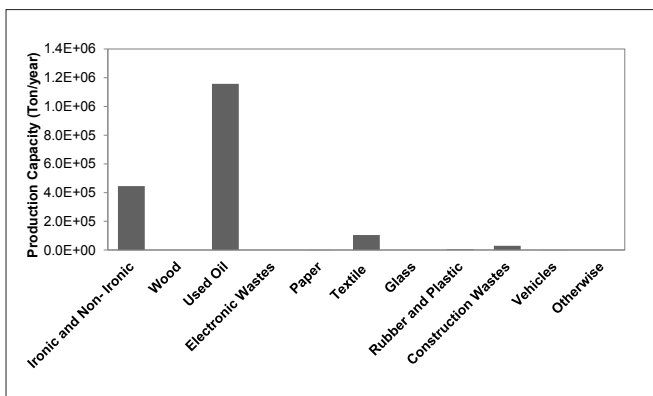
**Figure 5:** Measurement of employment in different recovery groups inside industrial parks



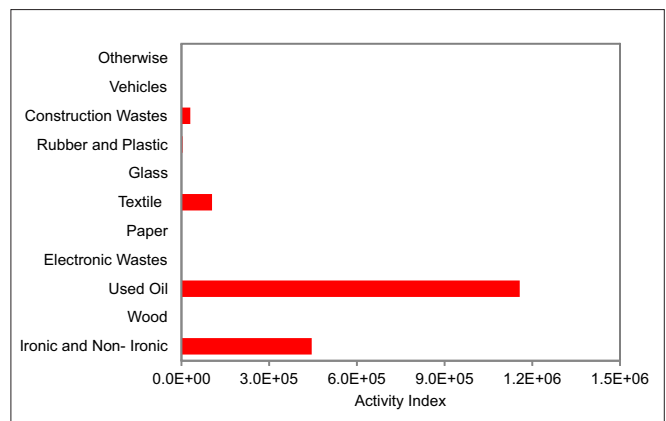
**Figure 6:** Evaluation of employment rate in different recovery groups of dispersed industries



**Figure 7:** Evaluation of production capacities of different recovery groups in the industrial parks



**Figure 8:** Production capacity measurement in different recovery groups of dispersed industries



**Figure 9:** Activity index for different recovery industries

**Table 1: Amounts and activity index for each group of recovery**

Type of industrial unit activity	Number of units	Capital	Employment	Production capacity	Activity index
Wood recovery	0.0689	0.0299	0.0689	0.0371	5.266 E <sup>-6</sup>
Metal and nonmetal materials	0.1839	0.6040	0.4454	0.3190	1.578 E <sup>-2</sup>
Rubber and plastic recovery	0.0919	0.0635	0.0748	0.0117	5.107 E <sup>-6</sup>
Construction waste recovery	0.0229	0.0033	0.0059	0.0150	8.732 E <sup>-9</sup>
Clothing recovery	0.3103	0.0750	0.1643	0.0145	5.544 E <sup>-5</sup>
Paper and carton recovery	0.1954	0.1686	0.1789	0.0258	1.520 E <sup>-4</sup>
Old cars recovery	0.0574	0.0280	0.0328	0.0035	1.845 E <sup>-7</sup>
Other recoveries	0.0114	0.0096	0.0082	0.0111	9.961 E <sup>-9</sup>
Used oil recovery	0.0574	0.0177	0.0205	0.5618	1.170 E <sup>-5</sup>

In most of the countries, sorting either on-site or at centralized facilities is an important means for most reusable or recycling processes.<sup>[9-11]</sup>

As can be seen in Figure 1, the maximum number of recovery units is in paper, carton, and clothing category and the minimum number in electronic wastes category. Based on Figure 2, the highest numbers of recovery units are in clothing category and the lowest in electronic, glass, and wood waste. As can be seen in Figure 3, most of investment was in recovery of metals, paper, and carton and the least in electronic and glass wastes. Figure 4 shows that the highest level of investment is in metals and no money has been invested in electronic, glass, and wood wastes. The reuse and recycling of waste paper sludge is increasing rapidly as far as the economical and positive environmental benefits are realized.<sup>[12]</sup>

The analysis of output data of the material recovery facilities in turkey showed that although paper, including cardboard, is the main constituent, the composition of recyclable waste varies strongly by the source or the type of the collection point.<sup>[13]</sup>

Based on Figure 5, the maximum jobs are created in paper, carton, and metals recovery and the minimum in electronic and glass waste.

According to Figure 7, the maximum production capacity relates to metals, paper, and carton and the minimum to electronic and glass waste. As Figure 8 shows, the highest production capacity belongs to metals recovery and in electronic, glass, and wood waste category no investment was done.

The household electronic equipments demand in Iran has rapidly grown since 2001 and it is expected to increase more quickly in next few years, due to increasing technological development.<sup>[14]</sup>

In order to find which recovery groups were more active, the activity index was used. In this index, firstly, the active and dispersed industries were recognized through the existing data. For measuring it, four types of statistics such as unit's number, capital, employment, and production capacity

were applied. These parameters resulted by dividing each group number to the total sum and the obtained numbers multiplied.

It can be concluded from Figure 9 that in glass and electronic waste recovery no action proceeds. In recovery of wood, rubber and plastic, used oil, construction waste, and other little action has been performed. In relation to old cars, paper, carton, and clothing recovery is moderate and high level of recovery was related to metal and nonmetal materials.

According to studies, it is concluded that the total amount of fixed capital, employment, and production capacity in 51 units inside the industrial parks are \$516 million, 1111 people and 416,950 tons in the years, respectively. The 36 number of active units outside the industrial parks have 1080 people employment and 1.6 mega tons production capacity including in a year.

Zand and Abduli presented that more than 9800 metric tons of household batteries were imported into Iran in recent decade, with the market value of about US\$ 42.6 million. At present, there is no program available in Iran regarding to collection, separation, recycling, or safe disposal of used batteries. Therefore, almost all of the spent household are discarded into municipal solid waste (MSW) and sent to sanitary landfills.<sup>[14]</sup>

Unsafe disposal of used electronics equipment may be associated with human health and environmental hazards. From the viewpoints of human health protection, environmental preservation, and sustainable development scopes, uncontrolled disposal of spent electronic equipments into MSW is not justifiable.<sup>[15]</sup>

The investment condition in Isfahan province, either active unit inside or outside the town shows that \$80 million investment has been allocated to the recovery industry. On the other hand, the assigned capital to active units inside the towns equals 43 million US\$. Thirty seven million US\$ has also been allocated to dispersed active units outside the town. The evaluation of investment and capital attraction in different groups of recovery in and out of the industrial parks indicate that dispersed units has absorbed the highest

investment in recovery of metal and nonmetal materials that is \$32 million.

Metal and nonmetal material recovery has absorbed the highest capital in industrial units inside the industrial parks that equals \$16.7 million. Therefore, based on the existing data, maximum investment has been owed to metal and nonmetal material waste outside the industrial units. Of course this is totally less than capital that has been absorbed by active industries inside the towns.

Metin *et al.* study in Turkey showed that the major constituents of municipal solid waste are organic in nature and approximately a quarter of municipal solid waste is recyclable. Also polls indicated that more than 80% of the population in the project regions are ready and willing to participate in separation and collection programs.<sup>[13]</sup>

About jobs created in recovery units, employment outside the town in comparison to units inside has less developed. Difference in employment of inside and outside of the town is related to the small size of units work more traditionally with lower capital.

In general, production volume of units which are outside of the town significantly exceeds the units inside of the town about 1,646,949 tons. Production volume of active units inside the town equals 416,950 tons that is less than outside units.

In relation to the recovery market of industrial units in the province, no similar study has been carried out. Based on the activity index and production capacity of recovery materials in the province, less attention has been paid to construction waste, rubber and plastic, glass, electronic wastes, and old cars. Finally, it is proposed to organize plants in recovery industry of construction waste, rubber and plastic, glass, electronic wastes, and old cars.

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