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Environmental and Sustainable Guidelines for Integrated Municipal Solid Waste Management in Egypt

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Abstract

Demolition activities, including renovation/remodeling works and complete or selective removal/demolishing of existing structures 3either by synthetic processes or by natural disasters, create an extensive amount of wastes. These demolition wastes characterized as heterogeneous mixtures of building materials that usually contaminated with chemicals and dirt. In developing countries, it estimated that demolition wastes comprise 20% to 30% of the total annual solid wastes. In Egypt, the daily quantity of construction and demolition (C&D) waste have been estimated as 10,000 tones. That is equivalent to one third of the total daily municipal solid wastes generated per day in Egypt.

This paper summarizes the proposed Egyptian demolition waste management guidelines, which cover:

(1) The waste management hierarchy based on the '4Rs' Golden Rule of Reducing, Reusing, Recycling and Recovering of waste;

(2) the different implementation stages which start from the early planning phase, followed by the tendering and contract formulation phase and finally the execution phase;

(3) The various techniques, methodologies, procedures and strategies recommended to reduce the amount of waste and;

(4) The degree of involvement of all the construction industry parties (owner, engineer, designer, and contractor) in the implementation of the guidelines;

(5) Finally, the paper shows the Egyptian National Strategy for Integrated Municipal Solid Waste Management (MSWM), which includ the development and implementation of an integrated waste management system.

Keywords: Construction materials waste, sustainability, Environmental, demolition waste, Egypt, waste management, waste plan.

1. Introduction

In developing countries, demolition wastes comprise 20 to 30% of total annual solid wastes. In Egypt, the quantity of construction and demolition (C&D) wastes has been estimated as 10,000 tons per day (approximately 4.5 million tons annually). That is equivalent to one third of the total solid wastes generated per day in Egypt. On the other hand, the annual production rate of construction and demolition waste from the whole planet is around three billion tons. In Egypt, demolition activities carried out by conventional demolition methods.

Construction sites often seen as the cause of many environmental problems such as dust, noise, vibration and pollution of soil and groundwater. The current problems of waste management are mainly the accumulation of wastes in landfills, which have limited space resulting in less stringent environmental protection regulations governing landfilling operations. Moreover, the biodegradation of wastes in the landfills causes a lot of health and environmental problems. When Gypsum drywall becomes wet because of reduction in landfill, the sulfate reducing bacteria (SRB) use sulfate electron acceptor to produce H_2S_4 characterized by its offensive odor. According to investigations carried out early in the US, it shown that 0.4% of the construction waste by weight disposed of in landfills is hazardous waste. These hazardous wastes often generated on construction sites from empty containers, which might contain some rests of hazardous wastes like left over paint containers, solvents and adhesives.

Advanced demolition techniques, i.e. by using explosive materials, not commonly used in Egypt. The recycling and reuse in Egypt suffer from many factors as shown in table (1).

Table (1) factors effect on the recycling and reuse in Egypt.

legal framework	Egypt lacks a legal framework for used tires management. However, the recycling or reuse facilities should be included in the environmental register.
planning	There is a need to initiate a national program for wasted tires collection, treatment and disposal.
financing	No financial allocations directed for wasted tires collection, treatment and disposal.
collection, treatment and disposal	The majority of tire waste collected by tire dealers and sold to mediators for recycling.

Available data on waste generation rates indicate data production gaps. Data compiled from different sources for years 2000 through 2005 as presented in Table 2.

Table 2. National Waste origins from 2000 to 2005

Waste source	**2000**	**2004**	**2005**
Households	14-15 million ton	14,9 million tons	15-16 million ton
Industrial	4-5 million tons	6.2 (of which hazardous 0.3) million tons	4.5-5 million tons
Agricultural	23 million tons	16,5 million tons	25-30 million tons
Cleaning of waterways	Around 20 million tons	29,4 million tons	Around 20 million tons
Sludge's and waste water	1.5 - 2 million tons	2 million tons	1.5 - 2 million tons
Medical waste	100 000-120 000 tons	130 000 tons	100 000-120 000 tons
Demolition waste	3-4 million tons	4 million tons	3-4 million tons
Total	63.6 - 69.1 million tons	73.1 million tons	66.1- 77.1 million tons

Sources : Ministry of Local development (for years 2000 and 2005) ; GTZ-ERM-GKW (2004). Mediterranean Environmental Technical Assistance Program, Country Report-Egypt (final). METAP, World Bank**:** 33p. (For year 2004).

Municipal solid waste been inadequately managed for many years in Egypt. Egypt generated an estimated 20 million tons of municipal solid waste (MSW) in 2009, and the amount of solid waste produced annually is growing at an estimated 3.4% per year. Waste collection systems have left large areas of towns and cities (in some cases more than 50%) without service or under-serviced, and the majority of collected waste dumped in facilities that lack any effective management. Composting, although widespread, generally not effectively implemented. Recycling activities only been undertaken in some cities under unsafe and unhygienic conditions subjecting workers who participate in these processes to many risks. The majority of dumping sites are unsafe, and there are no preventive measures at these sites to prevent the self-ignition of waste. 50 - 60% of the waste composition is organic matter. Responsibility for MSWM in the central government of Egypt dispersed among a number of ministries. The Ministry of Local Development through Governorates and respective municipalities is responsible for the implementation of MSW activities either through direct implementation or through tendering to other entities. Except for Cairo and Giza Governorate, in general, Governorates lack a specialized unit that is entirely responsible for waste management. The Ministry of State for Environmental Affairs (MSEA) and its technical arm the Egyptian Environmental Affairs Agency (EEAA) host a General Directorate for solid waste management. The mandate of this directorate is the formulation of policy directives and the provision of guidelines for proper management of municipal waste. The Ministry of Finance is responsible for approving budget allocations for operational costs. The legal framework regulating MSWM in Egypt is multisided and falls under the jurisdiction of different ministries. There is no legislation dedicated to SWM. Legislation is instead in the form of provisions within other laws. The most significant are Law 38 of 1967 and its subsequent amendments in Law 10 of 2005, and Law 4 of 1994 and its Executive Regulations. Other laws pertaining to SWM includes Law 48 of 1982 regarding Nile River Protection.

In 2000, Egypt adopted a National Strategy for Integrated Municipal Solid Waste Management (MSWM), which included the development and implementation of an integrated waste management system. Within this National Strategy, a new cost-recovery initiative introduced to provide sustained revenue for the financing of the privatization process. Privatization of solid waste management (SWM) had occurred in a number of governorates in Egypt. However, the process faced many administrative problems in these governorates. Nine private sector companies are operationally involved in waste collection. Three are international and operate based on Design, Build, Operate systems, and local private companies operate in other Governorates such as Suez, Port Said, Gharbia, Luxor and Aswan Governorates. Some NGOs are operational at the level of villages in Egypt. The informal sector has been playing a significant role in Egypt in terms of waste collection and recovery of recyclables. The most visible role was in Greater Cairo through the Zabbaleen groups as well as other groups in the other governorates. Conflicts been detected with the informal sector during the implementation of the privatization. Under current Presidential directive, EEAA is currently taking the lead and is starting reform and improvements in the Greater Cairo Region. A strategy and action plan is currently being prepared involving all stakeholders both formal and informal. The main point under this strategy is the establishment of one central entity responsible for handling SWM at the national level and establish cooperation mechanisms with the informal sector in addition to several technical solutions related to the dumpsite and the utilization of waste. [15]

2. Materials and Methods

The Egyptian Environmental Law regulated the disposal of demolition wastes; the law did not include any clauses that suggest waste minimization. The objective of this paper is to recommended practical guidelines to add to the Egyptian Executive Regulations 338/1995 of the Egyptian Environmental Law no. 4/1994 to manage the amount and types of demolition waste in Egypt. These guidelines scientifically tailored and based on the responses from Egyptian construction companies regarding how construction waste handled on their projects. In summary, the guidelines were designed based on conclusions inferred from two instructed surveys and published literature, and were then reviewed by selected participants. Subsequently the guidelines upgraded based on the evaluation by a number of prominent national and multinational construction organizations in Egypt.

The design of the recommended guidelines based on a planned research methodology that executed through four stages, as fully described in:

The *first stage* investigated public opinion regarding

(i) The waste problem in Egypt,

(ii) The current practice of waste management in the Egyptian construction industry and

(iii) The extent of awareness among practitioners.

This been achieved through two types of surveys / questionnaires. Data obtained from the questionnaire obtained statistically and analytically. The conclusions drawn from the participants' answers and helped to ascertain the limitations on the implementation of the proposed guidelines in the Egyptian construction industry. The second phase has extensively examined national and international literature on alternative technologies, techniques, methodologies and strategies used to mitigate the problem of demolition waste. At this stage, the practical requirements of the guidelines clearly defined rather than conclusions drawn from the surveys. Phase III guidelines designed to be practical and compatible in the context of Egyptian construction. Proposed guidelines designed on a hierarchical basis of the 4Rs Golden Rule.

Since the sustainability preference of the 4Rs Golden Rule is; source reduction techniques were more favorable in the proposed guidelines followed by reusing, recycling, and then recovering. Consequently, the undesirable option of waste disposal could possibly eradicated as a management option. The 4Rs Golden Rule strategies employed throughout the various stages of a demolition project, from the early planning to the execution phases. The 4Rs Golden Rule techniques offered a number of waste management alternatives and identified the roles and responsibilities of the project's different participants.

The *fourth phase* validated the proposed guidelines through a feedback process. This process accomplished by distributing the guidelines among construction specialists, with predetermined selection criteria based on the respondent’s area of specialty and years of construction experience. The specialists had evaluated and assessed the practicability and feasibility of implementing the guidelines in Egyptian demolition projects; accordingly, the guidelines were improved and upgraded. [2]

2.1. Proposed Demolition Waste Management Guidelines

The proposed waste management guidelines consist of five main sections: **Reduce Reuse, Recycle, and Recover and Disposal.** Each section exhibits strategies and roles for each member of the project team to mitigate the generated demolition waste.

2.1.1. Reduce technique

Reduce is a precautionary technique aimed at minimizing the waste generated from the source before it becomes a physical problem. The reduce technique could be employed in the planning, tender and contract formulation and execution phases as follows:

A. During the planning phase

During this phase, the main participants are the Owner and the Engineer, i.e. the Owner's team. It recommended during this phase that the Owner's team should choose a selective demolition technique instead of complete demolition/removal of structure whenever possible. In that case, some of the installations such as walls and ceilings can retained while the interior systems of the structure can renovated.

B. During the tender and contract formulation phase

During this phase the main participants are

(i) The Owner's team and
(ii) The Contractor's team.

The recommended roles for both teams are:

(i) The Owner's team's responsibilities could be:

- The Owner has to assign an "Engineer" to act as his consultant to provide the required professional and technical expertise in managing the demolition course of works.
- The Owner/Engineer should avoid evaluating the contractor's bid on the lowest price but should evaluate it instead on the lowest responsible bid in which prior experience in carrying out the demolition works safely and with maximum recovery of materials taken into consideration. The contractor should include the associated costs of implementing the waste management plan in the price quotation. If the contractor fails to submit the waste management plan within the tender/bid documents, the contractor should held irresponsible, and should hence disqualified.
- The Owner/Engineer should assure that the waste management plan is enforceable in the contract, possibly by means of a binding clause in the contract tendering documents.

The content of the clause could be:

"The owner desires that as many materials as possible from this project be recovered and recycled to minimize the impact of demolition waste on the surrounding environment and to reduce the expenditures of energy and cost in fabricating new materials. To this end, Contractor shall submit a waste management plan showing the separation and mitigation actions for each material in the waste stream- generated as part or full from demolition of the buildings, pavement, vegetation, utilities and any other works associated with the contract scope of work - within the bidding documents. The mitigation actions should planned to maximize the amount of reuse, recycle and recovery of wastes and to minimize the amount of wastes to be disposed. The waste management plan shall be part of the tender evaluation. If the contract awarded, it will be the Contractor's duty to implement and abide by the waste

management plan. Failure to do so will constitute a breach of contract on the part of the Contractor."

(ii)The Contractor's team's responsibilities could be:

The contractor should prepare a draft of demolition plan. The plan should include a summary/brief of the following:

- An estimated period to fulfil the goals of the waste management plan.
- The sequences of carrying out demolition works, such as: demolition, segregation, loading, hauling, crushing, consolidation and then stockpiling materials on site.
- A survey of the building materials that could reused recycled and recovered throughout the project- by type and quantity.
- The quantities of disposed materials.
- The quantities of each waste stream generated by the project. The quantities could estimate based on either data compiled from previous projects or from experience with similar types of projects.
- Identification of any hazardous materials and means of proper disposal.
- The on-site separation/sorting strategies to segregate recyclables from other waste materials.
- A list of all on-site recycling techniques.
- Name and address of licensed disposal facilities accepting the generated waste materials.

C. During the execution phase

During this phase, the main participants are **(i) the Owner's team and (ii) the Contractor's team.**

Their recommended roles and responsibilities are as follows:

(i) The Owner's team's responsibilities could be:

- The Owner/Engineer should provide stringent site supervision upon the Contractor's site works to ensure proper implementation of waste management tactics.
- The Owner's team should supervise the contractor's performance in implementing the waste management procedures, and taking corrective actions when needed.
- The Owner's team should establish criteria to evaluate the contractor's performance. Possible criteria could be visual inspection checklists.

(ii) The Contractor's team's responsibilities could be:

- After the receipt of Notice of Award to Bid, by a maximum period designated by the Owner, the Contractor should submit a full detailed waste management plan.
- The contractor should plan the demolition sequence in advance generating the least amount of wastes while maximizing reduce, reuse and recover endeavors.

D. Reuse techniques

The reuse technique defined as re-employment of materials to reuse in the same application or to use in lower grade applications. The Contractor has the major responsibility in adopting the reuse techniques in the project through the execution phase, ***as follows:***

(a) Collection procedures

- Separation/segregation/sorting techniques should implemented to the waste stream.

- Labelled containers for each waste stream and schedule of the pick-up times of the containers should provide.
- On-site storage areas to dump the containers should designated. In order to prolong the waste life and extend the reusable abilities, the storage areas should be: (1) remote enough from the site to limit the access to the stored material and hence control its contamination; (2) labelled by large signage to describe the purpose of the area and (3) protected from the weathering conditions, such as rain and dust.

(b) Waste management personnel

A waste management team should assigned to accomplish the tasks needed for this activity. The team could consist of a waste manager and a group of trained laborers. The task of the waste manager could be:

- Setting up the waste management program.
- Supervising the waste separation and sorting activities.
- Supervising the reuse of waste as per the contractor's waste plan.
- Supervising the waste preparation to transport to recyclers.
- Supervising the legal disposal of wastes.
- Instructing and supervising the work of the trained laborers.
- Monitoring the wastes periodically to prevent any mixing or contamination.

(c) Work activities

- The sequence of demolition activity shall start by removing any valuable materials such as doors, windows, hardwoods or flooring prior to demolition activity that could reused, recovered or salvaged. Afterwards, the building interior should demolished manually, followed by demolition of the core of the structure using heavy equipment. Then excavators could be used to sort and compact recyclable and salvaged materials on site.
- Salvaged/recovered materials could use in it or in other applications. Such materials include: wood, earth works, plastics, vinyl, foam, steel, concrete, masonry (e.g. blocks and bricks), tiles (e.g. ceramics, marble and granite), plasterboard, insulation materials, paints, solvents and carpets.
- The Contractor should designate a secure and safe storage area for recovered and salvaged wastes to avoid any loss or damage that may occur to these materials.

(d) Documentation

- The Contractor should record and control all the waste management procedures documents.
- The Contractor should periodically update the data in his registers in order to prove or disprove the adequacy of the selected management techniques during the project execution phase.
- The Contractor should track costs or profits associated with various waste management methods.
- The Contractor should develop learning curves to update the laborer’s abilities in implementing waste management techniques.
- The Contractor should document all methods and techniques of mitigating the waste, quantities and types of generated wastes experienced through the completion of project.
- The Contractor should submit within the progress of payment application, a summary sheet describing all reduce, reuse, recycle, recovery and legal disposal of wastes.

E. Recycle techniques

The recycle technique defined as utilizing wastes as raw materials in other applications. Recycle endeavors can successfully utilized during the execution phase by the Contractor. The Contractor's team responsibilities in this stage could be as follows:

- The Contractor should recycle wastes that cannot reduced nor reused. Metals such as steel, copper and aluminum can sold to factories in order to be recycled in producing new metals.
- The Contractor's team should assure that the recycled materials, such as recycled concrete or asphalt materials, are uniform in quality, of adequate grading, free from any contamination and meet with the Egyptian Specification and Code of Practice.
- The Contractor's team should crush all materials on site such as bricks, concrete, stone and marble in order to maximum their reuse as recycled aggregates and fill materials.
- The Contractor's team should stockpile all crushed materials in separate and secured designated storage areas to avoid contamination or deterioration by weathering.

F. Recover techniques

The recover technique is a process of generating energy from waste materials that cannot be reduced, reused or recycled. Recover techniques can be exhibited during the execution phase by the Contractor. The Contractor can apply various waste recovery techniques such as briquetting, incinerating, pyrolysis, gasification and bio digestion.

G. Disposal of wastes

The last category in the waste management hierarchy is disposal. Disposing of wastes should carried out in controlled landfills to prevent any contamination to water and soil. Therefore, there is a practical need to select, design, construct and operate the landfill sites with a proper environmental management system in order to protect the environment during the whole lifespan of the landfill. The main responsible in this phase is the Contractor. The major roles of the Contractor are to avoid the disposal option by implementing 4Rs Golden Rule and to manage the disposal of the inevitable wastes.

2.2. Recommended Egyptian Guidelines

A continuous development process recommended for the guidelines by monitoring the performance of the guidelines on ongoing projects. Thus, if any discrepancy or faults in the guidelines detected, subsequent corrective actions would take to rectify improve and upgrade the guidelines as shown Figure 1. Moreover, further developments recommended developing a scientific methodology to quantify demolition waste.[1]

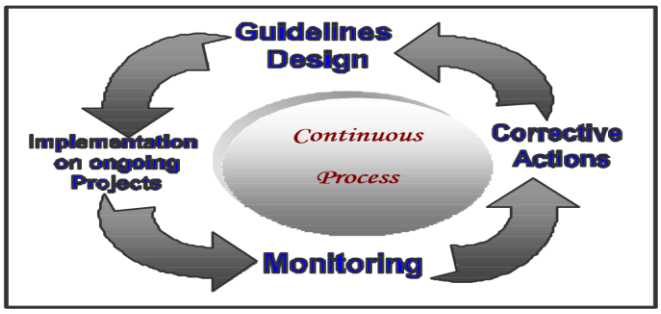

Figure 1 Continuous development of guidelines

Furthermore, support that is more political is required to enforce the implementation of waste management scheme in the construction/building field. This could attained, by firstly, adding some articles to the executive regulations 338/1995 of the Egyptian environmental law or issuing new decrees by the ministry(s) concerned to handle and manage demolition wastes. Secondly, diligent monitoring and follow up by municipalities and localities for illegal waste .

Disposal should performed. This could attained by creating special bodies for monitoring and following up. In addition, recruitment of licensed specialists recommended collecting demolition waste under the direct supervision of authorities. Finally, incentives to abide by environmental legislation should developed such as imposing a special tax levied on wastes when exceeding a certain level determined by the government.

It also recommended extending research on the area of recycling techniques of building materials to induct feasibility studies, including cost/benefit and payback period analysis for each technique. The research should survey the Egyptian market and seek the potential possibility of using waste as raw materials in factories. This research should integrate both the construction industry and the manufacturing industry to bridge the gap between the two disciplines.

Table (3): Evaluation tools to choose the building materials

Evaluation tools	**Life-cycle assessment**	This means considering the impact during the extraction of the raw materials, manufacture, transport, handling, installation, the lifetime of its use, recycling and disposal.
	Embodied energy	The total amount of energy that needed to produce, transport it to site and install it. For building products, it commonly measured in Mega Joules (MJ) per unit of product.
	Renewable resources	The resources that will replenished with time; they include plant and animal products such as timber, paper, cork, wool and leather.
	Sustainable resources	Sustainable resources are the products of cyclic closed systems that do not require outside inputs, and do not generate waste.
	Local resources	Locally sourced products need less energy for transport and they support your local economy.
	Toxicity	Some materials are relatively harmless for humans, but their production might cause habitat destruction or release toxins into the environment. Toxic materials can also be a problem for installers or when they disposed of at the end of their life cycle.
	Quality	The expected lifetime of the building is short; it makes little sense to use very durable materials.
	Re-use and recycling	Using second-hand or recycled materials is another option for reducing resource use.
	Uncertainty	Materials that have tested for a long time in your local conditions are a safer choice than new materials or those, which have not proven locally.

Table (4): The properties of industrial materials and recycling applications in building

industrial materials	The properties and the problem	recycling applications in building
Cement dust produced during the cement industry	Produced from the burning and grinding of raw materials used in the manufacture of cement, contains a high proportion of the components of the cement but in different proportions, and fails to plant one of the factories of the Egyptian cement per day at least 300 tons in the Mediterranean.	It has used in many engineering applications, including: Partially replace cement in some industries of construction materials such as bricks, tiles, the cement industry, glass, rubber, sewage treatment, the foundation layer for roads.
Steel slag	It is a byproduct of iron and steel industry and contains a high proportion of the components of the cement, but in different proportions. The amount of steel slag from iron and steel sector about a million tons annually, which is a national problem as well as emissions generated from the accumulation of slag.	It used in many engineering applications, including: as heap in concrete works of traditional and light production, types of cement (Ferrocement - high iron slag - high resistance to sulfate).
Foundry Sands	It sand that used to make molds and cores in the metal casting process. Although generally recycled many times internally by the foundries, about 3-4 million tons of foundry sand discarded each year. The recycling of nonhazardous, spent foundry sand can save energy, reduce the need to mine virgin materials, and may reduce costs for both producers and end users.	the spent foundry sands is used As partial replacement for fine aggregate in asphalt mixtures; in Portland cement concrete; As source material for the manufacture of Portland cement; and As a sand used in masonry mortar mixes, And in the other applications
Coal combustion	CCPs include the following materials:	Fly ash can be used as a replacement
products	Fly Ash; Ash; Boiler; Flue Gas Desulphurization Material (FGD); and Other types of material such as fluidized bed combustion ash, and scrubber residues The characteristics and physical properties of CCPs vary. In general, the size, shape, and chemical composition of these materials determines their beneficial reuse as a component of building materials or as a replacement to other virgin materials such as sand, gravel, or gypsum.	The Portland cement that binds traditional concrete mixes. The manufacture of Portland cement requires large inputs of energy, and it estimated that its manufacture constitutes about 8% of all carbon dioxide emissions from human sources. Approximately 75% of the fly ash produced annually is disposed of in landfills, which makes incorporating it into concrete a resource-efficient alternative.
Pulp and paper byproducts	Two significant byproducts from the paper industry are WWTP residuals and boiler ash	There are numerous examples of other uses Building board/fixture, Brick or concrete additive, Glass or lightweight aggregate

Construction and demolition (C&D) materials	It consists of the debris generated during the construction, renovation, and demolition of buildings, roads, and bridges. C&D materials often contain bulky, heavy materials, such as concrete, wood, metals, glass, and salvaged building components. In Egypt, the daily quantity of construction and demolition (C&D) waste has estimated as 10,000 tones. That is equivalent to one third of the total daily municipal solid wastes generated per day in Egypt.	It can make a number of products (solid cement bricks, hollow bricks, paving blocks) using the broken bricks and broken ceramics. As possible, get a light concrete using broken bricks as an alternative partial or total ruins of the great used in industry. You can also use the surplus concrete and rubble after rounding heap for the production of concrete suitable for the various structural elements.

Table (5) Advantages and disadvantages of the process of recycling waste

disadvantages of recycling waste	**Advantages of recycling waste**
▪ Some materials are generally more difficult to recycle ▪ other materials are dangerous or require more energy inputs to be recycled ▪ The durability of some materials can be extended if they properly protected and maintained while in use ▪ Environmentally preferable materials may be more expensive or difficult to locate ▪ Determining a product's environmental prefer ability can be a complex process for which no tools exist ▪ Prepare the materials may need more time ▪ Need efficient labors	▪ Conserves energy and reduces greenhouse gas emissions by decreasing the demand for products made from energy intensive manufacturing processes ▪ reduce the volume of materials which are sent to landfill as waste to achieve the continued development ▪ save the embodied energy content ▪ Preserves our natural resources by decreasing the demand for virgin materials ▪ Saves money by decreasing disposal costs for the generator and decreasing materials costs for end users. ▪ Local employment creation ▪ Reuse of old buildings and use of recycled materials.

Table (6) a variety of common building applications for industrial materials

(a,b) Green Roofs & Landscaping	Green roofs are roofs covered with plants; they reduce storm runoff and provide insulation. Scrap tires can used to make rubber tile for walkways. Bottom ash can used as bedding material. Clean wood, recycled gypsum wallboard, and cardboard can be ground and used as soil amendments in both green roofs and landscaping applications.
(c) Landscape Furniture	Benches can made with plastic lumber containing fly ash or with recycled C&D wood.
(d) Building Facing Material	Manufactured stone, which is concrete, mixed with aggregates, commonly used as building facing materials. fly ash can be used in the production of manufactured stone
(e) Sidewalks	Industrial materials can used to make concrete sidewalks, and used tires can be recycled to create rubberized sidewalks. Asphalt concrete sidewalks can made with recycled asphalt pavement and recycled asphalt shingles.
(f) Ceiling Tile	Ceiling tile can contain flue gas desulfurization (FGD) gypsum (a material resulting from burning coal to produce electricity), fly ash, recycled gypsum wallboard, or air-cooled blast furnace slag.

(g) Flooring	Industrial materials can used in various flooring applications. ▪ Carpet backing: Used tires, fly ash, or recycled carpet. ▪ Wood flooring: Salvaged lumber or recycled wood. ▪ Flooring tile: Fly ash, blast furnace slag. ▪ Tile underpayment: Fly ash.
(l) Backfill (Foundation Support)	Backfill surrounds the building foundation, supporting it and providing drainage. Scrap tires provide superior drainage, insulation, and wall pressure relief. Blast furnace slag and recycled concrete also can used for drainage.
(m) Foundation Structural Fill	Structural fill is an engineered fill that constructed in layers and compacted to a desired density. Coal fly ash, bottom ash, slag, and spent foundry sand can all used as structural fill. Concrete can crushed and used onsite as structural fill.
(n) Poured Concrete	Concrete, which is composed of cement, aggregate, and water, is used in a
Foundation	Wide array of building applications. Industrial materials can be recycled in cement and concrete in many ways. Here are a few examples: ▪ Fly ash and ground granulated blast furnace slag can used as partial cement replacements. Using these materials can produce stronger, longer lasting concrete. ▪ Portland cement itself can made with fly ash, FGD gypsum, foundry sand, recycled gypsum wallboard, blast furnace, and steel slag. ▪ Concrete aggregates can include bottom ash, foundry sand, crushed concrete, and blast furnace slag.
(o) Insulation	Air-cooled blast furnace slag can used to produce mineral or rock wool insulation (also known as slag wool insulation).
(p)Drywall/Wallboard	FGD gypsum and recycled gypsum wallboard can used to manufacture drywall.
(q) Mortars, Grouts, Stucco	Mortars, grouts, and stucco contain aggregate (sand), binder, and water. Fly ash, foundry sand, silica fume, and slag cement can all used as partial cement replacements.
(r) Masonry Blocks	Masonry blocks made from cement and aggregate. Slag cement, fly ash, or silica fume can substitute partially for cement. Bottom ash, blast furnace slag, and recycled concrete aggregate can substitute for newly mined materials.
(s) Base Material	Spent foundry sand can used in place of natural soil as base material for the building site. Recycled concrete also commonly used as base material.

2.3. Municipal Solid Waste Management in Egypt

Municipal solid waste has inadequately managed for many years in Egypt. Egypt generated an estimated 20 million tons of municipal solid waste (MSW) in 2009, and the amount of solid waste produced annually is growing at an estimated 3.4% per year. Waste collection systems have left large areas of towns and cities (in some cases more than 50%) without service or under-serviced, and the majority of collected waste dumped in facilities that lack any effective management. Composting, although widespread, generally not effectively implemented. Recycling activities have only undertaken in some cities under unsafe and unhygienic conditions subjecting workers who participate in these processes to many risks. The majority of dumping sites are unsafe, and there are no preventive measures at these sites to prevent the self-ignition of waste. 50 - 60% of the waste composition is organic matter.

In 2000, Egypt adopted a National Strategy for Integrated Municipal Solid Waste Management (MSWM), which included the development and implementation of an integrated waste management system. Within this National Strategy, a new cost-recovery initiative introduced to provide sustained revenue for the financing of the privatization process. Privatization of solid waste management (SWM) had occurred in a number of governorates in Egypt. However, the process faced many administrative problems in these governorates. Nine private sector

companies are operationally involved in waste collection. Three are international and operate based on Design, Build, Operate systems, and local private companies operate in other Governorates such as Suez, Port Said, Gharbia, Luxor and Aswan Governorates. Some NGOs are operational at the level of villages in Egypt. The informal sector has been playing a significant role in Egypt in terms of waste collection and recovery of recyclables. The most visible role was in Greater Cairo through the Zabbaleen groups as well as other groups in the other governorates. Conflicts have detected with the informal sector during the implementation of the privatization[14]

2.3.1. Assessment of the Current MSWM System in Giza

In Giza Governorate, the study revealed a number of positive aspects related to the MSWM situation. This, in particular, includes the high level of attention from the government and strong political will for a better situation and constructive reforms for the sector. Moreover, in Giza Governorate, SWM sector involves a range of actors with good experience in SWM. The informal sector group, particularly the Zabbaleen and wahys, enjoy the knowledge of the sector and have very rich experience in door-to-door collection service, which have proven, for long years, to be the most efficient and culturally appropriate SWM system in Giza Governorate. Moreover, there is generally an increased level of understanding of the value of recyclables and their high economic potential. While this not yet done in a structured and legalized framework, it still constitutes a core source of income for a large base of the urban poor. [14]

Table 7 Waste Composition in Giza Governorate (2009)

Waste Component	Percentage of Total Waste Generated
Organic waste	47
Cardboard	26
Plastics	6
Textiles	3
Bones	0.5
Metals	2
Glass	2.5
Others	13.5

As might be observed from Table 7 above, the organic component constitutes the largest portion of the generated waste. Due to the urban nature of the governorate, the organic waste is mostly food waste. These amounts used to fed to the pigs before they were culled in 2009

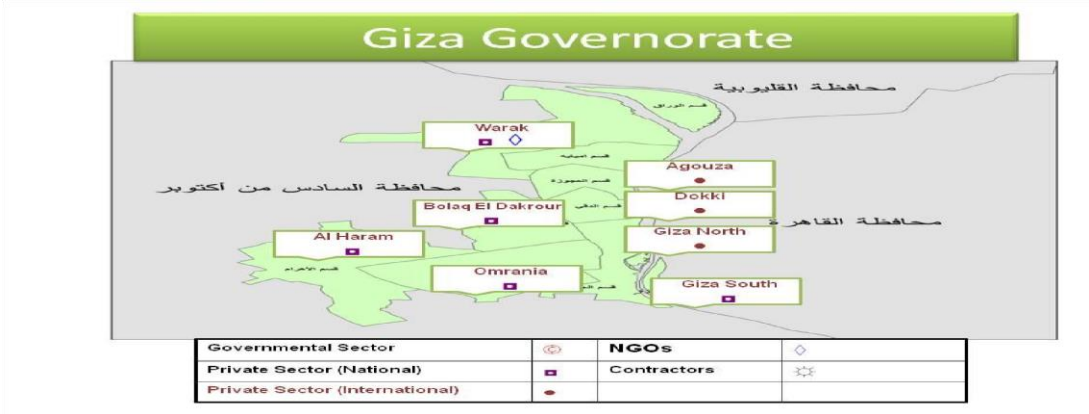

Figure 2 Waste Collection Services in Giza Governorate

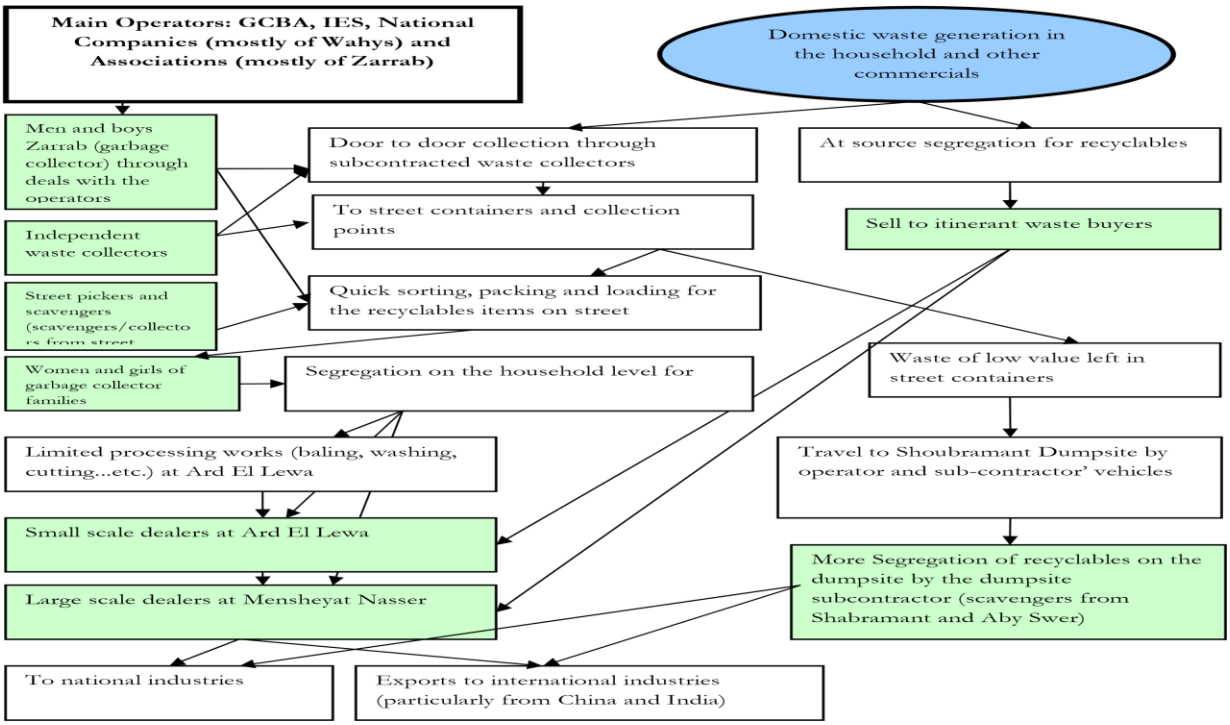

Figure 3 Waste from Generation to Recycling and the Role of Informal Sector Groups, Giza Governorate

On the other hand, the PSIA showed that the current system in Giza Governorate involves a number of weaknesses that can summarized in:

1- High level of dissatisfaction and negative socioeconomic impacts that the social survey strongly revealed.
2- Lack of clarity of the division of responsibilities
3- Conflict of interests among various actors
4- Duality of payment and economic burden on poor families

2.3.2. Assessment of the Current MSWM System in Gharbia Governorate

Gharbia Governorate is located in the Delta region and covers an area of 1942.3 km†. The total population of Gharbia estimated at 4 million and 11 thousands inhabitants, of which 70% reside in rural areas. The administration division of the Governorate includes 8 Markaz, 8 cities, 4 districts, 53 rural local units annexed by 318 villages and 1,249 hamlets. In addition, there are 47 informal settlements, among which 19 have developed by the Governorate and 28 are in the process of being developed.

The main economic activity is agriculture and the associated activities, which mean that waste generated is mostly agricultural waste. The Governorate is famous for crops such as cotton, rice, wheat, fruits and medicinal herbs. Gharbia also known for huge industrial textile complexes encompassing spinning and weaving. Other industries in the Governorate include fertilizer, pesticides, chemicals and paper, as well as perfumes.

Municipal Solid Waste Management System in Gharbia Governorate

The generation rate of waste in Gharbia estimated at 3000 tons/day in 2008. Tanta Markaz has the highest waste generation rate in Gharbia, estimated at 525 tons/day. This followed by El Mahala El Kobra Markaz at a generation rate of 510 tons/day. El Santa and Kotor Markazes recorded as having the lowest rate of waste generation in Gharbia.

Figure 4 Waste Collection Services in Gharbia Governorate

Organic waste constitutes 50-60% of the waste in Gharbia. Despite this, segregation and collection of recyclables still undertaken in Gharbia, especially in urban settlements.

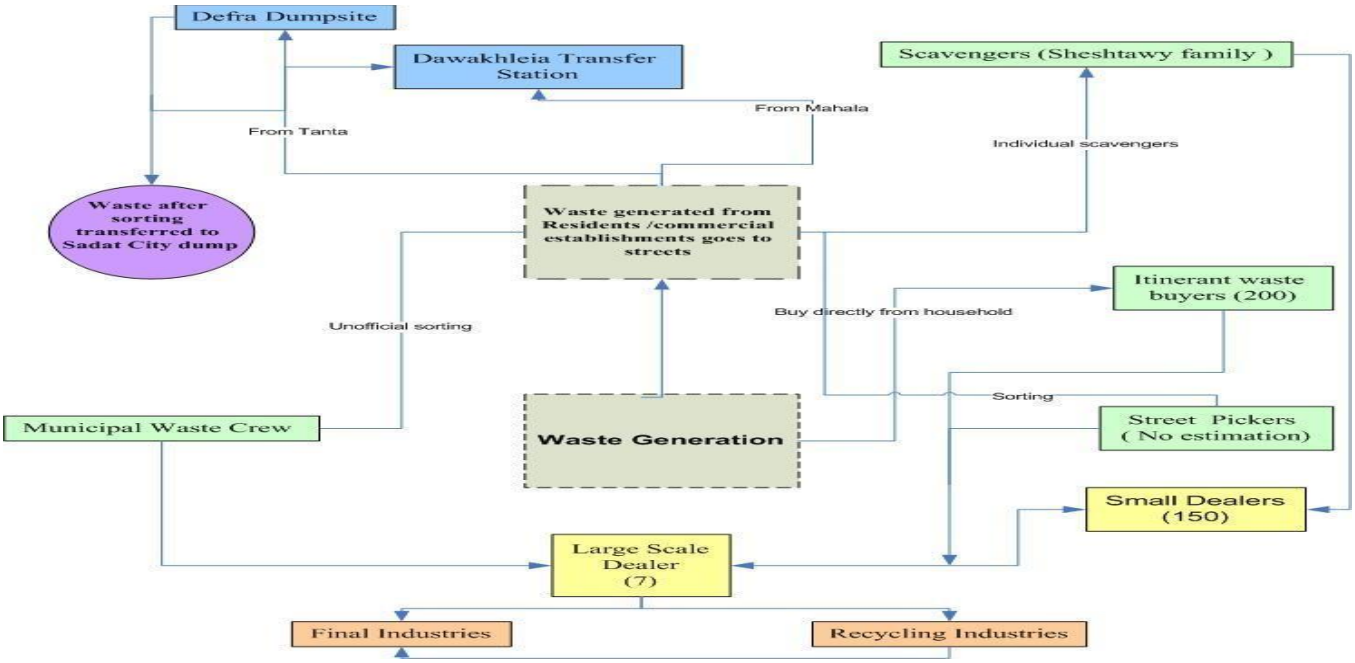

Figure 5 Waste from Generation to Recycling and the Role of Informal Sector Groups, Gharbia Governorate

The Local Government is the main entity responsible for municipal waste management in Gharbia. In this respect, the responsibility of the Local Government comprises:

1. Collecting, transporting and disposing of waste from streets and public areas.
2. Preparing tenders for contractors and private companies.
3. Contracting the private companies.
4. Monitoring the private company and the contractors.
5. Law enforcement for violations related to waste dumping.
6. Managing dumpsites and composting plants.

The Local Government in involved in the waste system in Gharbia at five different levels:

1. The Department of Cleansing at the Governorate level collects waste in Tanta.
2. The Department of Cleaning and Beautification collects waste in each city of the Markazes.
3. The Local Government Unit (LGU) collects waste from villages.
4. The operators of composting plants and or dumpsites.

Waste collected by the Local Government is disposed of in two sites: El Dawakhlia in El Mehala El Kobra and Defra. The Dawakhlia site used to be a sorting site, however it is no longer operational and is now being used as a dumpsite. The second site used for disposal of waste collected by the Local Government is a composting plant in Defra.

In addition to the Local Government, a number of private operators are functioning in Gharbia. Care Service is operating in the two major urban cities of El Mehala El Kobra and Tanta. The company is responsible for waste collection, transfer and disposal. The company was contracted for ten years to undertake door to door collection, however, this never took place. Currently, two years are left in the contract, and Care Service provides collection from large containers placed on the streets. They collect waste from residential areas, organizations and enterprises, and on a voluntary basis, they also sometimes collect waste that has accumulated in the streets. Waste is finally transferred and disposed of in Dawakhleia and Defra sorting/dumpsite in El-Mehala El-Kobar and Tanta respectively. The second private company operating in this field is Hany El-Naggar Company, which is contracted to undertake final disposal of waste from Dawakhlia and Defra sites to the dumpsite in El Sadat city. The company performs this task against a monthly fee of 160,000 LE.

The third private company operating in the waste management field is Mabouk International Company for Engineering Industries. The company works in the manufacturing field and produces waste collection equipment, among other types of equipment, which is competitive in the international market. (30% less than international prices according to the owner. The owner is currently preparing to participate in the new tender for waste collection.

Contractors (Motaahedeen) are individuals, who under a license agreement pay an annual license fee to the LGU in return for providing a waste collection, transfer and disposal service. By virtue of their license, contractors are permitted to collect a pre-agreed upon monthly fee from residents in return for their service. There are 15 contractors currently operating in El Mehala El Koubra Markaz.

There are CDAs working in Gharbia Governorate, among which only 16 CDAs work in municipal solid waste management.[1] However, some CDAs ceased working in this field because of lack of local transfer stations, which made their work economically unfeasible. CDAs are predominantly dependent on donor-funded grants to operate their services. The Social Fund for Development (SFD) has invested 700,000 LE to support CDAs operating in

this field. Another prominent donor in the field is the Egyptian Swiss Development Fund (ESDF).

Assessment of the Current MSWM System in Gharbia

From the survey sample, 51% of beneficiaries and 43% of the enterprises believe that the streets are not clean. The data collected revealed that the government provides the service for around 30% of the sample for the beneficiaries against 36% provided by the private company, 9% was covered by the CDAs and 21% received no service at all. 60.9% of the beneficiaries and 55.7% of the enterprises were not satisfied with the service. The main reasons for dissatisfaction were as follows:

1. Poor service provided.
2. Garbage collector does not come regularly.
3. Streets not cleaned.
4. Garbage not collected from apartments or shops.
5. Garbage collectors do not collect the whole garbage.
6. The government receives money yet provides no service

2.3.3. Assessment of the Current MSWM System in Luxor Governorate

The Governorate of Luxor is located in Upper Egypt, overlooking the Nile River and considered one of the most prominent touristic Governorates in Egypt. Following Presidential Decree 387 for the year 2009, Luxor upgraded from a city to a Governorate with a new administrative division. The administration division of the Governorate includes six cities, and 7 Markazes. Luxor City divided into two main sections the East Bank and the West Bank and inhibited by a population of around 1,031,014. The total area of Luxor is 2,424 .82 km^2 including the desert hinterland, out of which 241.42 km^2 inhabited.

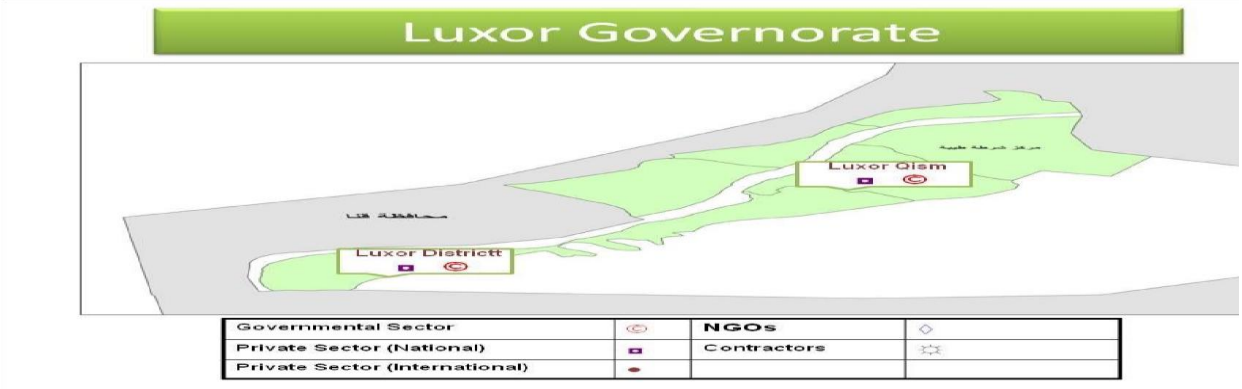

Figure 6 Luxor Map Indicating the Waste Collection Services in Luxor Governorate

Luxor governorate is predominantly touristic. Tourism is the main economic activity upon which the governorate depends. The touristic nature of the governorate has directly impacted the type of waste generated and has led to a waste composition rich in recyclables, especially plastics, including PET and empty soda cans. Agricultural activities take place in the governorate and are mainly concentrated in the cultivation of sugarcane, local beans, wheat, and maize. Some industrial activities also exist in the governorate and are mainly in the field petrochemicals and textiles.

Municipal Solid Waste Management System in Luxor

The generation rate of waste in Luxor estimated at 250 tons/ day in 2009. The key actors involved in SWM on the level of Luxor Governorate are the local Government, the private sector and the informal sector. However, a distinctive feature in Luxor is the fact that the private sector is greatly engaged in the waste collection from hotels given the touristic nature of Luxor. CDAs are operating in other Markazes such as Tawd and Isna.

The Local Government represented by the local government Unit (LGU) in Luxor City is responsible for street sweeping, collecting residential and commercial waste from municipal containers/ bins and for disposal of collected waste. In addition to this, the LGU is responsible for collecting waste from public utilities including governmental hospitals. Work performed through three daily working shifts carried out within the City s administrative sectors. Currently, the LGU worker paid a monthly salary of LE 500, and a plan has been set up to increase the number of labors to 1,800 workers Including 35 women. The local government dumps in Al Haubil dumpsite, which is the main dumpsite in Luxor Markaz and City. The dumpsite is located at the desert belt of the city. Two areas at the dumpsite dedicated to dumping the waste collected by the two private companies (Aal Al-Bayt and Al-Hoda). The west Side dumpsite is located in the desert 17 km away from Al Qurnah City. An area dedicated to dumping the waste from Redaco, a private company.

On the level of Al-Tawd City, there are five LGUs. They serve all residential areas. Waste transported to a dumpsite east of Deir El-Qeddiseen to burn without sorting. The cities of Armant and Isnah newly affiliated with Luxor Governorate. Service provided through LGUs. There are five private sector companies operating in Luxor. The companies contracted directly by the hotels they serve in return of a predetermined contract value to paid monthly per hotel or floating hotel. Private companies in Luxor do not cover residential areas in the Governorate. Contracts with hotels and floating hotels stipulate that the Company remove waste from spots designated for this purpose. A speedboat used to collect waste from floating hotels. Contracted hotels and restaurants buy bags designated for waste collection. Hotel workers collect these bags, screen them for security reasons and place them in the areas/spots as agreed. Aal Al-Bayt Company workers load these bags on board of the Company vehicles. Waste transferred and disposed of in the official dumpsite of Al-Hubail area. There is, generally, positive feedback regarding the service provided by the private company. The only negative aspect is the lack of any company social or insurance obligations toward the labor force.

Solid wastes collected from hotels and restaurants on land transported by trucks supplied with workers who load and unload the waste at the dumpsite located at Al-Hubail area. With respect to floating hotels, waste is transported by barge workers who collect, load, and unload this waste on the West bank. They, then, load them again onto to vehicles to take to the same dumpsite.

Assessment of the Current MSWM System in Luxor Governorate

54.3% of the beneficiaries sample found that the streets should classified in terms of cleanliness as clean. While 19% described the streets as unclean and 14.3% found that, the streets are unclean. For enterprises, 58% of the survey sample stated that streets should classified in terms of cleanliness as clean. The percentage of those who were not satisfied with the provided service

is less than 58.1% of the surveyed households and for the surveyed enterprises percentage of those who were not satisfied with the service was 46%, and about 2% did not determine their attitude. The main reasons for dissatisfaction are the absence of anyone to collect garbage (30.4%), the irregularity of the collection service and the unclean image of the streets. These reasons for dissatisfaction came very similar for enterprises that referred to the inefficiency and irregularity of service and attributed their dissatisfaction to the result, which is the low level of cleanliness on the streets.

2.3.4. Assessment of the Current MSWM System Ismailia Governorate

Ismailia Governorate is one of the Canal Governorates. The area of Ismailia is about 5066.96 km^2, and the urban structure of Ismailia is composed of five Markazes and seven cities. The Governorate also encompasses 25 mother villages, 6 satellite villages, and 592 hamlets. Ismailia Governorate population reached 942, 800 thousand inhabitants of which 53.6% are rural population. Agriculture and fishing sectors employ the largest portion of the Governorate labor force followed by services and governmental jobs, construction and commercial activities. The governorate of Ismailia is home to many industrial activities that depend primarily on utilizing agricultural production.

Municipal Solid Waste Management System in Ismailia Governorate

Ismailia Governorate generates an amount of around 752 ton/day. The Governorate has 2 two composting plants. The responsibility for MSWM in Ismailia Governorate divided among some key responsible parties. This includes the Governmental local units (LGUs)/municipalities/districts, private companies and CDAs.

Table 8 Amount of Waste Generated by Markaz

Markaz	Amount of Waste Generated (ton/day)
Ismailia	336
Fayed	73
El Kantara Gharb	117
El Kantara Shark	26
El Tal El Kebeer	13.5
El Qassaseen El Gededa	2
Abu Sweir	4.5
Total Governorate	572

Source: Ismailia EMU, January 2010

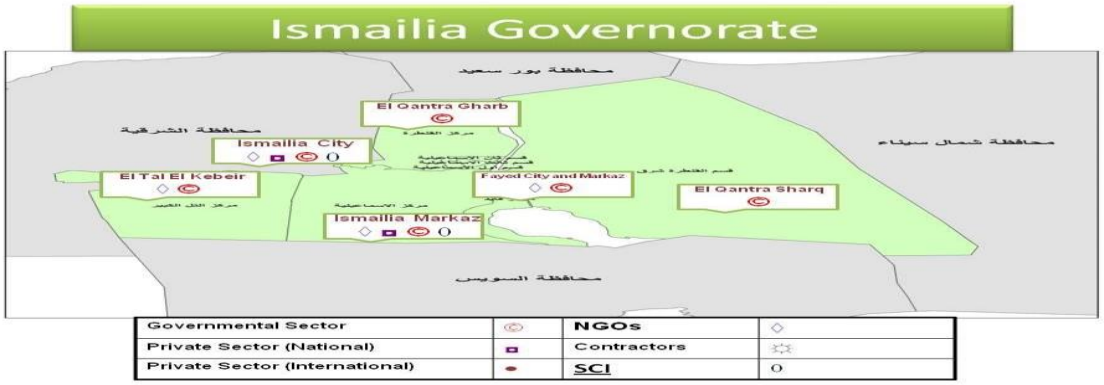

Figure 7 Ismailia Map Indicating the Waste Collection Services in Ismailia Governorate

The local government is key player in SWM in Ismailia Governorate. The survey carried out confirmed that the majority of respondents served by the LGU or the three districts services. Ismailia Markaz waste transferred to Abu Balah dumpsite, which is the main dumpsite for Ismailia markaz, in addition to other smaller dumpsites in Al Mostakbal and Kantara. There are 2 composting plants adjacent to Abu Balah which are not fully operational.

The private sector is contributing the MSWM in Ismailia with two companies who are working in the City of Ismailia. Suez Canal for Investment (SCI) is a company contracted by the Suez Canal Authority (SCA) to undertake collection, transfer and disposal of waste from various residential areas and establishments affiliated to the Suez Canal Authority (SCA). This constitute around 40% of Ismailia City population. Beneficiaries do not pay any service fees in return for the SWM collection service. SCA pay the SCI contract and provide the service to beneficiaries without service fees as part of its corporate social responsibility activities.
Care Service is the second private company working in Ismailia City, the company is in charge of the domestic and healthcare waste of the various Departments within the SCA Hospital waste then transported by Care Service vehicles to the public dumpsite. The company also provides a number of street containers in the neighborhood of SCI Hospital.
CDAs are a different model for service providers in Ismailia Governorate rural areas, several programs have worked in funding solid waste and sewage collection project. For this type of projects, donors usually provide funds for equipment, which usually include collection equipment. The CDA, then, holds the responsibility of operating and maintaining the project.

Municipal Solid Waste Management System in Ismailia
The survey showed that around 60% of the beneficiaries sample and 54% of the enterprises perceive their neighborhood as not clean. It also revealed high level of dissatisfaction with the current SWM situation among the surveyed beneficiaries and enterprises, 63.4% of the beneficiaries and 76% of the enterprise are very dissatisfied. The reasons for dissatisfaction included the unclean streets appearance and the unavailability of convenient tool for waste disposal. Random dumping of waste is still practiced by around 59.3 % of the surveyed sample of beneficiaries (Dump on the street, throw into a pile of garbage, dump on waterways, canals, drainage and burning) and 25.3% of enterprises (Dump on the street, put in a waste collecting vehicle, throw into a pile of waste, burning).

3. Conclusion and Recommendations

3.1. Conclusions

After investigating environmental public policy in Egypt with an emphasis on solid waste management using both qualitative and quantitative analysis, it can concluded that the performance of the Egyptian Waste Water Management procedures has a weak but significant positive relationship with the international solid waste management guidelines. This is due to four factors: shortcomings within the environmental public policy making process; shortcomings within Egyptian societal practices and culture; shortcomings within the Egyptian legal framework; and shortcomings related to sustainability.

First, with regard to the public policy making process, ill structured, inconsistent and intermittent environmental public policies built on a "lack of comprehensive data" impede the monitoring

process essential for the formation and implementation stages of policymaking, rendering the evaluation phase almost impossible.

Second, regarding shortcomings within Egyptian societal practices and culture, "cultural constraints" hinders both the agenda setting and implementation stages. The "lack of efficient human resources" applies to individuals with environmental expertise as well as to a general lack of knowledge regarding to environmental issues and solid waste management in particular.

Third, with regard to shortcomings within the Egyptian legal framework, the problem is not the issuance of laws but the need standardized environmental regulations and the ability to ensure compliance with and enforcement of these laws.

Fourth, with regard to shortcomings related to sustainability, the main problem is the reliance on international donors to place certain policies on the agenda, which, in turn, affects public policy formulation (assessing and evaluating alternatives), thus hindering the sustainability of environmental public policies and making long term commitments to certain policies impossible due to the dependence on sporadic and intermittent funds provided by international donors.

These drawbacks and obstacles must avoided in the future if Egypt's environment is to be preserved and protected. To achieve that, this study makes several recommendations for policy makers in the Ministry of State for Environmental Affairs (MSEA) so that they may play an effective role in environmental protection and solid waste management. The Egyptian Environment Affairs Agency (EEAA) in general should be less dependent on international donors when shaping Egyptian environmental public policies to ensure the persistence of such policies and guarantee the completion and consistency of the environmental public policy cycle.

Moreover, a public awareness program using media is necessary. The media in general, with a special emphasis on television, especially drama, could become an active partner in the protection of the environment due to its vital role in introducing new positive environmental habits due to its significant influence on Egyptian public behavior.

Based on the data collected from the literature survey, it revealed that the production of industrial materials waste is escalating both on the international and national scales. Furthermore, environmental, safety, visual and technical related problems generated from these wastes has severely added to the long-term negative impacts of these wastes on the surrounding environment. Therefore the disposal option can be avoided by the implementation of reuse them in building. Waste reduction opportunities begin with the earliest choices made in the building process, including architectural design and material selection. Effectively balancing resource-efficient design concepts requires the attention of skilled and environmentally conscious building professionals. These concepts include waste prevention, durability, and recyclables.

It has been monitoring some of the negatives facing the potential to activate the application of construction materials industry and summarized as follows:

(1)*Limited NGO non-governmental organizations concerned with the field of urban development in general and re-use of industrial materials in particular.*

(2)*Does not represent low-income housing a sufficient degree of urbanization, culture and enable them to participate in such environmental projects in an effective manner.*

(3)*Difficulty of maintaining such environmental projects for low-income.*
(4)*Building design re-use of industrial materials zero energy consumption in Egypt still needs some time.*
(5)*Non-participation of specialists sometimes leads to delays in implementation and increase the cost and other obstacles that may face the project when actual implementation*.

3.2.Recommendations

(1) Increased awareness, acceptance and proactive government policies are critical in order to continue the upward trend of recycling and reusing materials whenever possible
(2) More political support is required to enforce the implementation of waste management scheme in the construction/building field, collect industrial material wastes under the direct supervision of authorities. Imposing a special tax levied on wastes when exceeding a certain level determined by the government.
(3) It also recommended extending research on the area of recycling and reusing techniques of industrial materials in building to induct feasibility studies, including cost/benefit and payback period analysis for each technique. The research should survey the Egyptian market and seek the potential possibility of using waste as raw materials in factories. This research should integrate both the construction industry and the manufacturing industry to bridge the gap between the two disciplines.
(4) Overcoming these challenges may require advocacy work to strengthen policies and incentives to reduce construction and demolition waste, intensive education and marketing to expand the demand for reused building materials, as well as smart partnerships and inventory management to keep the right mix of reused materials in stock to meet local demand.

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