HAZARDOUS WASTE MANAGEMENT IN ISRAEL, CASE STUDY: HAIFA REGION

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SUMMARY: Typical indicators have been used to estimate the amount of hazardous waste generated by dry cleaners and public hospitals in Haifa region. The findings reveal a wide gap between the amount of hazardous waste reported by dry cleaners and the amounts predicted according to the indicator. Furthermore, a lack of documentation on hospitals Pharmaceutical & Chemical waste was identified.

1. INTRODUCTION

Indicators are useful management tools, which provide an estimate rate of a given pollutant for a given source, relative to the intensity of a specific activity. Indicators convert activity data to emission values and reflect the up-to-date status of environmental management systems. Indicators have an important role in assessing system wastages. In other words, Indicators can reveal whether the system is functioning well, according to law regulations.

Indicators can be used in order to quantify hazardous waste generation and treatment, minimization and recycling and may be used as measures to promote awareness and adoption of a cleaner production (Granados and Peterson, 1999).

2. PURPOSE OF RESEARCH

According to the Israeli legislation, a waste is considered hazardous if it contains hazardous substances, that is disposed-of from a plant, or which is designated for disposal, or is to be disposed-of by the director's decision (The director general of The Ministry of Environmental Protection)
(Licensing of Business Regulations (Disposal of Hazardous Substances), 1990). Hazardous waste is supervised by the Division of Hazardous Substances of The Ministry of Environmental Protection (MoEP).

According to the MoEP, about 300,000 ton of hazardous waste were produced during 2005. One third of this amount is transported to the only hazardous waste disposal site at Ramat Hovav, managed by the “Environmental Services Company Ltd”. The majority of this amount is treated by recycling and treatment plants or exported.

Due to manpower, budget and legislation constrains, the MoEP has restricted enforcement capabilities. Therefore, hazardous waste quantity control is primarily based on the plants’ reports

(according to the hazardous substances permits) and the “Environmental Services Company Ltd” annual reports.

Former studies (Korenberg, 1989; Messalem & Rieman, 1990; Goldshmid, 1993; Enosh, 2001) have estimated the amount of hazardous waste produced according to employment statistics. Those surveys have been held 7 to 19 years ago, and provided a wide range of assessments. This fact makes them difficult to relay on. Therefore, in order to better control hazardous waste production rates, an innovative methodology is needed.

3. RESEARCH METHODOLOGY

The current research uses unique quantitative indicators, based on typical production procedures. The methodology was tested on 8 industrial sectors in Haifa region. Two case studies are discussed in this paper. The research included two major stages. The first stage was dedicated to methodology’s design, by identifying typical indicators. The second stage was assembled from a feasibility test, aiming to compare between the amount of hazardous waste that have been predicted and the amount that have been reported by the plants. A deviation of +/- 30% was considered reasonable. For each of the industrial sectors, a unique indicator was identified, based on typical production procedures.

4. CASE STUDIES

4.1 Dry cleaners

Dry cleaners use perchloroethylene (perc) in the cleaning process. Perc is a volatile, non-flammable, colorless liquid and a possible human carcinogen (California EPA, 2006). The dry cleaning process produces still bottoms or cooked powder residues (from powder filtration systems) which are considered hazardous waste. Still bottoms contain grease, oil, detergent, dyes, sizing, waxes, filter materials and other non-volatile residues (EPA, 2004).

4.1.1 Survey design and methods

Typical indicators were identified using scientific literature data. These indicators predict the amount of hazardous waste produced according to the amount of clothes (by weight) being dry cleaned and/ or the amount of perc consumed. Several indicators were pinpointed and then examined in light of the activity extent in several dry cleaners in Haifa region.

In order to characterize the Haifa region dry cleaning sector, a questionnaire was distributed among six active dry cleaners. The questionnaire was designed to address the following issues: (a) Business information (license number, hazardous substances permit, contact details); (b) Operating information (solvent type used, solvent consumed amount); (c) Machine information (type, total amount of clothes dry cleaned); (d) Waste information (amount, evacuation destination).

After analyzing the data gathered from the questionnaire, a feasibility test was implemented. The data was further verified by interviews and field observations.

4.1.2 Results and Discussion

A literature review has revealed two types of indicators. While one study was based on the perc consumption, four different studies were based on the amount of clothes dry cleaned. Table 1 shows the different indicators by type.

Table 1. Hazardous waste generation rate in dry cleaners.

Reference	Indicator Type	Machine Type	Hazardous waste generation rate (kg/ kg)
EPA, 1981; EPA, 1990; The University of Tennessee, 1997; California EPA, 2006.	The amount of clothes (by weight)	dry-to-dry	0.01-0.08
California EPA, 2006	The amount of perc (by weight)	dry-to-dry	4.2

Table 2 summarized the characteristics of dry cleaners in Haifa region.

Table 2. Questionnaire main findings*.

Dry Cleaner	A	B	C	D	E	F
The amount of solvent consumed	1,500	1,200	100	130	261	163
The amount of clothes dry cleaned	25,000	15,000	N.A**	N.A	N.A	850
The amount of hazardous waste reported	1,000	45	20	120	240	90

*All dry cleaners operate a dry to dry machine using perc.
**N.A- Not Available

Table 1 outlines wide variance between the different indicators types. Therefore it was essential to further identify the most applicable indicator. In the first stage a basic calculation was conducted according to the "perc indicator", which is summarized in Table 3.

Table 3. Calculated and reported amounts of hazardous waste of dry cleaners in Haifa, based on the "perc indicator" (California EPA, 2006).

Dry Cleaner	Hazardous waste estimation (ton/ year)	Hazardous waste reported (ton/ year)	Gap (%)
A*	6,150	960	-84%
B	4,920	45	-99%
C	410	20	-95%
D	535	120	-78%
E	1,069	240	-78%
F	668	90	-87%

*The dry cleaners actual names are not specified in this paper.

With regards to the "cloth indicator" estimate, it was found that the amount of hazardous waste produced by Dry Cleaner A is in accordance with The University of Tennessee's indicator. This estimate was the basis for the calculation in Table 4 (only Dry Cleaners A, B & F reported about the amount of cloth dry cleaned).

Table 4. Calculated and reported amounts of hazardous waste of the dry cleaners in Haifa, based on the "clothes indicator" (The University of Tennessee, 1997).

Dry Cleaner	Hazardous waste estimation (Ton/ Year)	Hazardous waste reported (Ton/ Year)	Gap (%)
A	769	960	25%
B	481	45	-91%
F	27	90	233%

In order to verify the questionnaire data and determine which indicator is applicable, a further inquiry was needed. Interviews and field observations were conducted on the two largest dry cleaners in Haifa region (Dry Cleaners A & B cover 40% of the market).

According to the interview with the manager of Dry Cleaner A, the facility removes three barrels of hazardous waste, equals to 960 kg during one year. The manager of this facility assessed that, on average, 0.04 kg of hazardous waste will be produced per 1 kg of clothes dry cleaned. (Dry Cleaner A manager, 2007). An interview and a field observation were also conducted in dry cleaner B. Table 5 summarizes the field observation results.

Table 5. Field observation results- Dry Cleaner A and B.

Findings	Dry Cleaner A	Dry Cleaner B
The nature of waste in the still bottoms container	Oily sludge	Lint
The nature of waste in the storing container	Oily Sludge	Oily Sludge
Storing container volume	3 barrels of 200 liter	1 container of 50 liter
Storing container location	Fenced, locked, signboard	Open area with no signboard

The difference between the two hazardous waste management systems in Dry Cleaners A & B can clearly be seen. While Dry Cleaner A produces hazardous waste comparable with the literature specification, Dry Cleaner B, allegedly, produces only lint.

4.1.3 Summary and Conclusions

Analyzing the feasibility test results has revealed large gaps (78-99%) between the amounts of hazardous waste reported versus predicted according to the "perc indicator". On the other hand, a high correlation (25%) was found between Dry cleaner A reported amount of hazardous waste and the amount predicted according to The University of Tennessee's indicator (0.03 kg hazardous waste/ kg clothes). Interviews and field observations revealed a great difference between the hazardous waste management system of the two largest dry cleaners in Haifa region- A and B. Three findings have lead to the conclusion that Dry Cleaner B does not manage correctly its hazardous waste streams: (a) The nature of hazardous waste in the bottom distiller container; (b) The difference between the nature of waste in the bottom distiller container and the storing container, (c) Low amounts of waste compared to the activity reported.

These findings have led to the conclusion that the "clothes indicator" is feasible in predicting the amount of hazardous waste resulting from dry cleaning activity. It was found that a dry cleaner operating a dry-to-dry machine, will approximately produces 0.03 kg of hazardous waste per 1 kg of clothes. Dry cleaner A and B cover 40% of the market and treat 40 tons of clothes annually. Therefore it is estimated that the total dry cleaning market in Haifa region dry cleans about 100 tons of clothes. The dry cleaners in Haifa region have reported producing 1.5 tons of hazardous waste during 2006. According to the indicator the amount of hazardous waste was estimated to be 3.2 ton. Therefore, more than half of the hazardous waste being produced from dry cleaning activity in Haifa region was not properly disposed-of at the national site for hazardous waste at Ramat Hovav

4.2 Hospitals

Health-care waste includes all the waste generated by health-care establishments, research facilities and laboratories. In addition, it includes the waste originating from "minor" or

"scattered" sources- such as that produced in the course of health care undertaken at homes (dialysis, insulin injections, etc.) (Pruss, Giroult & al, 1999; WHO, 2000). According to World Health Organization (WHO, 2000), from the total wastes generated by health-care activities, almost 80% are comparable to domestic waste. The remaining is considered hazardous materials that may be infectious, toxic or radioactive. The wastes and by-products cover a diverse range of materials, such as: Infectious waste, Pathological waste, Sharps, Cytotoxic waste, Pharmaceutical & Chemical waste, etc. The present research focused on Pharmaceutical & Chemical waste, which is legislated under the Israeli Licensing of Business Regulations (Disposal of Hazardous Substances), 1990. According to WHO, Pharmaceutical & Chemical waste amount to about 3% of waste from health-care activities.

4.2.1 Survey design and methods

A Typical indicator was identified using scientific literature. This indicator predicts the amount of hazardous waste produced according to the number of hospital bed occupied per year. A feasibility test was then conducted, comparing the indicator's estimation to the amount reported in the Annual report of the Haifa District Municipal Association for the Environment (2006). The report did not comprise data regarding hazardous waste transferred to Ramat Hovav site trough transfer stations. In order to complete the missing data, a formal request for information was directed to the MoEP. This data was further verified by an interview with the information specialist of the MoEP. Four public hospitals were sampled: "Rambam Medical Center", "Carmel Medical Center", "Bnai Zion Medical Center" and the "Italian Hospital".

4.2.2 Results and Discussion

An extensive literature review revealed a correlation between the amount of Pharmaceutical & Chemical waste being produced by hospitals and the number of hospitalization beds. The number of hospitalization beds indicates the extant of hospital activity. Bed occupancy varied during the year according to actual number of hospitalized patients; therefore, the indicator is based on actual hospitalization beds occupancy.

According to the literature (Pruss, Giroult & al, 1999), the daily health care waste production rate in Western Europe is 3-6 kg/ bed/ day. Pharmaceutical & Chemical waste amount to about 3% of waste from health-care activities (WHO, 2000). Meaning, the daily Pharmaceutical & Chemical waste generation rate is 0.09-0.18 kg/ bed. In order to examine the indicator feasibility, the amount of hazardous waste that has been reported was compared to the amount predicted by the indicator. Under research restrains, a cautious estimation was used, and the assessment was calculated based on daily generation rate of 0.09 kg/ bed. Table 6 describes the feasibility test results.

Table 6. Calculated and reported amounts of hazardous waste of Haifa public hospitals.

Hospital	Actual beds Occupancy*	Hazardous waste estimation (ton/ year)	Hazardous waste reported (ton/ year)	Gap (%)
Rambam	795	26	N.A**	-
Carmel	447	15	12.54	-15%
Bnai Zion	349	11	N.A	
The Italian	41	1	N.A	-

*Source: The Ministry of Health, Information Department (2007)
**N.A- Not Available

According to Table 6, it can be estimated that 54 tons of Pharmaceutical & Chemical waste was anticipated to be produced by the four public hospitals in Haifa during 2006. Since there is no available documentation on Pharmaceutical & Chemical waste disposed-of by "Rambam", "Bnai Zion" and "The Italian", it can not be determined whether there is a gap between the disposed-of amount and the predicted amount. On the other hand, a high correlation (15%) was found between "Carmel" reported amount of waste and the predicted amount.

A request for information was directed to the Information & Operation Center of the MoEP (Blitman, 2007). According to the center's information specialist "Rambam", "Bnai Zion" and "The Italian" removed health care waste via transfer stations. Transfer stations are an intermediate facilities at which hazardous waste is transferred from collection vehicles and than temporarily stored or merged before being transported to the hazardous waste disposal site at Ramat Hovav. According to the general operation of hazardous waste transfer stations, they are authorized to merge similar waste stream of different small quantity, up to 5 ton per year, waste generators. Merged waste streams will ultimately be attributed to the transfer station.

The Information & Operation Center had no documentation on Pharmaceutical & Chemical waste being evacuated by these hospitals. In fact, according to the data provided, all three hospitals removed only cytotoxic waste and used gas containers.

The Information & Operation center receives date from transfer stations. This information is not verified neither compared to the removal data (Blitman, 2007).

4.2.3 Summary and Conclusions

Typical indicators predicting hospitals Pharmaceutical & Chemical waste generation rate was identified and tested on 4 public hospitals in Haifa region. The amount of hospital Pharmaceutical & Chemical waste can be predicted according to the following indicator: 33 kg/ hospitalization bed/ year. Based on this indicator, it was estimated that the total amount of Pharmaceutical & Chemical waste in Haifa public hospitals amounted at 54 ton/ year (this figure does not include private hospitals, geriatric institute, private clinics, etc.). A high correlation (15%) was found between the predicted amount of waste and the amount reported by "Carmel". Due to lack of documentation of merged waste streams, it is not possible to determine the exact amount of Pharmaceutical & Chemical waste which was or was not disposed-of according to regulations. The assumption is that, roughly, 42 tons of Pharmaceutical & Chemical waste is apparently attributed to the transfer stations, which are authorized to merge similar waste streams of different small quantities generators. Though, according to calculations, "Rambam" and "Bnai Zion" produce more than 5 tons annually, therefore, they can not be identified as small quantity generators.

5. FINAL CONCLUSIONS

Hazardous waste produced in different industrial sectors, each characterized by different waste streams. The current research has developed a methodology to predict the amount of hazardous waste produced in different industrial sectors. Former studies were based mainly on employment statistics for estimating hazardous waste generation rate. The current research is based on unique indicators, according to specific industrial sector. The estimation method for each industrial sector was determined according to the processes characteristic. The research findings indicate several weak spots in the Israeli hazardous waste management system: (a) The waste generator does not always keep track on production amounts; (b) The hazardous waste transfer station merge waste streams, making it impossible to identify the specific generator; (c) Lack of data verification and control by the MoEP.

To conclude, the research findings demonstrate the need of developing key indicators in order to assess the amount of hazardous waste being produced by different industrial sectors. Indicators are important tools that assist decision makers to formulate and implement policies for management at local and national levels. The main conclusion is that the hazardous waste management system in Israel should be significantly improved. It is recommended to require toxic release inventories, from both hazardous waste generators and hazardous waste treatment facilities; to better control the transfer stations activity and to legislate source reduction and best available technology regulations.

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