Industrial Solid Waste Management in a Developing Country Governorate and the Opportunities for the Application of Cleaner Production Principles

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Abstract

Hebron is an industrial governorate south of Palestine where the lack of studies ends up to inexistent evaluation of its environmental status. Understanding the status of industrial solid waste management (SWM) largely contributes to the determination of the opportunities and the appropriate roadmap for the application of cleaner production principles.

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In this chapter, we report the results of an extended research-constructed survey conducted in Hebron both at municipal level and industrial level. Primarily the municipal level research was aimed at identifying the current SWM practices. Then the industrial level research was aimed to collect data on both the applied SWM practices in local industries and record the generated quantities of ISW.

Towards the development, updating and implementation of a legislative framework, which will support an integrated SWM in the local industrial area, the stakeholders are highly encouraged to develop an incentive system for industries to reduce and recycle the generated ISW. This need clearly emerges from the current research results: Only 21 out of 91 factories treat SW before final disposal; 83.33% of them recycle the waste in situ or in collaboration with local recycling stakeholders; 51.65% of the investigated industries produce a mixture of process and nonprocess ISW, the average rate of nonprocess ISW is 23.22 kg/day; 8.4% of factories always separate process ISW from nonprocess ISW; 85.7% of factories do not separate their ISW into specific components. Only 13.6% of factories reuse and 16.5% recycle ISW; 77.3% of the recyclable materials are used as secondary raw materials, and 22.7% of them use the separated ISW as secondary raw materials in production, both implementing the fundamental 3Rs principle.

Keywords
Industrial solid waste · Field research · Cleaner production · Collection · Policy

Introduction

Developing the industry sector means achieving a high rate of economic growth, creating many job opportunities and increased economic diversification necessary to achieve general economic and social growth.

Developing countries has many pressing problems of poverty, population, hunger, water, sanitation, public health, or ethnic and political strife, so proper environmental management has not been considered as key issue in these countries. Competing priorities of municipalities often consider other public works programs more important than solid waste management improvements, not-to-mention industrial waste management. In these countries, hazardous wastes have not received sufficient due attention. In many countries, industrial wastes, both hazardous and nonhazardous wastes, are still handled and disposed of together with domestic wastes and thus posing great health risks to municipal staff, the public, and the environment (Mato and Kaseva 1999).

Cleaner production can be defined as "the continuous application of an integrated preventive environmental strategy to processes, products, and services to increase overall efficiency, and reduce risks to humans and the environment" (Abbasi and Abbasi 2004; Žarković et al. 2011). "Cleaner Production can be applied to the processes used in any industry, to products themselves and to various services

provided in society" (UNDP 2002). Waste minimization, reduction at source, pollution prevention, eco-efficiency, etc. are synonyms for cleaner production (Shkoukani 2008; Cagno et al. 2005).

The main goal of the performed research presented in this chapter was to evaluate the existing SWM practices and assess the opportunities for the application of cleaner production principles in six industrial categories in Hebron governorate. Towards this, the current ISW management practices on localities and factories levels were examined and the level of services provided was accessed. Additionally the quantities of ISW generated were estimated and the opportunities of practicing cleaner production (to recycle and reuse of ISW) in industries and the readiness of the owners and managers for that were identified.

Background

Across the world, a growing commitment to sustainable development is leading to businesses reassessing their management practices. Cleaner production is now the basis for industries' approach to waste avoidance. Increasingly companies are looking beyond compliance and are focusing their investments to optimize both environmental and economic outcomes. The role of government in these changes is to set the signposts, to map out the pathways for the future and to provide a safety net for when systems fail (EPA 1998).

Different industrial sectors have applied cleaner production concepts as preventive measures in order to increase eco-efficiency, reduce risks to both humans and the environment, and save natural resources since people are becoming increasingly aware, more than ever, of shortages in natural resources and of increases in air, land, and water pollution (Abbasi and Abbasi 2004). Waste minimization techniques can provide long-term benefits to industries such as waste reduction, promoting a positive public image, improving product quality, improving the health and safety of employees, cost savings, improved compliance, process and operation efficiency, and reducing liabilities (Taylor 2006; Petek and Glavic 1996).

Developed countries have established legislation to deal with such problems, while for developing countries such legislation and polices have still been under processing, and some countries cannot even create an action plan to deal with industrial pollution (Al-Qaydi 2006). Developed countries are busy in developing and implementing waste-to-energy technologies associated with energy recovery, composting for waste avoidance, and recycling and reuse, while developing countries are still struggling to decide on the best options to treat and dispose of waste (Mrayyan and Hamdi 2006).

Industrial solid waste management forms an essential issue that related directly with public health and environment. Industrial wastes vary considerably in quality and degree of seriousness, depending on the type of industry, manufacturing methods, and material used. An advanced system of industrial solid waste management is composed of several functional elements. In such a system, all steps of management from the generation of waste to the final disposal step are considered

carefully. The different functional elements of modern industrial waste management are generation and storage, pollution prevention and waste minimization, recycling and reusing, collection and transferring, treatment, and disposal (LaGrega et al. 2001; Mokhtarani et al. 2006). The aforementioned were taken into consideration and were embedded in the field research performed.

Methodology

The Study Area

The study area is Hebron governorate which is bounded by Bethlehem district from the north and by the 1948 green line from the other directions; it is located in the southern part of the West Bank at about 36 km to the south of Jerusalem, Palestine.

Hebron governorate is the largest one in the West Bank in terms of size and population; total population of Hebron governorate was 551,130 persons which represent 14.7% of the total population of Palestine; the large number of population indicates large number of housing units, so Hebron governorate contains 103,086 housing unit (PCBS 2008).

Economic Situation in the Governorate

Hebron district is one of the most economically active districts, with its exports reaching 10.75 million dollars, out of the 39.3 million dollars of the overall Palestinian exports, as stated by a statement by the Palestinian Federation of commerce chambers on December 3, 2008 (Hilal and Salaymeh 2011).

The Palestinian industrial sector developed significantly and increased its share in GDP after the creation of the Palestinian Authority in 1994 from 13.3% in 1994 to 16.5% in 1998 (Hilal and Salaymeh 2011), while this percentage decreased to 14.6% in 2003, according to the Palestinian Central Bureau of Statistics 2001. The contribution of the industrial production to Palestinian GDP was 15.3%, 14.9%, and 14.6% in 2007, 2008, and 2009, respectively (PCBS 2010).

The economic situation in the Hebron governorate moves through a fluctuation range and depends, to the large extent, on the stability of the political situations. The industrial sector still suffers from dependence on Israeli industry which has affected its development and growth. In addition, the procedures and practices of Israel since 2000 such as closures and the Israeli military siege on Palestinian areas in the West Bank and Gaza Strip had negative impact on Palestinian industrial sector; productive ability dropped in all Palestinian industries and in all governorates of the West Bank and Gaza Strip, and the industrial sector sustained much damage because of the siege and its impact on the movement of people and goods, the increase in time, the associated costs, and creating unpredictability in trade flows and market shrinkages (World Bank 2007; Hilal and Salaymeh 2011). Another difficulty that Palestinian industries suffer from is the reliance of many of them on Israeli and foreign raw materials, which leads to rising production costs, reduces the quality of the product,

and makes these industries vulnerable to changes and the political situation, resulting in the decline of these industries (Hilal and Salaymeh 2011).

The Palestinian industry sector consists of three main activities: mining and quarrying (extractive industries), manufacturing, and supply of electricity, gas, and water. Manufacturing is considered the largest branch of the industrial sector, accounting for more than 95.8% of its facilities (Hilal and Salaymeh 2011).

The advantage of Hebron is the availability of one of the most important components of any industry: raw materials, where it is endowed with raw materials for food industries (agricultural products and milk) as well as leather (livestock in the governorate) in addition to raw materials for the construction industries (stone, marble, and remnants of cut stone), and also cosmetics and other crafts, these industries could provide economic opportunities, according to the situation of the governorate; complementary services to industries in general also provide an important economic opportunity, particularly those that support them through marketing and packaging and those that provide design work for the timber, mineral, and leather industries (Hilal and Salaymeh 2011). The majority of establishments of the industrial sector were found to be micro, small, and medium enterprises, and these industrial facilities face many problems in the areas of administration, finance, marketing, and packaging (Hilal and Salaymeh 2011).

SWM in the Study Area

Solid waste management services are usually the responsibility of the municipalities and local or village councils in Palestinian urban and rural areas. In the refugee camps, the United Nations Relief and Works Agency for the Palestinian Refugees in the Near East (UNRWA) is the body responsible for providing solid waste management services (Khatib and Al-Khateeb 2009). There are a number of communities, however, for which there is no municipal authority or village council; approximately 12% of communities in Hebron District fall into this category (Southern West Bank Joint Service Council for Solid Waste Management 2009).

Management of industrial solid waste is distinctly different from the approach used for municipal waste. There is a lot of similarity between the characteristics of the waste from one municipality or one region and another, but for industrial waste, however, only a few industrial sectors or plants have a high degree of similarity between products and waste generated. Nowadays, industrial solid waste management is an important part of industry. The number of contaminated sites, which are polluted by industrial and hazardous waste, are increasing in developing countries (LaGrega et al. 2001). For proper management of industrial waste, it is necessary to obtain exact information and data about the waste characteristics, climatic conditions, and the effects on human health and the environment (Mokhtarani et al. 2006).

The Study Means

Data was collected using structured questionnaires; the first one addressed the localities that are responsible to manage industrial solid waste and the second one the factory representatives/stakeholders.

The collected data included:

- Estimation of the quantities of ISW generated from the six industrial categories (paper, plastic, metals, textiles, plants, chemicals, others)
- Rating of indicators involved with:
  - Temporary storage processes
  - Collection and transfer processes
  - Treatment and final disposal processes
  - Clean product process
  - Safety and security processes
  - Policy obstacles for cleaner product
  - Financial obstacles for cleaner product
  - Technical obstacles for cleaner product
  - Administrative obstacles for cleaner product

The retrieved data was analyzed using the Statistical Package for Social Science (SPSS version 12) program and Microsoft Office Excel. Descriptive statistics such as frequencies and percentages were computed.

Results and Discussion

Characteristics of the Questionnaire Respondents

Localities: There are 17 municipalities and one local council which is Nuba council; one of the municipalities was excluded from analysis because it had no factories; this municipality is Kharas. So the total localities included in this study are 17. Most respondent's positions were head of health section which accounted for 59% of the respondents. Ninety-four percent of them were male, and 6% were female (engineers). Results related to education level of respondents revealed that 14 out of 17 have high education, and the other 3 have secondary level.

Factories' representatives: Among 91 respondents, 96.2% of respondents were male, and 3.8% were female. Most respondents reside in the city (93.7%) and 6.3% reside in villages. Results related to education level of respondents revealed that 53.2% have high education, 38% have secondary education, and the other 8.8% have elementary education. Seventy-three percent of respondents were owner of the factory, 9.4% manager, 9.4% production manager, and 8.2% were human resource, financial, and quality manager and labors.

Factories characteristics: Forty-nine percent of factories are modern since they had been established after 1999; 30.8% of factories have less than 10 labors, 41.8%

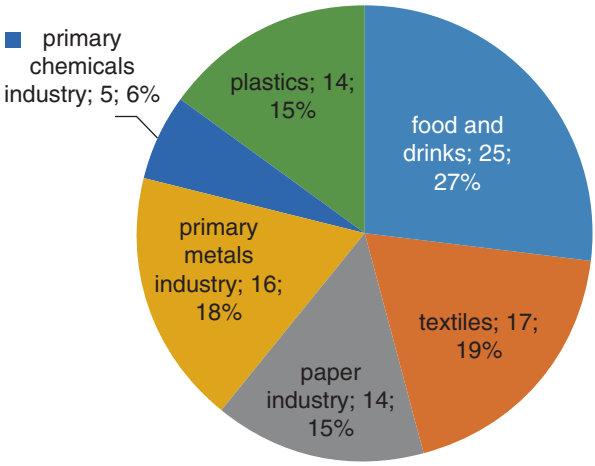

Fig. 1 Factories products distribution of the survey sample

have 10 to 19 labors, 24.2% have 20 to 99 labors, and 3.3 have more than 99 labors. The highest percentage (73.6%) of factories located in the city between houses, while 20.7% in the city in the industrial area, 4.6% in villages, and 1.1% in commercial area. So it is clear that the choices of factories locations in Palestinian territories are not based on a structured master plan; so existing highest percent of (73.6%) factories within residential areas are posing higher pollution and more public health risk for the people who are living near factories. Forty-three percent of factories were individual ownership, and 57% were private joint-stock company. Figure 1 shows the factories products distribution of the survey sample.

SWM Practices on Locality Level

ISW Collection and Transferring

In Hebron governorate, the community container collection system is the main common practice used in the solid waste collection and storage; the percent of collecting solid wastes from the factories was 100%. Hebron, Beit Ula, Taffuh, and BanyNa'im municipalities declined that industrial waste is collected with domestic waste (constituting 23.5%), but the other 13 municipalities confirmed that (76.5%).

There were no special containers for ISW in the study area, excluding six factories in Hebron city. Although these factories have special containers for temporary storage of their wastes, 100% of municipality'slaborers are responsible for collecting and transferring waste from factory to Yatta dumpsite. This is completely different compared to Dar es Salaam City, since 40% of ISW is collected by private SWM contractors, while the individual industries collect and transport their own waste (the remaining 60%) (Mbuligwe and Kaseva 2006).

Hebron, Surif, Beit Ula, Taffuh, Sa'ir, and Dura municipalities have different vehicles for the transport of industrial solid waste that account for 37.5% of the

respondent localities; the remaining localities use the same as the domestic waste collection vehicles (62.5%).

Vehicles used for collecting and transporting ISW are mainly in the range of 5–25 m^3. Each of the localities participating in the survey have 12 special vehicles in the range of 7–25 m^3 and 28 compressor vehicles in the range of 5–18 m^3 for long-range transport, 9 of them in the Hebron city alone. They are generally self-tipping trucks and are used because of their versatility with respect to unloading the waste at the final disposal site. Loading of the waste is normally done mechanically or mixed (manually and mechanically), according to the results: the percentages of solid wastes that are loaded inside the vehicles manually, mechanically, and mixed were 5.9%, 23.5%, and 70.6% respectively. It is worth noting that some of the ISW collection vehicles are not specially designed for that purpose. The vehicles fleets of the localities are all covered vehicles (70.6%), or some of them have covers (17.6%), while in 11.8% of the cases, they have no covers.

52.94% of localities face thresholds and bottlenecks in collecting and transferring ISW from factories, which are summarized to be the absence of coordination with the locality, increase of ISW quantities, vehicles and containers' limited number, ISW disposal in nonconfirmed locations, ISW unsuitable for truck loading (semi liquid), long distance between temporal storage/disposal and final disposal leading to high transferring cost, and lack of control.

ISW Temporal Storage

In the study areas, researchers found out that there is no separation between industrial and domestic solid wastes at all. Beit Ula, Taffuh, Tarqumia, Dura, and BanyNa'im municipalities have a temporary storage of ISW before final disposal (29.4%), while 70.6% do not. Hebron and Tarqumia municipalities answered that there are industrial solid waste transfer stations before final disposal, but the majority of localities denied it.

For 15 out of 17 localities it is an easy task to locate containers near factories area, but in 94% of the cases those containers have no covers. Hebron, Surif, Halhoul, and Edh Dhahiriya seem to have no problems with adequate size of the containers (given the waste generation from nearby factories) that accounts for only 25% of the respondents. Ninety-four percent of the respondent localities confirmed the existence of bad odors, insects, or rodents near to SW storage containers that are potential to cause negative impacts on both the health and environment.

ISW Treatment, Processing, and Final Disposal

Cleaning, separation and classification, separation of hazardous components, reuse, and recycling are the usual methods of ISW treatment. In the area where the field research took place, the ISW are not treated at all.

Currently, most of the solid waste from Hebron governorate and from some villages in Bethlehem governorate is dumped at the dumping site at Yatta. Solid waste from Israeli settlements in Hebron and from the UNRWA-managed refugee camps and some industrial waste are also taken to the dumpsite (Southern West Bank Joint Service Council for Solid Waste Management 2009). Referring to the results of

this study, all the collected wastes from the included localities have been dumped at Yatta dumpsite. Landfilling is still the cheapest and most common method of both industrial and municipal waste disposal in Poland. Incineration, composting, and neutralization are other utilization methods of wastes but in small scales (Jurczak 2001); while the final disposal of ISW in Dar es Salaam city are in Vingunguti and Mbagala municipal disposal sites, the proportion of the industries that use these disposal sites are 56.9% and 37.9%, respectively, and 5.2% of industries use onsite disposal (Mbuligwe and Kaseva 2006).

Yatta dumpsite has been used to dump wastes since 1994 and has been managed by Higher Council for SWM for Hebron and Bethlehem Governorates. The dumpsite is located southeast of Hebron city, near the town of Yatta and has a total area of 150 dunums without fencing around. There are nine employers working on the site and it has weighing bridge to weigh the loaded trucks entered the site. According to Alsari', about 20 ton/day of industrial wastes enter the site, and they get 16 NIS/ton whatever the type of wastes. There were 17 dumpsites in Hebron governorate, 11 out of them were closed by Higher Council for Solid Waste Management for Hebron and Bethlehem Governorates and the others with Yatta dumpsite will be closed when Al-Minya landfill start operating in the middle of 2013; the landfill will be divided into eight cells (none of them is specialized for ISW); one for every 2–3 years operation (Higher Council for SWM 2012). Al-Minya landfill with a total area of 254 dunums is currently under construction, and it is located to the east of Se'ir; it is financed by the World Bank and the European Union with 20 million dollar (Hebron Municipality 2012).

Coordination Between Localities and Authorities

The results showed that there is a good coordination between the respondent localities and other authorities related to management of ISW, and 76.5% of respondent localities said that there is coordination with health department and JSC.

Surif, Halhoul, and Yatta municipalities that accounted for 30% of respondent localities said that they impose regulations related to management of ISW to the factories; the other 70% said that such regulations are imposed by other authorities such as EQA and MNE; the results showed that almost 70% of regulations were imposed by EQA and 30% by MNE. In the absence of regulation application some penalties are imposed, the result explained that 43% of penalties were financial, 21.4% were postponed or canceled factory licensing, 7% were closure of the factory, and 28.6% were all of them together. And in order to check the validity of these answers, the participants were asked whether any penalties were applied during their work performance; the majority (75%) confirmed that and 25% of them did not.

Financial Aspects

It is well known that most localities have financial constraints regarding SW sector, in addition to political conditions that significantly affect providing the services; the lack of proper funds and infrastructure is making solid waste management services one of the most expensive services. Although municipalities and councils have assigned fees for the collection and transferring of wastes, few people have been

able to pay for the services, and hence the revenue actually collected from the fees has contributed to less than 20% of the money needed to run the services (UNEP 2003; Khatib and Al-Khateeb 2009). According to respondent localities the collection of management fees for factories' generated SW is performed in the mean of monthly fees (ranging from 10 to 100 NIS) as stated by 81.3% of them. Other stated that they depend either on SW quantities (12.5%) or on factory size (6.3% of respondents). On the other hand, the percentage of respondent localities that said the current solid waste management budget is enough was 25%, and also 25% of them said sometimes it is enough, while 50% of them said it is not enough.

Labors in SWM Sector

As a result of the above facts about SWM, the results of questions regarding labor specialized in working in SWM section were as expected in terms of the following:

- There are no labors specialized in working in SWM.
- Labors in SWM section are always wearing protective clothes by 43.8%; labors in SWM section are sometimes wearing protective clothes by 43.8%, labors in SWM section are never wearing protective clothes by 12.5%.
- Inoculating against diseases like tetanus and typhoid: 37.5% confirmed it and 18.8% indicated partly inoculating labors; but in most of the cases (43.8%), there is no inoculation.
- Labor awareness about the safety principles and how to deal with solid waste is existent in 82.4% of the cases.
- The required training that suit their work: 11.8% confirmed that labors get the required training, 52.9% that the labors get sometimes the required training, and 35.3% indicated the absence of the aforementioned activities.
- Safety and health regulations application imposed by specialized authorities: in most cases (47.1%) this is frequent and in others (41.2%) occasional.

SWM Practices on Factory Level

ISW Generation

Development of proper industrial waste management system needs to know the mean generation rate of ISW expressed as kg/day and m^3/day; both of them are necessary in order to determine the proper way of handling, for example, wastes such as paper and cardboard, plastic, and wood have a high volume, so special collection technology is necessary. This could take the form of mechanical volume reduction or another processing technique. According to the results of this field research, there were no machines to reduce volume of solid wastes.

Mean generation rates in this study were calculated depending on quantities of ISW produced by factories. The results were estimations since they depend on the estimates of the respondent from factories. The mean generation rates of ISW produced from factories is presented in Fig. 2. They are ordered from highest to lowest rate is 719.38 kg/day (262.6 tonne/year) from metals industries, 200 kg/day

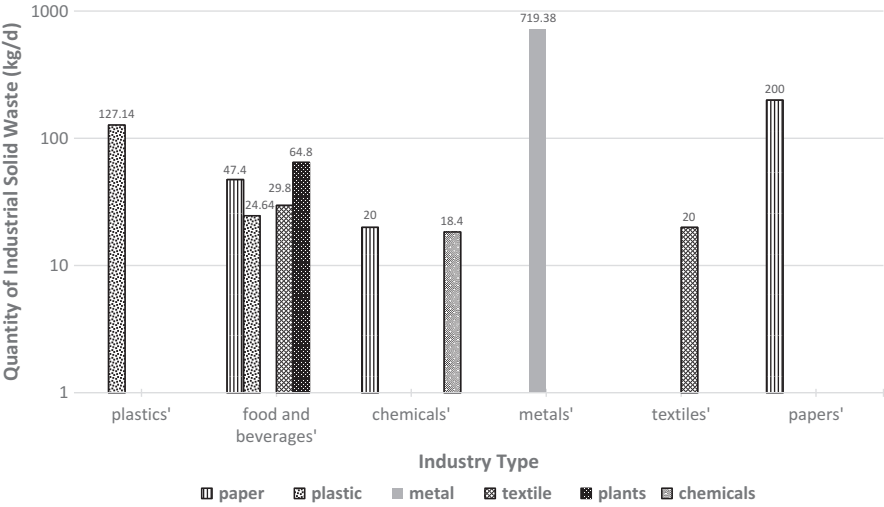

Fig. 2 Types and quantities of industrial waste per type of industry

Table 1 Mean and total generation rates of ISW

Category	Average industrial solid waste kg/day						Total ISW (kg/day)
	Paper	Plastic	Metal	Textile	Plants	Chemicals	
Plastic	0.00	127.14	0.00	0.00	0.00	0.00	127.14
Food and beverage	47.40	24.64	0.00	29.80	64.80	0.00	166.64
Chemicals	20.00	0.00	0.00	0.00	0.00	18.40	39.40
Metals	0.00	0.00	719.38	0.00	0.00	0.00	719.38
Textile	0.00	0.00	0.00	20.00	0.00	0.00	20.00
Paper	200.00	0.00	0.00	0.00	0.00	0.00	200.00
Total	267.40	151.78	719.38	49.80	64.80	18.40	1272.56

(73 tonne/year) from paper and printing industries, 166.64 kg/day (60.8 tonne/year) from food and beverage industries, 127.14 kg/day (46.4tonne/year) from plastic industries, 39.4 kg/day (14.4 tonne/year) from chemicals industries, and 20 kg/day (7.3 tonne/year) from textile industries.

In terms of quantities of ISW, Table 1 shows that metals, papers, plastic, and plants are the most common wastes resulted in the survey; these wastes are generated at 16, 14, 14, and 25 factories, respectively.

ISW Temporal Storage

Steel and plastic containers, which account for 36% for each of all temporal storage facilities, are the commonest method of ISW storage, percentage of 14.6% represents steel and plastic containers altogether. Other storage facilities are plastic sacks (7.9%), steel containers and sacks (3.4%), and open to air (1.1%). Metallic

containers of the same size as the plastic ones are used for ISW that has a relatively high bulk density. In addition, containers which will carry high loads are made of metallic materials. 66.3% of the containers do not have covers, but 33.7% do. A study by Mbuligwe and Kaseva (2006) in Dar es Salaam city showed that solid waste storage of open-air piles accounts for 43% of all storage facilities; other storage facilities are metal and plastic bins (34%), open masonry enclosures (11%), 200 l used oil drums (6%), covered masonry enclosures (4%), and concrete silos (2%).

Only 17% of the ownership of the containers is for factories and the other 83% is for localities. The temporary storage of ISW in the factory vicinity is accounted for 96.6%, and 3.4% is out the factory vicinity.

ISW Collection and Transferring

94.4% declared that those responsible for collecting solid waste and transferring ISW to temporary storage locations are the factory labors in general and specific trained personnel/labors. The numbers of labors responsible for this activity are 1–2 labors (85.2%), 3–4 labors (9.1%), 5–6 labors (3.4%), and more than 6 labors (2.3%).

ISW collection frequencies differ depending on generation rates, nature of the waste, especially with respect to its biodegradability, and the transportation means used. In 66.7% of the factories, the collection of ISW is performed once a day, 14.9% twice a day, 14.9% three times a day or more, 3.4% once a week. The waste is collected mechanically (57.5%) and manually (42.5%); manual handling is the most common way to transfer ISW from inside factory to collection places. Figure 3 shows the percentages of means of transferring solid waste from inside factory to collection places.

Local council vehicles and trucks that account for 52% constitute the highest percentages of the means of transferring solid waste to the final disposal. The other means and their percentages are presented in Fig. 4.

Treatment, Processing, and Final Disposal

Cleaning, separation, volume reduction, reuse, and others are the treatment methods of ISW. Most of ISW is not treated prior of final disposal; 61 factories which account for 69.3% do not treat SW after collection and before final disposal, 21 factories which account for 23.9% always treat, and 6.8% sometimes treat. 83.33% of 21 factories recycle their waste and only 16.67% perform separation activities. 51.65% of factories produce a mixture of process and nonprocess ISW but in small amounts, the average rate of nonprocess ISW was 23.22 kg/day, while 48.35% of factories produce process ISW only. A study by Mbuligwe and Kaseva (2006) in Dar es Salaam city showed that 11% of the industries in Dar es Salaam city produce significant quantities of nonprocess ISW, the other 89% of the industries produce process ISW. Only 8.4% of factories in this study always separate process ISW from nonprocess ISW, 14.5% sometimes separate ISW, and 77.1% do not separate ISW.

85.7% of factories do not separate their ISW into specific components, while 9.9% sometimes perform separation activities, and 4.4% always separate ISW into specific components. In the case of providing the required containers, the respondent

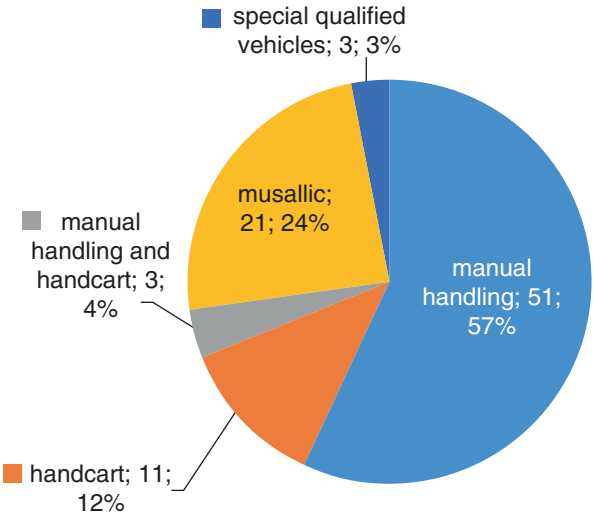

Fig. 3 Means of transferring solid waste from inside factory to collection places

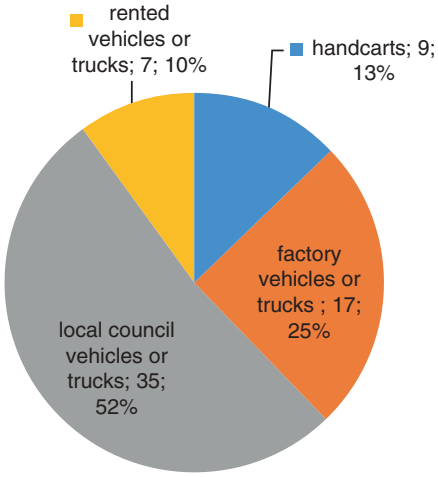

Fig. 4 Means of transferring solid waste to the final disposal sites

had been asked if they were ready to separate ISW, the results were: 5% of respondents are willing to separate ISW against paying, 75% are not interested to paying but they are willing to separate, and 20% reported their indifference in the aforementioned. The hazardous classification of SW produced by the factory according to the respondents was: 12.2% classification of SW as low threat on human and environment and 87.8% classification as no threat at all.

SW may constitute a resource (sold to other industries/factories as secondary raw material), but unfortunately, 88.4% of respondents said that they do not sell ISW or part of it and only 11.6% said they sell it to individuals. 29.2% of factories are paying

Table 2 Results of final disposal methods of ISW in factory survey

Methods of final disposal	Percent (%)
On-site treatment	1.1
Backfilling in special dumping sites	1.1
Backfilling in local council landfill	54.5
Random disposal	1.1
Burning outside factory	1.1
Burning inside factory	1.1
Reuse	4.5
Recycle	27.3
Transferring to unknown site	1.1
I do not know	6.8
Total	100.0

for disposing SW, while 70.8% do not pay at all. The main methods for final disposal of ISW are as shown in Table 2.

94.4% of factories do not record the daily SW produced, and 93.3% of factories do not have written instructions (guide manual) about dealing with ISW. There is a lack in monitoring of SWM at the factory level, 5.7% of respondent factories said that there are governmental authorities that follow up the issue of SWM, but 93.1% of them declined the performance of this activity. 80.8% of respondents said these authorities do not impose regulations regarding handling of SW produced, even though 90.7% said there is a need to impose such regulations. Almost half of them (47.4%) did not confirm the fact that these authorities impose penalties when regulations do not apply. Overall, 75.9% of respondents were satisfied with the service of transferring ISW to the final disposal.

Safety and Security of Factory Labors

The results of survey regarding safety and security of factory labors can be summarized as:

- 86.4% of factories aware labors of safety and mechanism of dealing with SW.
- 74.2% of factories trained labors in accordance with their work nature and their relation with SW.
- 79.8% of factories apply safety regulations and rules.
- 46% of factories said that labors wear special uniform to protect them while collecting and transferring SW.
- 75.6% of factories do not have an accident guide manual to react during and after accidents.

Cleaner Production Principles Application

The survey shows that 60 factories that accounted for 66.3% of factories adopt an integrated preventive environment strategy; this result is considered high compared

to only 4 industries out of 170 which had plans to implement an Environmental Management System in Asegra in Spain (Casares et al. 2005).

Outcomes of social survey conducted in eight West Bank districts made by Khatib and Al-Khateeb (2009) showed that the level of knowledge concerning reuse and recycle is poor; referring to outcomes of this study, 23.1% of respondent heard about CPP; 31.6% of them from TV, 26.3% from internet, 10.5% from radio and workshops, and 5.3% from bulletins.

The results of using raw materials were: 95.6% of factories use the raw materials in their production process, while 4.4% of them use either reused or recyclable materials. The respondents were asked if they were ready to use SW as raw materials in their factories (if possible), 38.2% of them replied positively and 61.8% negatively, but most of the latest belong to the food and beverages industry. 16.3% of respondent can replace raw materials by others with lower SW production, while 83.7% cannot because the category of industry (food and beverages industries) for example, lower prices of raw materials used, and sometimes no substitute for raw materials.

Low percentages of industries reuse or recycle SW for use as raw materials in their production processes; both intra- and inter-industry reuse and recycling are practiced. It is found that 13.6% of factories reuse and 16.5% recycle ISW as intra-industry reuse and recycle; which means SW are collected from generation points and reused directly in industrial processes or recycled for eventual use within the same industry. 77.3% of the recyclable materials are used as raw materials, and 22.7% of them used as an initial materials help in production.

Nevertheless, inter-industry reuse, which means SW discarded by one industry are reused directly or processed for use as raw materials in another industry, is practiced in recycling paper plant in Hadera (Al-Hudayrah) (occupied Palestinian city in 1948) as mentioned by Eng. Abdulrahman Abu Ras; he said that there is no economic feasibility to recycle papers at small scales; it depends on economies of scale (Al-Qasrawi Industrial & Trading Co. L.T.D 2012).

Industrial Solid Waste Management Performance Indicators

Nine indicators were conducted in order to evaluate the performance of the factories in SWM sector, and they also represent the main obstacles of the application of CPP.

Overall, respondents indicate that the situation of temporary storage inside the factories is moderate (80.2%) since the internal management of the factories regarding that issue had high percentages in terms of 95.3% said that number of containers is enough, 94.4% of industries have no problem in storing inside factory, 80.7% said there are no dogs or cats near SW containers; while 66.3% of the containers do not have covers; the reason may be attributable to the nature of the waste produced by the factories which means waste produced are not attractive to animals. Also 77.1% do not separate process from nonprocess ISW and 85.7% of factories do not separate their ISW into specific components; these percentages can be reduced significantly if there are programs that encourage the application of CPP.

The outcomes of CTI research indicate that the situation of collection and transfer ISW inside the factories is good (90.1%) even though 72.7% reported that there is no

monitoring for transferring and disposing of SW. The monitoring is responsibility of ministries and institutions related to waste management that is supposed to impose instructions in this regard and follow their implementation on the ground, and impose real penalties when regulations not applied.

The outcomes of TFDI research indicate that the situation of treatment and final disposal of ISW is good (81.3%). However, there are some negative practices such that 69.3% of factories do not treat SW after collection and before final disposal. This high ratio does not belong to the factories internal management alone, it belongs significantly to governmental authorities and localities policies which do not support or encourage treatment of SW. Maybe because even if all factories treat their wastes (which means more efforts and costs), in the end the segregated wastes will come to the same final disposal.

The outcomes of CPI research indicate that the situation of cleaner product of ISW in general is good (97.8%). Only 23.1% of respondents had heard about CPP; a result that is considered low compared to the result of 31.8% that resulted from a survey conducted in Nablus and Ramallah and Al-Bireh governorates by Al-Khatib et al. (2015). This can be overcome by disseminating CP concepts through multi-media and campaigns in all Palestinian territories to increase awareness of all relevant industrial and SWM sectors. 61.8% replied negatively when asked if they were ready to use SW as raw materials in their factories; a reasonable answer for food and beverage factories which constitute the highest percentage of the questioned number of questionnaires (25 out of 91 questionnaires). The absence of an integrated SWM system in this field (not involving recycle and reuse) is not creating the background to apply internationally tested good practices.

The outcomes of Safety and Security Indexes (SSI) research evaluated the situation as good (39.6%), as moderate (40.7%), and as bad (19.8%). High percent of factories have good concern of labors in terms of safety and mechanism awareness of dealing with ISW and trained labors in accordance with their work nature, since 79.8% apply safety regulations and rules. On the other hand, in 75.6% of factories there is an accident guide manual to react during and after accidents when they occur.

The outcomes of the research indicate that all cleaner production obstacles indicators are strong (over 80%), which indicated a significant weakness in the application of cleaner production aspects on policy, financial, technical, and administrative levels. The aforementioned situation may be improved through the adoption of SWM and CP roadmaps by the governmental authorities and of course the imposition of supportive policies.

Conclusions and Recommendations

This chapter presented the final results of two parallel surveys (in localities and in local factories) regarding the current SWM in Hebron governorate and the existing opportunities for the application of cleaner production principles in the governorate. The most notable deficiency of the existing ISW management practices in Hebron governorate is that the hazardous component of the ISW is not segregated from the

rest of the waste for appropriate treatment. Additionally, the final disposal is performed in dumpsites. This situation is expected to be improved when Al-Minya sanitary landfill will start operating.

SWM on factories level is good in some aspects and need improvements in other; for example, the status of collection and transferring of ISW inside the factories and labors safe and security is good and has no pressing problems. On the other hand, the reuse and recycle aspects are rather low; the results showed that only 21 out of 91 factories treat their wastes and this can be partly attributable to the absence of supported policies from the responsible local/governmental authorities. Regular monitoring and treatment of ISW are the first steps towards the identification of needs and the application of improvements actions.

Involved actors in SWM sector must develop and update the legislative framework that is expected to support an integrated SWM and encourage the reduction of SW quantities, which are currently dumped/landfilled, by developing an incentives system for factories backed-up with targeted projects in order to reduce and/or promote recycling of ISW. A good coordination between the responsible authorities and the factories will define responsibilities and enforce clear and viable policies. A cost-benefit analysis to assess the feasibility of recyclable SW in existing landfills versus separating and recycling SW items in new recycling plants will show them the roadmap towards problem solving and transfer costs mitigation. Recording, auditing, and continuous collection of data will act positively in order to update the data of hazardous waste including types, quantities, sources, and impacts.

Cross-Reference

▶ Bioventing for Remediation of Vadose (Unsaturated) Zone and Permeable Reactive Barriers (PRBs) for Remediation of Aquifers

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