

Original Article

System analysis of industrial waste management: A case study of industrial plants located between Tehran and Karaj

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INTRODUCTION

As a result of the rapid industrial development at the global level, environment was subjected to hazard and crises in the past decade. Pressures arising crisis in industrialized countries led to establish of more rigid regulation and environmental

standards enforcement, unfortunately, this practice, in most developing countries, have not in the actual status yet.^[1,2] As a part of industrial activities, industrial wastes have been problematic, however, comprehensive management is considered in order to minimize their risks.

Improper industrial and municipal waste management can lead to many forms of contamination, such as groundwater contamination, air quality deterioration, and greenhouse gas emissions (e.g., methane gas emissions from anaerobic decomposition).^[3] Industrial waste is the waste produced by industrial activity which includes conventional wastes and hazardous waste. Currently, industrial activities are the main sources of world's hazardous waste production.^[4]

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ABSTRACT

Aims: In this study, management of industrial waste in industries located between Tehran and Karaj in 2009-2010 was examined.

Materials and Methods: This is a cross-sectional study which was done by site survey (Iranian environmental protection organization) questionnaire usage and results analysis. This questionnaire was consisted of 45 questions about industrial waste, quantity, quality, and management. A total number of industries with over 50 employees was 283, and Stratified sampling method was used. Sample of size 50 was selected from 283cases.

Results: The major hazardous waste-generating industries include chemical and plastic. Private sectors disposed 45% of generated waste. Majority of wastes were buried (62%), and only 17% of industrial waste was recycled.

Conclusion: For hazardous waste reduction in this zone and health and economic attractions, the opportunity for reuse and recovery for these wastes must maximize in short-term and burial of industrial waste must be minimized. Industries such as chemical-plastic and electronics which have higher hazardous waste, in long-term, must be replaced with other industries such as wood cellulose and paper that have lower hazardous waste production rate.

Key words: Industrial waste, tehran–Karaj zone, waste management

Hazardous wastes as defined by the United Nations Environment Program are wastes (solid, liquid or sludge) other than radioactive waste which, is defined by of their chemical activity or toxic, explosive, corrosive, or other characteristics that has potential risks for human health and environment.^[5] Hazardous wastes, the main defect of the industrialized world, showed their importance because of their potential hazard to human health and environment when improperly identified and managed.^[6] Discovering hundreds of barrels of toxic waste in a park in Istanbul, Turkey^[7] or fire in the warehouse containing chemical waste at the factory in basal Switzerland in 1986^[8] can be mentioned as examples for the hazard of these wastes. Similar incident was happened in Iran, for example, explosion of the tank contains oil and complete destruction of installations and the deaths of at least five people in 2005.^[8] Now-a-days, efficient management of large amounts generated waste with different composition poses a major challenge for the industries.^[9] The main elements of comprehensive waste management are production, storage, collection, transportation, processing, disposal, and treatment.^[10] Industrial Waste Management history returns to approval of Resource Conservation Recovery Act in United States in 1976.^[11,12] The first laws and regulations pertaining to hazardous waste management have been implemented in member countries of the Common Market in 1980, Europe.^[13] Now-a-days, laws and regulations for the control and safe disposal of industrial waste are implemented in many industrialized countries. In developed countries such as the United States of America, England, France, Germany, Japan, and The Netherlands have been provided a detailed list of databases, processes, industrial waste, or hazardous waste. However, Industrial wastes in many developing countries are still transporting with common household waste and posing many health risks to workers, public, and environment.^[14] In Iran, there is no comprehensive study concerning about identification and management of industrial wastes. The results of studies shown that in most cases, wastes management is improper in industrial towns, and there is no detailed information about quantity and quality of industrial waste in Iran.^[15,16]

Compilation detailed database of status and industrial waste quality is inevitable in order to establish a national industrial wastes control system.^[5]

With the support of relevant organizations such as Ministry of Industry, Environmental Protection Agency (EPA) and Department of Health, existing database state for Iran's industrial waste management, should be developed and regularly updated.

This study aimed to assess the industrial waste management in industrial plants located between Tehran and Karaj in 2010, and can be considered as a pilot study in this regard.

MATERIALS AND METHODS

This study is cross-sectional and adopted in industrial units located between Tehran and Karaj on

the longitude of 51° 19 min' east and the latitude of 35° 48 min north.

Length of the area is approximately 45 km. According to Mining and Industry census in 2008, the number of industrial in Iran with more than 10 employees, are 15,878 units. 4000 units are located in Tehran province. The number of industrial units located between Tehran and Karaj are 1116 and manifest the importance of this region in terms of industrial aggregation and production of industrial wastes.^[17,18]

This study was performed based on a survey of selected industries, questionnaires prepared database and analysis of the results. Iran EPA questionnaires were used. The questionnaire contains 45 questions in four sections, including background information, quantity, quality, and industrial waste management. Basic information included the name, address, type of industry, number of employees, type and quantity of industrial products. The industries located between Tehran and Karaj are under supervision of Tehran Department of Industries and Mines. Thus, information was collected with referred to this organization.

Questions about source separation, storage status, waste discharge frequency, transport and disposal responsible organization of waste, and methods used for final disposal industrial solid waste, were composed management sector in the questionnaire.

Industrial classifications based on census of industrial, was performed in 10 categories, including food and pharmaceutical, plastic and chemical, metal, nonmetallic mineral, wood and cellulose, pulp and paper, textiles, machinery and equipment, electronic and cosmetics industries.^[17] Between the 1116 industrial units, 833 units have employed <50 persons and 283 units more than 50 persons. Since the industries with less than 50 persons are considered small, industries with staff over 50 persons were survived.

Stratified sampling method was used to select a representative sample of industries. In this method, according to the number of industries in each class, a certain percentage of the selected industries were studied. Finally 50 samples were selected, in 10 categories: Machinery and equipment (11 samples), metallic minerals (8 samples), food and drug (8 samples), plastics and chemicals (7 samples), textile (6 samples), electronics (4 samples), nonmetal mineral (2 samples), paper (2 samples), cosmetics (1 sample), wood and cellulosic (1 sample), respectively. After selecting the samples, inspection was made, and questionnaires were completed. Finally, the collected data were analyzed.

RESULTS

Figure 1 shows the percentage of employees and generated wastes in different industries. Based on this figure, the maximum

number of worker related to machinery and equipment industrial group. Largest percentages of wastes are produced by these industries. Minimum number of worker and the lowest percentage of waste related to paper industrial groups.

The largest of hazardous wastes was plastic and chemical industries. In this group industries such as pesticide manufacturing plant, fertilizer manufacturing, plastic products manufacturing and dyes and colorants manufacturing, produced major part of hazardous waste. In this group, 3500 kg of wastes is produced per day. The lowest producer hazardous wastes were wood, pulp, and paper. Machinery and equipment industrial group produced lower amount of hazardous waste than the metallic minerals, plastics, and chemicals and electronics industrial groups while maximum number of personnel related to this groups [Figure 2].

The most common way for industrial waste storing until final disposal is warehouse (33%) and then keeping waste in open space (23%), respectively. Using of plastic bag, tank, barrel, and pool are other options for temporary storage of industrial waste in mentioned industries [Figure 3].

As shown in Figure 4 about 31.18% of the produced waste in these industries discharged monthly, 35.3% weekly, 23.53% daily, and 10% irregular.

Figure 5 shows that 45.18% of the generated waste disposed by the private sector, 31.73% by the industries itself, and 23.35% disposed by municipalities. Municipalities, in given area often disposed industrial waste with municipal wastes.

About 62% of solid waste was buried, 17% recycled and reused, 10% was burned, and 11% disposed in an unknown manner [Figure 6]. The primary option for disposal of the wastes is landfilling. Landfilling has a low cost which makes it an attractive choice for industrial owners. Compared to landfilling the rate of recycling is low (17%), result showed that the main reason is the lack of a recycling system.

DISCUSSION

Management of industrial solid wastes which includes a wide range of hazardous pollutants is one of the

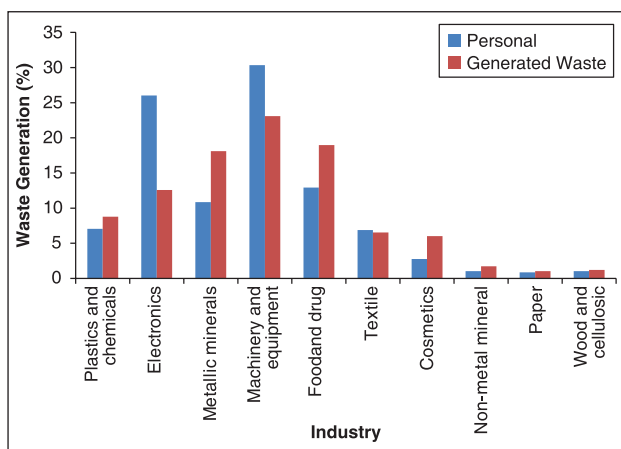


Figure 1: Status of employees and generated waste in various industries in study area

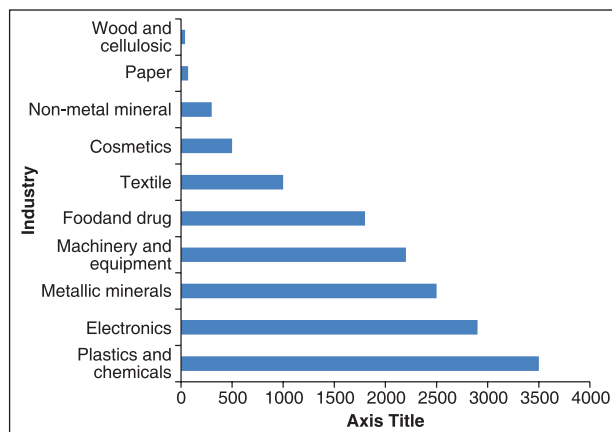


Figure 2: Quantity of industrial hazardous waste in the study area

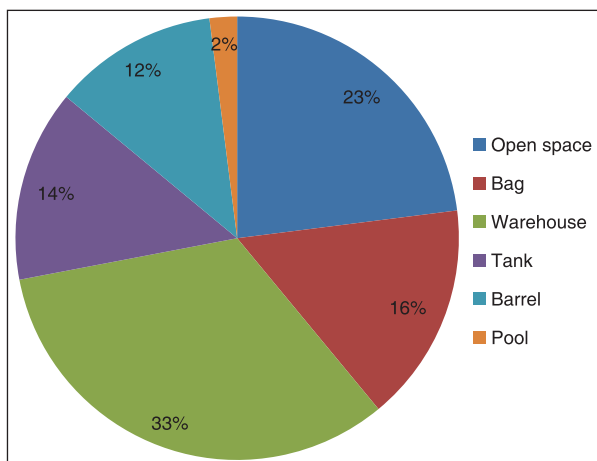


Figure 3: Various methods for temporary storage of industrial waste in the selected industries

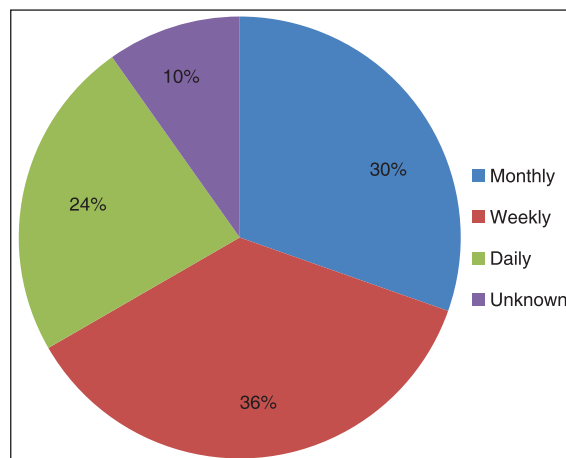


Figure 4: Frequency of waste discharge in selected industries

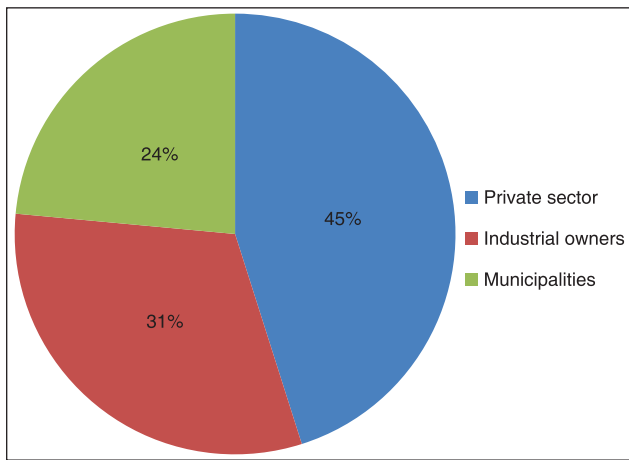


Figure 5: Responsible agencies for transportation and disposal of industrial waste in the selected area

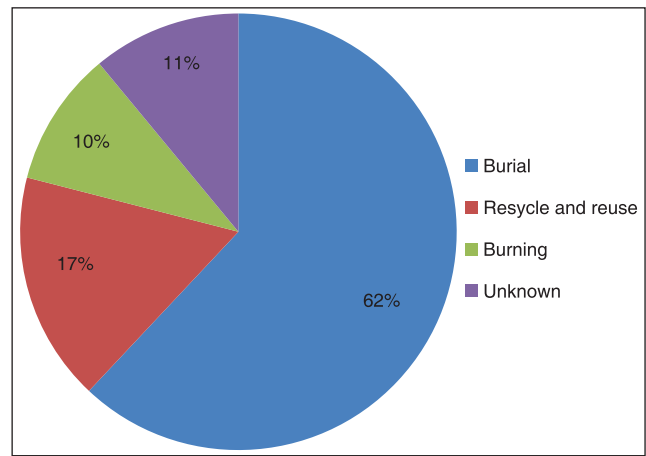


Figure 6: Final method for disposal of industrial waste in selected industrial

main environmental issues especially in the developing countries.^[19]

As can be seen in Figure 1, total generated waste in various industries was 123,451 kg/day and total workers in different industries were 21,185 persons. Maximum number of personnel related to machinery and equipment and electronics industry, with 6519 and 5503 workers, respectively. Wood and cellulose with 114 and nonmetallic minerals industries with 205 persons has a minimum number of personnel. Abdoli *et al.* showed that in 9th zone in Tehran, 4850 ton of waste generated per year.^[20] Differences in obtained result with the result of this study can be attributed to the amount of larger industrial unit in the study area.

The largest amount of hazardous wastes was produced by plastics and chemicals, electronics, and nonmetallic minerals industries, respectively. Industries that produce the least amount of hazardous wastes are wood and cellulose and paper [Figure 2].

Total amount of industrial hazardous waste was 14,810 kg/day that accounted for 12% of total industrial waste. The ratio of hazardous waste in plastic and chemical industries to the total hazardous waste was 22%. The ratio of hazardous waste to total generated industrial waste compared to other countries such as Turkey, China, and Lebanon, was 7%, 5.8% and 1.1%, respectively. The reported generation of hazardous waste for countries such as Turkey, China, and Lebanon were 1.195, 11.62, and 0.347 million ton per year.^[1,6,7] As can be seen, the generated industrial wastes in these countries are far less hazardous than the study area. In a study conducted by Shahreyari *et al.* in relation to the management of industrial waste in Birjand industrial park, the ratio of hazardous waste to total produced waste was 33%.^[21] This indicated that production of waste in this industrial park was more hazardous than study area. Difference in proportion of produced hazardous waste in this study compared with those studies can be attributed to three aspects: Differences in the

nature of industry, waste minimization with establishment of clean industries and increase the maximum recycling and reuse of produced waste.

Figure 3 shows that the main approach to storage of industrial wastes until disposal is use of warehouse and open space. The results of the study in Rasht revealed that 48% of the industrial unit stored their waste in open warehouse and 40% of them used covered warehouse for storage of waste.^[22] In another study that conducted in Ghuchan, it was founded that 28% of the wastes are stored in the bag, and 66% are piled.^[23] From the point of view of industrial owners, storage and use of open space for temporary storage of waste are affordable. But in this way, there are absorption fluid possibility, dispersion of wastes in the environment, and contamination of water and soil through the leachate leakage. It was found that the private sector was the main responsible for transportation and disposal of industrial wastes. Compared with other sectors, municipalities have less contribution in handling and disposal of industrial waste with 23%. Results of a study conducted by Abedinzade and Monavari in Rasht industrial area showed that the poor function of waste collection system is one of the main problems in this area. Most of the industrial units in this area were not satisfied how to collect and transport their wastes.^[22]

As Figure 6 shows first and second options for disposal of industrial wastes in the study area was the burial with 62% and recycling and reusing with 17%, respectively. A study conducted by Nabizadeh shows that more than 85% of all industrial waste in Esfahan was disposed to the environment in different ways without recycling or reuse.^[24] Another study in Ghuchan shows that only 16% of industrial wastes are recycling, and 80% of waste without any recycling was landfilled directly.^[23] These results are very similar to that obtained in this study and indicate a lack of planning for reuse of these wastes in the studied areas. Metallic mineral, food and drug, chemical and plastics, and paper industries have the highest recycling. Because of the most portion of

paper industry wastes are paper and cardboard, their wastes sold to cardboard industries. Another hazardous industrial waste disposal is incineration that mostly takes place unsanitary. Previous studies also confirmed that, insanitary incineration of waste due to less difficulty is attractive to industrial owners. This method due to emission of high polluted gases such as dioxins, furans, and unburned hydrocarbons is environmentally unsafe and should be discarded promptly.^[25]

Industrial waste management in the city of Daralsalam showed that the main problem was improper disposal of these wastes. Hazardous industrial waste constituents are not properly separated.^[26]

Improper industrial waste management in most of the studied areas in Iran,^[16,21,22] including area of this study, are in concern.

Results show that industrial waste management in this region was encountered with major problems. These problems, due to proximity of residential areas to the industrial unit, are in high importance and must be modified immediately. These harms include the following:

- Proportion of hazardous waste to total waste (12%) compared with the average of this index for other countries such as, Turkey, Lebanon, and China are approximately 7.4 times greater. This implies inefficient industrial waste management in this area. To reduce hazardous waste generation in this area, in short-term, maximum materials recycling and reuse must be take place and in long-term, industries with many hazardous waste such as plastic-chemical and electronic should be replaced with less hazardous waste such as cellulose and paper.
- Industrial wastes temporary storage was done mainly in warehouses (56%). Because of hazard potential in this method, safer storage methods like covered warehouses must be replaced.
- This study showed that the majority of generated waste (62%) was buried, and only 17% are recycled. Due to environmental problems caused by unsanitary landfills, health and economic attractions of industrial waste reuse, recycling should be maximized, and waste landfilling should be minimized.

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