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ASSESSMENT OF SOLID WASTE MANAGEMENT SYSTEM IN THE CITY OF MANSOURA, EGYPT

تقييم الأثر البيئي لنظام إدارة المخلفات الصلبة
في مدينة المنصورة – ج. م. ع.

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الخلاصة

الهدف من هذا البحث هو تقييم الأثر البيئي لنظام إدارة المخلفات الصلبة في مدينة المنصورة بجمهورية مصر العربية. وقد تم تسليط الضوء على عدد من الدراسات لبعض مدن العالم وطرق تعاملها مع المخلفات الصلبة سواء كان إعادة تدوير لاعادة استخدامها او لتوليد الطاقة الكهربائية منها والسياسات والبرامج التي وضعت للعمل على تقليص المخلفات الصلبة. وعلى الجانب الآخر تم القاء الضوء على نظم إدارة المخلفات الصلبة في جمهورية مصر العربية على وجه العموم وفي المناطق الحضرية على وجه الخصوص وإظهار مختلف الأساليب والسياسات المتبعة في النظم القائمة للجوانب المختلفة؛ الجوانب الإدارية والمالية والتقنية. وقد تم تحليل المراحل المختلفة لمنظومة المخلفات الصلبة في مدينة المنصورة بما في ذلك توليد النفايات وجمعها ونقلها والتخلص النهائي منها، حيث تمثل هذه البيانات أداة هامة يمكن استخدامها لمساعدة صناع القرار في مدينة المنصورة لوضع حلول واقعية لتطوير هذا النظام. وقد تم التوصل الى توصيات من أجل تحسين منظومة المخلفات الصلبة في مدينة المنصورة.

ABSTRACT

The objective of this research is to assess the environmental impact of solid waste management system in the city of Mansoura, Egypt. Number of studies has been reviewed for some of the world's cities indicating ways of dealing with solid waste recycling, either for reuse or for power generation and the policies and programmers developed to help in reducing solid waste. On the other hand light has been shed on solid waste management systems in Egypt in General and in particular the urban areas and show various methods and policies in existing systems for various aspects such as administrative and financial aspects. Having analyzed the different stages of the solid waste system in Mansoura city, including waste generation, collection, transport and final disposal, where these data are an important tool that can be used to assist decision-makers in Mansoura city to develop realistic solutions to improve this system. Recommendations for improving the system of solid waste in the city of Mansoura have been presented.

Keywords: Solid waste management system, Environmental impact assessment.

1. INTRODUCTION

Solid waste is a very general term which encompasses all waste materials in solid conditions. Most solid waste regulations include hazardous waste within the definition of solid waste. Solid wastes are divided into three main categories: municipal, industrial, and agricultural waste.

Municipal solid waste has several sources such as residential, commercial, institutional, construction and demolition, and municipal services. In general, the amount of solid waste has been increasing in urban areas and the more urbanized the area is, the higher the amount of waste generation.

A solid waste management system consists of prepared plans and plants that are built for final disposal of waste as well as recycling, reuse, composting, and incineration. The municipal solid waste management system deals with the municipal solid waste from its source of generation until its final disposal, which includes all the operations and transformation of this waste. The activities of the municipal solid waste management system can be categorized as six functional elements which are: (1) waste generation; (2) handling, separation, storage, and processing at the source; (3) collection; (4)

transfer and transport; (5) separation, processing and transformation; (6) disposal. Solid waste management is the implementation of the prescribed measures, proper waste management procedures in the collection, transport and waste disposal, including control of these activities descriptive. Waste management in developed countries has created numerous recycling industries with activities that includes considerable amounts of secondary materials and provide new jobs.

The existing solid waste management system in the city of Mansoura is highly inefficient. Primary and secondary collection, transportation and open dumping are the only activities practiced; these are actually done in a non technical manner. In this work the obstacles in the existing solid waste management system are systematically assessed. It is also tried to assess the potentials for its improvisation.

2. LITERATURE REVIEW

During the past decades, a large body of studies concerning the solid waste management applications is undertaken. In light of success stories in various solid waste recycling programs and studies, solid waste management strategies in many

developing countries ought to be reorganized to include a separate collection and processing system for waste recycling that can work parallel with the conventional systems operated by municipal bodies which are responsible for waste collection transportation and final disposal. This approach will reduce quantities of wastes to be disposed, create employment and thus income for the poor people. There are many ways to reduce the amount of waste needed to be disposed, such as waste prevention, recycling, and composting.

In this section a thorough literature review concerning models and tools illuminating possible overlapped boundaries in waste management practices is conducted.

System dynamics computer models have been developed to predict solid waste generation, collection capacity and electricity generation from solid waste and to assess the needs for waste management of the urban city [1-5]. Other models for the prediction of solid waste generation in a fast-growing urban area and describe a waste generation and composition analysis have been developed [6-9]. These provide a comprehensive review of municipal solid waste management system comparing several MSW management elements (such

as collection, budget, and disposal) in municipalities, village councils, districts and the problems faced by these institutions in handling the waste. It also provides information on MSW collection service availability and waste disposal practices in the studied districts.

There have been studies to examine the positive impact of the recycling and/or reduction in household wastes from different countries worldwide. Many studies focus on different analysis of strategies for material and energy recovery from waste and explore the potential recovery of the energy available in the municipal solid wastes [10-11]. On the other hand, many research approximate carbon and energy footprints of the waste treatment phase and to find out what is the best waste treatment option for biodegradable materials [12].

3. SWM IN THE CITY OF MANSOURA

In the city of Mansoura, solid waste constitutes potential environmental threats in addition to its negative aesthetic impact. The waste is generated from different sources. Most of the solid waste generated is disposed in the main dump site (located in the south east area of the city) where it is openly burned. Burning of solid waste poses potential hazards to the surrounding

environment as will be elaborated further on. The solid waste system is managed by the two districts separately. As will be clarified in this section, the role of the private sector in solid waste management is limited and most activities are undertaken by the district administration.

3-1 SW Flow in the City of Mansoura

This work highlights the most important steps involved in the existing solid waste management system in the city of Mansoura which includes generation, collection, transportation, disposal, and strong recycling.

➤ 3-1-1 SW generation in the city of Mansoura

➤ Sources of SW

The sources of the solid waste in the city of Mansoura are: flats, small factories, workshops, general markets, traffic stations, commercial shops, governmental offices, private offices, schools, hospitals, clubs, and streets.

➤ Total quantity of SW generated / day

It was beyond the scope of this study to precisely determine the quantity of solid waste generated in the city of Mansoura. Given that not all the generated waste is collected, field sampling of waste of different generators should have been the

method used to obtain more accurate figures.

However, a rough working estimate of the quantity of daily solid waste generated in the city of Mansoura could be provided through determining solid waste sources and the rate of generation per source mainly obtained from the city municipality. The total quantity of solid waste generated in the city of Mansoura was therefore estimated to be 750 tons/day.

➤ Total quantity of SW generated per capita/day

The quantity of solid waste generated per capita in the city of Mansoura has been estimated at 0.70kg in the east district, 0.60 kg in the west district and 0.65kg as an average for the city.

3-1-2 SW collection in the city of Mansoura

There is only one formal system for solid waste collection (SWC) in the city of Mansoura. Primary collection is undertaken by individuals at generating sources to solid waste collection boxes distributed by the formal system. A parallel, informal system of door-to-door collection exists through personal agreement with the municipality solid waste transportation crew. The solid waste collection boxes available in the city of Mansoura are allocated at different points in the main

streets and squares of the city. Number of these boxes are 175 box in the the east district and 250 box the west district. The volume of each box is 1 m^3 .

➤ Private sector involvement in the collection of SW

The willingness of Mansoura citizen to pay for a door-to-door collection arrangement, revealed through agreement with the municipality transportation crew has encouraged some private collectors to provide such service. The private sector involvement in solid waste collection and transportation has been initiated by a private company called "Mansoura Richland". The company had an agreement with the Governorate to collect, transport, and dispose of solid wastes.

- Collection capacity of the formal system

Based on the number of the collection boxes an approximate figure for the total daily SW capacity in each district of the city of Mansoura can be estimated using the following relation:

$$\text{Total daily SW collection capacity} = \text{BOXES NO} * \text{BOXES VOLUME} * F * \text{SWD} * \text{ACR}$$

Where:

F: is the filling factor and it is assumed to be 0.8 (this means that the boxes are 80% full before they are emptied each time).

SWD: is the solid waste density ton/m^3 .

ACR: is the average collection round from the boxes. In this study ACR is known to be 3.0 for east and west as per the municipality records.

Therefore, the daily SW collection capacity in the east district = $175 * 1.0 * 0.8 * 0.5 * 3.0 = 210 \text{ ton}$, and the daily SW collection capacity in west district = $250 * 1.0 * 0.8 * 0.5 * 3.0 = 300 \text{ ton}$, and as a result the daily SW collection capacity in the city of Mansoura = 510 tons.

Comparing the above figure with that obtained previously, a slight difference is detectable. This result shows that there is no critical shortage in collection capacity.

The solid waste accumulated in some city areas may be the result of inaccurate transportation schedules, shortage in transportation capacity, inadequate location of collection boxes (which might increase the need for additional boxes), or careless behavior from some citizens.

3-1-3 SW Transportation in the city of Mansoura

Solid waste is transported from the collection boxes to the main dump site by the municipal transportation system.

➤ Municipal Transportation System

The municipal transportation system of the city of Mansoura consists of the following:

East district: 1 truck (20 ton) + 7 truck (10 ton) + 15 truck (5 ton) + 3 tractors + 1 loader (120 hp).

West district: 1 truck (20 ton) + 8 truck (10 ton) + 29 truck (5 ton) + 3 tractors + 2 loaders (120 hp).

The tractors and trucks are maintained and overhauled in two central workshops, one for each district. These workshops are not only providing service to fleets of the cleaning activities division but they are also responsible for all maintenance and repairs of other vehicles and equipment in the districts. The capacity of this transportation system is estimated as follows:

Total daily SW transportation capacity =
No. of vehicles * Average vehicle capacity
* No. of collection rounds. Therefore,

Solid waste transported from east district = $[(1 * 20) + (7 * 10) + (15 * 5)] * 0.7 * 3.0$ shifts = 346.5 tons.

Solid waste transported from west district = $[(1 * 20) + (8 * 10) + (29 * 5)] * 0.7 * 3.0$ shifts = 514.5 tons.

Filling factor is assumed to be 0.7 (this means that the truck are 70% full).

The quality of solid waste transported daily from the different zones of the east and west districts of the city of Mansoura by the municipal system. Distance between each zone and the main dump site of the city.

In summary the total daily waste transported from east district is 218 tons and from the west district is 388 tons. The total daily solid waste transported from the city is 606 tons. As stated earlier the total quantity of solid waste generated in the city of Mansoura is 750 tons and the collection capacity is 510 tons/day. It is important to note that these 606 tons are transported by the municipality system. Additional quantity is transported from the villages and center of Mansoura (400 tons) by their own transportation means.

➤ **Staffing Of the Cleaning Activities Divisions**

Cleaning activities divisions in the east and west districts are staffed as follows:

East district

133 labor, 61 supervisor, and 15 driver.

West district

253 labor, 82 supervisor, and 40 driver.

➤ **Financial Support of the Cleaning System**

The solid waste management system of the city of Mansoura is financially supported by the cleaning fund at the city level. The total income of the fund are collected from citizens for cleaning service with the rules of 2008 to regulate the cleaning works according to law 10 in year 2005. The fund covers salaries of temporary employees, cost of the cleaning tolls and

beautification, and O& M of the transportation system.

3-1-4 SW Disposal in the city of Mansoura

The solid waste of the city of Mansoura is dumped in different places in the city such as the main dump site and the side dumps.

➤ Main Dump Site

The major portion of the collected solid waste is transported to the main dump site which is located in the south east region of Mansoura. It is an open area of approximately 8 fedans (33600 sq. meters) and receives 1000 tons of solid waste per day from the city and some villages around the city. (Source: The Cleaning Administration Department of Dakahleya governorate).

Burning of the solid waste is the most common practice employed at present at the dump. A substantial amount of expired food products is also burnt in the main dump site producing hazardous gases emitted to the surrounding community. However, it seems that burning is not an effective means to get rid of the daily collected quantities of solid waste. This is demonstrated by the progressively increasing height of the solid waste day after day (30-35 m). The solid waste accumulated in the main dump site has been roughly estimated to amount 180,000

cu. meters. Analyses samples of the accumulated solid waste have shown relatively high content of nitrogen, phosphorus, potassium, zinc, and copper. (Source: The Egyptian fertilizer development center, Talkha, Egypt).

➤ Composition Of SW transportation to main dump site

In general the solid waste is composed of paper, carton, plastics, metals, wood, bone, rags, agricultural waste, dung, food and others. Representative samples were selected, weighed and sorted to the different components described above. These components were also weighed separately. Six and five representative samples were selected from the east and west districts respectively originating from zones selected to represent the different socioeconomic activities present all over the city of Mansoura. The proportion of the various solid waste components of the total analyzed samples from the east and west districts are estimated. The predominant component of the sampled solid waste is organic matter (food and agricultural waste) (69.3%) while the other recyclable items (paper, carton, plastic, glass, metals, wood, bones, rags) represent 20.2% of the total quantity of collected solid waste at the dump site.

➤ Site dumps

There is a substantial number of site dumps in the city of Mansoura most of which exists in the new residential area. A significant number of these site dumps are used for the disposal of construction waste.

➤ **Mansoura composting plant**

Unfortunately there is only one composting plant in the city of Mansoura. This plant capacity is 60 ton/day (which represents about 10 % of the SW generated in the city).

SORTING FOR RECYCLING OF SW IN THE CITY OF MANSOURA

Sorting for recycling in the city of Mansoura takes place at the following three stages:

- At the solid waste generating sources.
- During solid waste transportation from collection boxes to the main dump site.
- At the entrance of the main dump.

The sorted materials are plastic, paper, carton, bones, metals, and glass. These materials are sold to some private dealers.

3-1-5 Ecological and health hazards

In the city of Mansoura, the present practices for solid waste management pose many ecological and health hazards that are most manifest at the following sites: (i) at the main dump site where open burning

of the solid waste is practiced, (ii) at some collection locations in the city where the solid waste is scattered around the collection boxes, (iii) at some collection points in the city where the solid waste inside the collection boxes is locally burned.

At the main dump site of the city of Mansoura solid waste is continuously burned; this contributes extensively to the air pollution of the surrounding areas. Clouds of smoke and vapor are so intense to a limit greatly reducing horizontal vision. These gaseous emissions are swept by wind to cover great residential areas closed to the dump.

The emitted smoke and vapor are essentially mixtures of carbon monoxide, carbon dioxide, hydrocarbons, sulfur oxide, nitrogen oxides and particulate. These compounds are dangerous air pollutants threatening the environment and human health. Air pollution exerts a dramatic effect on the plant cover in the vicinity of the main dump site. It is very likely that the ground water could be polluted due to the accumulated solid waste in the main dump site.

4. CONCLUSIONS AND RECOMMENDATIONS

It can be concluded that, the solid waste management in Mansoura is facing a lot of

technical difficulties. There are various recommendations that have to be taken into consideration to improve the solid waste management system in the city of Mansoura.

1. Existing laws concerning waste should be enforced. The feasibility of its use for land filling activities should be assessed in terms of its economic viability, Environmental and public health safety. Collection and transportation of construction waste should be undertaken at developer's expense.
2. An investigation of the design of the currently used collection boxes, their distribution, service demand, fixation as well as the schedule for the transportation of waste from these boxes will be helpful. Also an assessment of the technical and logistics performance of the transportation fleet currently in use by the municipality should be conducted taking into account the increasing demand for service; this assessment is to identify the most efficient means to modify the service.
3. Detailed community attitude surveys should be undertaken to enable planners to plan for better service provision. Studies of household's reuse

and recycling habits, their perceptions needs opinions and understanding of the problem may be quite different from the planners.

4. Media should give attention to educate people on the best way to manage their waste.
5. Alternative disposal means should be identified for hospital and industrial hazardous types of wastes taking into account their negative environmental and public health impacts. The segregation of these types of waste will relieve the pressure on the current system.

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