
By
Ali Ahmed Abdelah Mohammed
B.Sc.(general) in Health and Environmental Sciences
Faculty of Health and Environmental Sciences
University of Gezira (2008)

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University of Gezira

Main Supervisor
Prof. Abdulah Mohammed Elhassan Abdesalam

Co-Supervisor
Dr. Mohammed Bakri Osman

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By
Ali Ahmed Abdelah Mohammed

Supervision Committee:

Name:  Signature

Main Supervisor: Prof. Abdelilah Mohammed AL-Hassan Abdesalam …….  
Co-Supervisor: Dr. Mohammed Bakri Osman  

November 2012

By
Ali Ahmed Abdelah Mohammed

Examination Committee:

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<td>Chair person</td>
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Date of Examination: 15/11/2012
Dedication

To My Parents, Brothers and Sisters and Friends
To All Who Supported Me in This Study.
Acknowledgments

After thanking Allah, I wish to express my gratitude to everyone who contributed to the success of this study. I must single out the my main supervisor prof. Abd elelah Mohammed AL-Hassan Abdesalam who gave his approval to this project and supported it during the months it took to bring it to fruition.

I also want to thank my Co-supervisor Dr. Mohammed Bakri Osman for his insightful comments, helpful advice, encouragement, and support.

I am also grateful to my parents, generous family, and friends for their patience, support and encouragement.

My thanks go to all people that helped me in finishing this study.

I sincerely hope that, this study will be beneficial to the policy makers, planners, and health providers in the sanitary field in all localities in Omdurman city.

Ali Ahmed Abdelah Mohammed
Master of Science in Public and Environmental Health (November, 2012)
Department of Environmental Health
Faculty of Health and Environmental Sciences
University of Gezira, Sudan

ABSTRACT

Solid Waste Management System is one of the most important environmental health services and is an integral part of basic urban services indicating to the organized management of activities related to wastes collection, source separation, storage, transportation, processing, treatment, and final disposal of solid wastes. This study was carried out in localities of Omdadah, Omdurman and Karary, Khartoum state. It targeted citizens whose ages are not less than 15 years. aim to evaluate their attitude and practices regarding domestic solid wastes and heads of the localities and operation directors in the branch sectors to evaluate work plans of solid Waste Management System at the level of the three localities. The method included both the quantitative and qualitative methods, included tow questionnaires and three interviews in addition to observations. The sample size was statically estimated, It was 400 among the citizens and 19 for the operation sectors. SPSS was used to analysis the data. The study revealed that the budget available for the management of the solid domestic wastes in Omdurman city was 70% of the required budget; and percentage coverage of the solid domestic wastes service was 90% the houses, and the waste workers in the localities do not use means of prevention and safety procedures against the risks of the solid domestic wastes and that containers are not used as means of keeping waste ; the vast majority of the citizens (82%) have the desire to sort domestic solid west into organic and non organic, while 18% have no desire to sort the waste. The study concluded that, Solid Domestic Wastes Management System is considered as one of the most important health services in towns to preserve environment and citizens safety and it requires big budget. The study recommended the necessity that localities should engage the public and private sectors in these services to develop the Solid Domestic Wastes Management System, in addition to the necessity of providing the necessary support for all the stages of the system. And conducting more study in area in the state.
تقييم نظام إدارة النفايات المنزلية الصلبة بمدينة أم درمان، ولاية الخرطوم، السودان في العام (2012م)

علي عبد الله محمد

ماجستير العلوم في الصحة العامة وصحة البيئة (نوفمبر 2012م)
قسم صحة البيئة
كلية العلوم الصحية والبيئية
جامعة الجزيرة

مستخلص البحث

إدارة النفايات الصلبة من أهم خدمات صحة البيئة وجزء مكمل للخدمات الحضرية الأساسية يشير إلى الإدارة المنظمة للأنشطة المتعلقة بجمع النفايات ، العزل المصدري ، التخزين ، النقل ، المعالجة ، المعالجة والتخلص النهائي من النفايات الصلبة . أجريت هذه الدراسة في محيطات أم بدة ، أم درمان وكري، ولاية الخرطوم . واستهدفت المواطنين الذين لا يقل عمرهم عن 15 سنة بهدف تقييم مواقفهم وممارساتهم للتخلص من النفايات المنزلية الصلبة ورؤساء المحليات ومديري العمليات بالقطاعات الفرعية لتقديم خطة العمل لنظام إدارة النفايات المنزلية الصلبة علي مستوى المحليات الثلاثة . شملت المنهجية التي تم استخدامها في هذا البحث الطرق الكمية والنوعية معاً ، وشملت استبيانات وثلاث مقابلات بالإضافة إلى الملاحظات . وقد حدد عدد السكان وبلغ حجم العينة 400 وسط المواطنين و19 لقطاعات العمليات . وقد استخدمت (SPSS) لتحليل البيانات . توصلت الدراسة إلى أن الميزانية المتوفرة لإدارة النفايات المنزلية الصلبة بمدينة أم ديرمان كانت بنسبة 70% من الميزانية المطلوبة ، وأيضا أظهرت الدراسة أن نسبة التغطية لخدمات النفايات المنزلية الصلبة كانت 90% من المنازل ، وأن عمال النفايات بالمحليات لا يستخدمون وسائل الوقاية وإجراءات السلامة من مخاطر النفايات المنزلية الصلبة ولا يستخدمون الحاويات كوسيلة لحفظ النفايات . كما أظهرت أن الغالبية العظمى من المواطنين (82%) لديهم الرغبة في فرز النفايات المنزلية المنزلية إلى عضوية وغير عضوية ، بينما 18% ليس لديهم الرغبة في فرز النفايات . خلصت الدراسة إلى أن إدارة النفايات المنزلية الصلبة تعتبر من أهم الخدمات الصحية في المدن للمحافظة علي البيئة وسلامة المواطنين ، وتحتاج الي بذل ميزانية كبيرة . أوصت الدراسة بضرورة أن تشارك المحليات في هذه الخدمات القطاعين العام والخاص لتطوير نظام إدارة النفايات المنزلية الصلبة ، إضافة إلى ضرورة توفير الدعم اللازم لكل مراحل النظام المختلفة ، وإجراء المزيد من الدراسات في هذا المجال بالولاية .
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<td>WHO</td>
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<td>MSW</td>
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<td>MSWM</td>
<td>Municipal Solid Waste Management</td>
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<td>SWMS</td>
<td>Solid waste Management System</td>
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<td>DSW</td>
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<td>DSWM</td>
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<td>UNEP</td>
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<td>USEP</td>
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<td>ISWM</td>
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1.1 Background

Needless to say, the problem of Solid Waste Management in urban areas is among the major challenges faced by the local bodies in recent times. Over the years, the quantum of waste generated has accelerated with urbanization. (Government, 2008)

Rapid increase in volume and types of solid and hazardous waste as a result of continuous economic growth, urbanization and industrialization, and changing lifestyles, food habits, and change in living standards, is becoming a burgeoning problem for national and local governments to ensure effective and sustainable management of waste.(UNEP, 2009).

Solid Waste Management is one of the primary functions of the urban local bodies. In order to scientifically handle and dispose solid waste, a number of measures are being implemented by the local bodies.(Government, 2008)

Aesthetic, land-use, health, water pollution, air pollution, and economic considerations make proper solid waste management an ongoing concern for municipal, corporate, and individual functions that must be taken seriously by all. Indiscriminate dumping of solid waste and failure of the collection system in a populated community for two or three weeks would soon cause many problems. Odors, flies, rats, roaches, crickets, wandering dogs and cats, and fires would
dispel any remaining doubts of the importance of proper solid waste management. (john, 2003).

The insanitary methods adopted for disposal of solid wastes . and absence of integrated proverb management for disposal of waste and garbage. semi of European were died caused by plague disease and led to a series endemic and epidemic diseases, raising the rates of death, destruction and loss of cultivation and crops.

**Worldwide** in 2009, Americans generated about 243 million tons of trash and recycled and composted 82 million tons of this material, equivalent to a 33.8 percent recycling rate. On average, we recycled and composted 1.46 pounds of our individual waste generation of 4.34 pounds per person per day. (EPA, 2012)

**In developing countries**, it is common to find large heaps of garbage festering all over the city. The problem gets further complicated due to large population and the obsolete techniques employed for waste management (Mbuligwe et. al., 2002). The solid waste is considered to be one of the dangerous causes of pollution; therefore this problem has to be treated in a wise manner to protect our environment (Al-Yaqout et. al., 2002, Vidanaarachchi et. al., 2005).

**In Sudan** individual daily generation of solid waste and garbage from 0.3 to 0.7 kg average 0.5 kg /per day /capital . quality of garbage generation about 0.9 million /
ton. By consider with expecting rapid population growth and economic development in the country, the quality of solid waste and garbage generation up to 150 ton per hour addless industrial waste and production of electronic waste and creasing rate over successive statistical forecasts (Khartoum, 2006).

1.2 Problem Statement

A generation of municipal solid waste, industrial, hazardous waste, biomedical waste have been increasing due to population growth, life style changes and economic development. On the other hand, waste management responses have not kept pace with the increasing quantities of waste resulting in (a) a high proportion of uncollected waste, and (b) poor standards of transportation, storage, treatment and disposal. The insanitary methods adopted for disposal of solid wastes is a serious health concern with significant environmental, social and health costs associated with it. Open dumping of garbage facilitates the breeding of disease vectors such as flies, mosquitoes, cockroaches, rats, and other pests. The poorly maintained landfill sites further, are prone to groundwater contamination because of leachate production.

As the cities are growing in size and problems seen as the generation of plastic waste, various municipal waste treatment and disposal methods are now being used to try resolving these problems. Garbage generation in household can be recycled
and reused to prevent creation of waste at sources and reducing amount of waste thrown into the community dustbins. (WHO, 2000).

The relationship between solid waste and human disease is intuitively obvious but difficult to prove. If a rat is sustained by an open dump, and that rat sustains a flea that transmits murine typhus to a human, the absolute proof of the pathway would require finding the particular rat and flea, an obviously impossible task. Nonetheless, we have observed more than 20 human diseases associated with solid waste disposal sites, and there is little doubt that improper solid waste disposal is a health hazard. Disease vectors are the means by which disease organisms are transmitted, and water, air, and food may all be vectors. The two most important disease vectors related to solid wastes are rats and flies. Flies are such prolific breeders that 70,000 flies can be produced in 1 to 3 of garbage, and carry many diseases like bacillary dysentery. Rats not only destroy property and infect by direct bite, but carry insects like fleas and ticks that may also act as vectors. The plagues of the Middle Ages were directly associated with the rat populations.

Public health is also threatened by infiltration of leachate from MSW disposal into groundwater, and particularly into drinking water supplies. Leachate is formed when rainwater collects in landfills, pits, waste ponds, or waste lagoons, and stays in contact with waste material long enough to leach out and dissolve some of its
chemical and biochemical constituents. Leachate may be a major groundwater and surface water contaminant, particularly where there is heavy rainfall and rapid percolation through the soil. (John, 2003)

1.3 **Justification of the study**

1. Solid waste disposal creates a problem primarily in highly populated areas. The more concentrated the population, as Omdurman city.

2. Solid waste management not only comes from industrial units. It also comes from various sources. Every man with the operation of daily domestic work creates solid waste for disposal.

1.4 **OBJECTIVES**

1.4.1 **General objective**

To Evaluation municipal solid waste management system in Omdurman city

1.4.2 **Specific Objectives**

1. To compare availability of equipment, workers and mechanisms by what is really required according to target population

2. To gather regarding information about management of solid waste from the Head of the Cleansing Section of Omdurman city.

3. To identify the potential of other factors which influence the performance of domestic solid waste management system.
Institutional Setup of Waste Management

Assessing the roles of the various stakeholders is an important step in the MSWM survey. A first step is to identify the main Institutional actors (national Gov, Local Gov. etc.), the private sector stakeholders (formal and informal private sec-tor), the civil society movement (CBOs and NGOs) and finally the citizens. Furthermore it might also be necessary to take "external support agencies" (multilateral, bilateral, development banks, etc.) into account as important stakeholders with power and influence. For each stakeholder the current role and responsibility, the interests and tasks can be determined. This can be obtained for the past, the present and the assumed future development. Methodology of stakeholder analysis and stakeholder mapping is common in development projects and there is much information on the internet on how to conduct such analysis.

Waste Generation and Classification

There are significant differences between solid wastes generated from different sources. Such sources can be:

Households

Solid waste is the consequence of household activities. In some countries, up to two thirds of this category consists of organic wastes (composition). In poor
neighbourhoods traditional cooking can also produce ash, and where sanitation facilities are limited, the waste might also include faecal matter.

**Commercial**

All solid waste emanating from business establishments such as stores, markets, office buildings, restaurants, shopping centres and entertainment facilities. The wastes typically consist of packaging and container materials, used office supplies and food wastes.

**Institutional**

Waste originating in police barracks, schools, hospitals, prisons, research organizations and other public buildings. Where the institution involves residents, the waste composition is similar to those from households. For hospital waste it is important for the management system to implement segregation at the hospitals of toxic and infectious waste and conventional household-type waste. After segregation waste which pose a threat to public health need separate collection and disposal arrangements.

**Street Sweepings**

These always include dust/sand, dirt and litter although in low-income countries they may also contain appreciable quantities of household refuse, drain cleanings, human and animal faecal matter.
Construction and Demolition

The nature of this material depends upon the resources used in a given region or country for the purposes of construction. In the absence of adequate local ordinances, responsibility for the removal and disposal of these wastes is invariably assumed to lie with the municipality.

Industrial

Although strictly speaking management of such waste lies with the responsibility of the industries, often through lack of control and enforcement the wastes end up in the regular municipal waste stream. The wastes are generated from processing and non-processing industries and utilities. Composition is quite site specific and depends upon the natural resources, raw materials and markets which provide the base for a given city’s industrial activity. It may include liquid, sludge, solid or hazardous waste.

Sanitation Residues or `night-soil’

Although not part of the solid waste stream, depending on the level of sewerage provided, human excreta collected from public toilets, latrines or septic tanks (often called faecal sludge) may be dumped in streets drains and therefore arise in drain clearing and street sweeping wastes.

From the same sources quantities of waste generated varies according to: household size, income level season, cultural activities and festivities. Thus it is
important to distinguish these features in a waste generation survey, or then make
sure that a good representative average sample is taken for the category of waste
source.

If collection of primary empirical data is necessary, it is com-mon practice to
undertake analysis in one or more sample areas which are areas significantly
smaller than the whole planning area, but which are representative in some way of
the larger area. However, even in a small city there are many types of areas with
different characteristics, and it is there-fore vital that the chosen sampling areas
reflect the whole system of study. It

Projected waste generation can be obtained with projected population growth and a
factor of "consumption development".

Important waste data may further include:

- waste composition: when considering recycling issues or incineration. In most
cases surveys distinguish between: organic matter, paper & cardboard, plastic,
glass, metal, other. Further details of composition are distinguished depending
on the research question.

- waste density: for determining correlations between waste volume and waste
weight

- waste moisture: which relates to density and is critical with incineration.
Waste Prevention

Waste prevention programmes (qualitative or quantitative) often initiated by government authorities or NGOs can be assessed through specific interview with key persons in these institutions or by review of literature and reports. Main questions to keep in mind are the impact of the programmes and their long term sustainability.

Typical waste prevention measures are taken up through incentives (user pays by amount generated or deposit programmes) or legislation and enforcement (e.g. abolishing plastic bags). For industries such programmes follow up on "clean production" or "ecodesign" programmes which again are induced through potential financial or image benefits. Assessment can include description of the existence and functionality of such tools and measures.

Storage and segregation at source

Household waste management falls into this category of information. Typical data/information include:

- Household storage containers, materials, life span, costs and sizes. Where in the house are these containers located? Are containers shared between various households?
- How and when is waste disposed into these containers (directly or indirectly by ways of heaps in the backyard?)?
What are social cultural habits towards waste, hygiene and cleanliness.

What are roles of the household members in managing wastes? Although most frequently the responsibility of women, children often are the ones that bring the household waste to a larger container or collection point and payment of fees is often the task of men.

Existing segregation of waste fractions at household level gives indication of recyclable materials value and/or environmental awareness. Who segregates? What materials are segregated, how much quantity? What are incentives/revenues of such activities? Who is the counterpart (waste dealer) and what relation-ship exists between household and dealer?

**Waste Collection and Transport**

**Defining Service Levels**

It is important to assess baseline service levels to the various service users. This includes

- coverage
- type of service
  - communal collection
  - block collection
  - kerbside collection
  - door-to-door collection
- frequency of collection
- fees
In the case where household members bring their waste to collection points (communal collection), the average distance to the nearest located point is of special interest.

Most often two steps in solid waste collection can be observed (see figure). A "primary collection", involving waste collection from households and its transport to a transfer site (e.g. a large container or built collection point), and then a secondary collection systems which collects at the transfer site and transports the waste to a final disposal site.

The different types of operating systems can be assessed individually which may have evolved to meet local conditions. This includes an assessment of:

- human resources involved
- equipment for the specific type of service
- equipment maintenance
- organizational structure of service provider
- costs and revenues
- distance to point of transfer (if any)
- distance to disposal site
- collection routing
- frequency of collection at the transfer station
transfer station equipment (type) and hygiene

personnel management, health and safety

communication of service provider with service user, service user with municipality, and service provider with municipality

Street Sweeping

Municipal authorities often provide a range of public cleaning services in association with waste collection. For street sweeping and cleansing services both manual and mechanical methods are available, the former being more typical in developing countries.

In many cities, particularly in medium and low-income areas, a high proportion of street wastes is generated from deficiencies in the waste collection system and littering. Due to the poor coverage of the collection system, some waste is discarded or becomes spread in the street. In essence, this situation transfers the responsibility for removing the wastes from the formal collection crew to the sweeping crew, thereby encouraging further manual handling of waste.

Causes that lead to the large quantities of litter include:

- improper or no clean-up activities after public works
- inappropriate species of plants and trees selected for urban landscaping
- erosion of soil from vacant lots and unpaved streets
- inefficient or non-existent storm drainage systems
accumulation of construction materials and debris on the streets

spillages of waste set out for collection by waste pickers or animals

spillage of collected waste during its transfer to collection vehicles

spillage during vehicle transit where wastes are in-adequately covered

Public Cleansing Services may include:

Street sweeping

Gully emptying

Drain cleaning

Construction and demolition waste removal

Night soil removal

Septic tank / cesspit emptying

Beach and foreshore cleaning

Mud removal

Grass cutting

Waste backlog clearances

Clean up after natural disasters

Litter prevention

Cleaning of public toilets

Other cleaning tasks

Quantitative indicators of street sweeping activities include:
human resources involved

equipment involved

coverage

frequency of sweeping, drain cleaning

amounts of wastes swept

road/drain lengths swept and cleaned

costs and revenues

personnel management, health and safety

Non Organic Materials Recycling

Recycling plays a critical role in reducing waste quantities, returning resources back to use, and minimising the financial and environmental burden of MSWM. Thriving secondary materials markets and recovery schemes are well established in most developing countries. They are usually located in the informal economy and consist of either individuals or groups of waste pickers, or Micro/Small-Enterprises (MSE) and Community-Based Organisations (CBOs).

In many informal recycling systems:

- Newspapers, cardboard and metals are collected from door to door with simple equipment or vehicles such as three wheelers, bicycle carts, which are then sold on to neighbourhood ‘junk’ shops.
Materials are recovered by employees of the municipality (waste collectors) from the refuse, both at the collection point, during collection and transport.

Many families depend on waste picking from dump sites depend for their. They sell to dealers, who often perform some simple sorting and clearing of the recycled materials.

Itinerant buyers sell to the wholesalers who distribute up the dealer chain to primary industries.

Critical issues to assess on the various levels of the recycling chain can be:

- What materials?
- Recovered by whom and where?
- What amounts?
- What cost and revenues?
- What further processing steps?
- Which middle men and dealers and which industries?
- Social organization of waste picker communities?
  
  Social marginalization and health risks of such individuals?

**Organic Materials Recycling**

Organic waste recovery, reuse and/or recycling in a city can be assessed with data and information on:
organic waste generated from different sources. This data can be obtained by waste generation data and waste composition data

Direct use of organic waste, includes direct use for animal feed, or on soil for agricultural production and possibly its seasonality

Existing composting activities on household, neighbourhood or city scale and the amounts of wastes processed, processing systems and resulting quality of compost

Existing users, their location (distance), amounts used/bought, their perceptions and knowledge of compost use and their requirements to compost quality and price

**Disposal**

Existing final disposal practices for MSWM in most countries consist of dumping of MSW (most of the time without any control) in vacant plots/areas of land. In many cases MSW is dumped in low-lying marshy areas, often as a means of raising land levels for development of housing or commercial/industrial units.

Indicators for assessing waste disposal as well as its associated key environmental, heath and safety issues are:

- size and remaining life span of site
- amounts of waste delivered daily
- site management
○ professional site manager with overall responsibility?
○ trained and qualified operational staff?
○ health and safety of workers?
○ measurement of incoming waste?
○ inspection and clearance?
○ clear direction to the tipping face?
○ good access to the tipping face?
○ supervised placement at the tipping face?
○ working areas of operation in small, well-defined cells?
○ compaction of waste?
○ daily cover?
○ communications at the site?
○ proper control and management of waste picking?

☐ equipment on site and its utilization

☐ contamination of water resources from leachate (generated from decomposition of MSW)

☐ location of dump site (often close to community residential areas, drinking water wells, urban water supply intakes, or in sensitive ecological habitats)

☐ levels of odour, dust and visual impact

☐ burning of dump sites causing air pollution
vermin, insects and scavenging animals

scavenging by waste pickers at a dump site

delivery of hazardous, toxic or infectious waste

planning for siting of future landfills and its participatory approach

Financing

In many cities, solid waste management services are provided by a city waste department that is an integral part of the municipal administration. In others, the services are provided by a wholly owned municipal enterprise operating to some extent at arm’s length from the government. In others, although rarely, services are provided by a fully autonomous enterprise (public or private) operating under contract to the government. Each of these arrangements reflects a different level of sophistication in terms of the financing and cost recovery arrangements typically found to be in place.

Where services are provided by a municipal waste department, funds tend to be provided out of the normal municipal budgetary process. Domestic users may make a contribution to the cost of providing the services possibly through a local property tax or a communal services tax (indirect charge) or a user service fee (direct charge). But the amount of funds raised through such mechanisms does not usually relate directly to the cost of service. The waste department is often in the position of having regularly (usually annually) to present its budget request for the
following period. This is then subject to municipal treasury review, and a decision is made on the amount of funds to be allocated. The outcome often reflects as much the budgetary circumstances of the municipal government at the time, and the nature of competing claims on scarce resources, as it does the actual costs involved in providing an efficient service.

It is necessary to establish clearly the existing funding arrangements, both in terms of payments to the service provider and charges to the service users. Sometimes it can be useful to show this diagrammatically (Money fluxes). To assess cost of the waste management system, if possible distinction should be made between expenditures for the various waste elements (e.g. sweeping, collection, treatment, disposal) as well as the different cost types (e.g. capital in-vestment and recurrent costs). Recurrent costs are probably more critical, as it is on this that the financial sustainability of the MSWM system ultimately depends. These costs can be further detailed in cost items such as salaries, fuel, etc., if necessary for the financial assessment.

This can allow determination of costs per tone of waste for the various components of a proposed solid waste management system.

Critical issue to assess furthermore are tariff structures and level of cost recovery and operational system for revenue collection and its effectivness.
There is also the issue of affordability and willingness to pay for MSWM by the waste generators. Annex 6 provides an example of a questionnaire from a willingness to pay survey.

**Affordability**

Two aspects of affordability need to be addressed. The first is whether the whole solid waste management system is generally affordable to the society in which it is being proposed. This question relates to the appropriate or inappropriate approach and technology chosen for the city. The second question is whether user charges proposed to finance the strategy are affordable (or even appropriate) to all members of society. This question relates to whether user charges are affordable to poorer members of society. Payment structures can be designed to reflect different levels of affordability (cross subsidies, that the more wealthy users subsidies the poor; or different levels of service for different charges).

Affordability studies depend on the availability of information on household income and expenditure. This is frequently available from national household surveys undertaken periodically by the statistics agency. Statistics specific to large metropolitan areas can usually be obtained but, if not, then national-level information must be used and adjustments made. When using these surveys care must be taken to ensure that the year to which the data relate is known and that adjustments to the present are made appropriately. Advice from the statistics
agency should be sought when making such adjustments. Other relevant information is sometimes available from government agencies, such as a department of economic development, from international agencies operating in the country, such as the World Bank, or from NGOs. Average income statistics provide an indication of the overall affordability of a strategy to society, but their use can give a distorted picture in a country with a high level of income variability. Income statistics are particularly useful if they are available for different income groups (population quartiles or quintiles) from which the broad characteristics of income distribution can be inferred. These characteristics can include:

- average per capita disposable income for society as a whole
- average per capita disposable income of the poorest group
- the income differential between the richest and the poorest in society
- the relative shares of the richest and the poorest groups in total disposable income
- changes in the distribution of disposable income between survey periods, providing an indication of whether income distribution is becoming more equitable or more skewed

**Willingness-to-pay**

Willingness-to-pay surveys assess what hypothetical MSWM service options different customers would be willing to pay for and, as a result, can show how
much they value different services. Experience has shown that WTP surveys can provide a range of valuable economic information about the customer base and its preferences for MSWM options.

In particular, WTP studies can help:

- estimate people’s willingness to pay for a specific MSWM system, based on the planned improvements
- ascertain consumer satisfaction with the current type and level of MSWM services provided. This information can help devise a number of service enhancing and remedial measures
- identify gaps in public knowledge about a number of MSWM issues that may hinder the implementation of programmes that would ultimately be in the public interest
- collect useful information for the design of future MSWM programmes on current practices priorities over different services and attributes and levels of those services
- minimise the mismatch between what is supplied and what the public wants by increasing the knowledge about the level of MSWM service that the public wants and is willing to pay for
Participation, Environmental Education and Awareness

This section gives information on status in the surveyed city involving:

- Participatory planning", meaning the involvement of the key stakeholders in the planning process
- "Public Consultation", a forum for the public to voice opinions
- "Public Awareness and Education Programme" involving programmes designed to raise public awareness and understanding of the relevant issues with a set of targeted campaigns.

Public Awareness Campaigns are campaigns designed to raise public awareness and knowledge, targeting specific groups and issues of importance to sustainable waste management. These may include:

- participation in the proper use of collection systems (e.g. container or timing of collection).
- participation in keeping their streets and waterways clean (no littering and dumping)
- participation in reducing overall quantities of waste (e.g. waste avoidance or segregation at source and recycling)
- determining willingness to pay to enhance payment of service charges
- participation in landfill site selection
awareness of the potential health, safety and environmental impacts associated with poor waste management or the benefits of recycling and resource conservation.

Assessing awareness campaigns involves looking at:

- Who is/was doing it?
- Who is/was being addressed?
- Which methods and tools are/were applied?
- When is/was it done?

Some of the indicators are:

- number of PA&E activities undertaken in the municipality
- rate of attendance at information events
- number of inquiries from the public
- number of complaints from the public
- general appearance of city (ie, cleaner, less litter)
- amount of coverage of SWM issues in local press, radio, local TV
- awareness of key issues; and
- willingness to cooperate, participate and pay for services
2.1 Introduction of Solid waste

Solid waste is defined as a material that is cheaper to throw away than to store or use. It is no longer considered as wanted material to be dumped out of site. Solid wastes are simply 'material of wrong place', which can be segregated, transformed, recycled and reused with great financial and environmental benefits. Includes any garbage, solid waste, sludge from a waste treatment plant, water supply treatment plant, or air pollution control facility and other discarded material, including solid, liquid, semisolid, or contained gaseous material resulting from industrial, commercial, mining, and agricultural operations and from community activities but does not include solid or dissolved material in domestic sewage or solid or dissolved materials in irrigation return flows or industrial discharges, which are point sources subject to permit under Section 402 of the Federal Water Pollution Act (as amended), or source, special nuclear, or byproduct material as defined by the Atomic Energy Act of 1954, as amended. Also excluded are agricultural wastes, including manures and crop residues returned to the soil as fertilizers or soil conditioners and mining or milling wastes intended for return to the mine. (JOHN, 2003).

Anything that is not of further use in a process is known as waste for that process. That can be useful for other process and can be termed as raw material for that process. So actually waste is a misplaced resource. When this waste is in a
comparatively solid form it is known as the solid waste. Whatever may be the form of waste, it deteriorates the environment if it is disposed in an offensive manner. The waste water and its treatment and disposal have already been discussed.

Solid waste is defined as discarded solid fraction produced from domestic, commercial, trade, industrial, agricultural, institutional, mining activities and public services. The waste is a term that means useless, unwanted or discarded material. (Givil, 2009)

2.2 Sources of Solid Waste

Solid waste is non-liquid waste generated in homes, workshops, by agriculture, industries, mines and elsewhere. Non-liquid is however, a relative issue, since sludge resulting from some wastes is considered solid waste, especially sludge generated from industrial, agricultural, and wastewater treatment plant sources.

Many materials, such as soil, food waste, packaging materials, paper, metals, plastics or glass, the remains of unwanted clothes, furniture, garden wastes, dead animals, construction waste, industrial waste, from manufacturing and cutting processes, medical wastes, and hazardous and radioactive waste make up solid waste.

The weight, density, and content of household wastes differ not only from country to country but also from city to city. Daily household solid waste generated in the Eastern Mediterranean Region per person averages from 250 to 1,200 grams with a
density range from 150 to 360 kg/m³. A material breakdown of solid waste composition revealed the following: putrescible vegetable waste from 30%-85%, inert materials, 2%- 18%, paper, 4%-35%, glass, 0%-8%, metals, 0%-4%, plastics and leather, 0%-3%, worn cloth, 1%-7%, and bone, 0%-4%. (WHO, 2002).

2.3 Solid waste characteristics

The most significant characteristics of solid waste are:

2.3.1 Density of solid waste Density is usually expressed as kg/m³

2.3.2 Moisture content

The moisture content is usually expressed as the weight of moisture per unit weight of wet or dry material. In the wet weight method of measurement, the moisture in a sample is expressed as a percentage of the total weight of the sample.

2.3.3 Chemical Composition

Information on chemical composition of solid waste is important in evaluating processing and recovery options (i.e. Energy recovery, composting process, waste derived fuel, etc.)

2.3.4 Physical composition

Information on physical composition is also necessary in evaluating processing and recovery options.

These characteristics vary widely for the major solid waste components, such as garbage, rubbish, street sweeping, etc.
These characteristics are affected by (1) Type of collection systems, (2) Standard of living, (3) Seasonal and local variables, (4) Extent and type of commerce and industry, (5) Prevailing climate, and (6) other considerations (Srivastrava et. al., 2005).

2.4 Classification of solid waste

The solid waste can be classified as per the Manual on Municipal Solid Waste Management, Government of India publication as follows:

2.4.1 Domestic/Residential waste

This type of waste is originated from single or multifamily household units. These wastes are generated from the household activities such as cooking (ashes) cleaning (dust) repairs (residues), hobbies (unuseables), redecoration, empty containers, used packets, old clothes, books, papers, broken glass, plastic items, broken and useless furniture.

2.4.2 Domestic solid waste

This type of waste is originated from single or multifamily household units. These wastes are generated from the household activities such as cooking (ashes) cleaning (dust) repairs (residues), hobbies (unuseables), redecoration, empty containers, used packets, old clothes, books, papers, broken glass, plastic items, broken and useless furniture. B. E.E(2009).
2.4.3 Municipal waste

Municipal waste includes waste resulting from municipal activities and services such as street sweepings, dead animals, market waste and abandoned vehicles. Generally, this term ‘Municipal Waste’ is used in a wider sense to incorporate domestic wastes, institutional wastes and commercial wastes.

2.4.4 Commercial waste

This category includes solid wastes that originate in offices, wholesale and retail markets, restaurants, hotels, warehouses (godowns) and other commercial establishments.

2.4.5 Institutional waste

These are those wastes generated from institutions such as schools, colleges, universities, hospitals and research institutes. Some of these wastes (like hospitals) may be hazardous (more bad, offensive, strong, disease producing) waste. Actually in India there is hardly any waste collected in this category as it is sold to the kabaries. (Givil, 2009).

2.4.5 Street sweepings

The waste collected from streets, walkways, parks etc. is known as street sweepings. In developing countries like our country manual street sweeping is done and it makes the largest portion of the municipal solid waste as we are in a habit of throwing everything on the streets. It includes mainly dust, dirt, plastic
bags (thin), dry leaves, useless papers, cardboard, rags, tyres, vegetable matter etc. In our country most of the usable portion of the waste like rags, paper, thick plastic bags, plastic utensils, any form of metal is collected by the rag pickers. The organic matter including the paper and even plastic sheets is consumed by cows and other stray animals. Only in big cities or the developed countries they form the part of waste. That is why the calorific value of Indian solid waste is far less in comparison to the other countries. (Rathi et. Al ,2005)

2.4.6 Dead animals

This term includes the dead animals that die naturally or by accidents on roads. It does not include the animal parts from slaughter houses which are regarded as industrial waste. There are two types of dead animals, large and small. The smaller ones like dogs cats rabbits, rats etc., are either consumed by the other animals or can be easily lifted and disposed. The large ones like cows, horses, camels etc. require special and immediate attention as traffic is affected and they emit foul smell.

2.4.7 Industrial wastes

The discarded solid material of manufacturing processes and industrial operations comes in this category. There is a vast range of substances that are unique for each industry so they are considered separately from municipal wastes. (Al- yousfi, 2004)
2.4.8 Hazardous waste

Hazardous waste is defined as wastes of industrial, institutional or consumer origin that, because of their physical, chemical or biological characteristics are potentially dangerous to human beings and the environment. In some cases the active agents may be liquid or gaseous, they are classified as solid waste because they are confined in solid containers. Typical examples are solvents, paints, and pesticides whose spent (empty) containers are frequently mixed with municipal wastes and become part of the urban waste stream. Certain hazardous waste can explode in the incinerators (controlled large kilns) and cause fires at land fill sites. Others such as pathological (disease producing) wastes from hospitals and radioactive waste, require special handling at all times. Proper management practice should ensure that hazardous wastes are collected, stored, transported and disposed off separately, preferably after treatment to make them harmless. (Givil, 2009).

2.4.9 Sewage waste

The solid by-products of sewage treatment are classified as sewage wastes. They are mostly organic and produced from the treatment of organic sludge from both the raw and treated sewage. The inorganic fraction of raw sewage such as grit is separated at the preliminary stage of treatment, but because it entrains putrescible organic matter that may contain disease producing bacteria (pathogens), must be buried or disposed off quickly. (Buenrostro et. al., 2001).
2.4.10 Mining and quarrying wastes

Mine tailings or spoils are the waste material that is extracted in the process of mining minerals of economic value. The waste materials may include topsoil, rock and dirt. It may be inert, such as material from china clay mining, but mine tailings from ore extraction are contaminated with metals or chemicals that have been used for mineral separation. Mechanisation of the underground mining process has also increased the amount of spoil reaching the surface and needing disposal. Reduction in spoil from mechanised extraction seems unlikely in the developed world, and the amount of spoil arising in developing countries could increase substantially with rising mechanisation rates. Arising of mining wastes is likely to be of some significance in many developing countries where extraction and processing of minerals are important economic activities (Givil, 2009).

2.4.11 Garbage

Garbage is the term applied to animal and vegetable wastes generated from the handling, storage, sale, preparation, cooking and serving of food. Such wastes contain putrescible (easily and quickly biodegraded with bad smell) organic matter. This attracts rats, flies, mosquito and other vermin, that is why it requires immediate attention.
2.4.12 Rubbish

It is a general term applied to solid wastes originating in households, commercial establishments and institutions excluding garbage and ashes.

2.4.13 Ashes

These are the residues from the burning of wood, coal, charcoal, coke and other combustible matter for cooking and heating in houses institutions and small industries. When produced in large quantities in thermal power plants (fly ash) they are known as industrial wastes. Ashes consists of fine powdery residue, cinders and clinkers often mixed with small pieces of metal and glass.

2.4.14 Bulky waste

Bulky wastes are large household wastes that cannot be accommodated in the normal storage containers of the household and thus they require special collection.

2.4.15 Construction and demolition waste

These are the wastes generated by the residue of the construction, refurnishment, repair and demolition of houses, commercial buildings and other structures. Generally, the demolition waste is used by the contractors in filling low lying areas and the plinth filling of new houses and nothing is left on the sites. Even then some small quantity of sand, stone or concrete may be left. (Givil, 2009).
2.5 Quantities and composition of solid wastes

Because solid waste is generated from many different sources, it naturally contains an almost infinite variety of materials. These range in size from specks of dust to discarded automobiles. The major constituents of domestic and commercial wastes are fermentable organic matters; glass, paper, wood, metals and plastic with relative proportion depending upon many local factors. (Huang et. al., 2005).

**table 2.1 Quantities of Solid Waste for different income groups**

<table>
<thead>
<tr>
<th>Composition % by weight</th>
<th>Low income countries</th>
<th>Middle income countries</th>
<th>High income countries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metal</td>
<td>0.2 – 2.5</td>
<td>1 – 5</td>
<td>3 - 13</td>
</tr>
<tr>
<td>Glass, ceramics</td>
<td>0.5 – 3.5</td>
<td>1 – 5</td>
<td>4 – 10</td>
</tr>
<tr>
<td>Food and garden waste</td>
<td>40 - 56</td>
<td>20 - 60</td>
<td>20 – 50</td>
</tr>
<tr>
<td>Paper</td>
<td>1 – 10</td>
<td>15 – 40</td>
<td>15 - 40</td>
</tr>
<tr>
<td>Textiles</td>
<td>1 – 5</td>
<td>2 - 6</td>
<td>2 – 10</td>
</tr>
<tr>
<td>Plastic/Rubber</td>
<td>1 – 5</td>
<td>2 – 10</td>
<td>2 - 10</td>
</tr>
<tr>
<td>inert</td>
<td>20 – 50</td>
<td>1 - 30</td>
<td>1 – 20</td>
</tr>
<tr>
<td>Density (Kg/Cu.m)</td>
<td>250 – 500</td>
<td>170 – 330</td>
<td>100 – 170</td>
</tr>
<tr>
<td>Moisture content</td>
<td>40 – 80</td>
<td>40 – 60</td>
<td>20 - 30</td>
</tr>
<tr>
<td>Waste generation Kg/capita/day</td>
<td>0.4 – 0.6</td>
<td>0.5 – 0.9</td>
<td>0.7 – 1.8</td>
</tr>
</tbody>
</table>

(WHO, 2002).
Quantities of solid waste discarded each day vary through the week according to whether it is the weekend, shopping days or holidays. They also vary through the season depending on the availability of fresh fruit and vegetables. Solid waste composition and quantities also vary over the year with changes in diet, packaging, etc. Residents of large towns also seem to throw away more than the people in small towns. In short, the general rule is that as one goes from a small poor traditional, illiterate community to a large, rich, modern, and literate one, the refuse weight becomes more, the food preparation waste becomes less, the paper and packaging fraction increases and the average particle size increases (Osams, 2006).

2.6 Waste generation, density and sources

Waste is produced by households, shops, markets, businesses, medical centres and distribution points. Generation rates vary considerably according to seasons, diets (e.g. changes from fresh vegetable to packaged aid goods) and even the day of the week. An average of around 0.5kg/capita/day is common in low-income cities. Waste densities also vary considerably. Densities for low-income cities are usually around 200-400 kg/m3. Where lots of packaging is used in emergency situations, densities are likely to decrease (WHO, 2002).
2.7 Solid Waste and Health

The unsanitary disposal of solid waste generates health problems. Leachate from landfills can pollute groundwater. This is a major health concern. Improperly disposed of hazardous waste and trace metals also contribute to groundwater pollution problems. Leachate related health problems are difficult to identify, and once these problems arise, they are more difficult and costly to correct. Rain penetrates the soil covering solid waste in landfills and forms leachate. As the rain seeps through the buried waste, water soluble chemicals may be dissolved. The leachate then may enter the groundwater system. The content and concentration of the leachate will vary depending on local conditions. Yet, there are certain common problems. Carbon dioxide generated from the decomposition of solid waste in solution, can form carbonic acid; which can dissolve rock that protects groundwater aquifers. This can lead to contamination. Other gases in landfills include methane, hydrogen sulfide and hydrogen. These gases are dangerous to vegetation. Methane when mixed with air can be explosive. Hydrogen sulfide is both toxic and smells bad. If organic matter is degradable, it can become food and/or a breeding site for flies and rats, creating vectors, for many diseases. Less degradable wastes offer shelter for rodents, mosquitoes, dogs and cats. Runoff may carry litter and dissolved waste
to bodies of surface water. Additionally, solid waste can cause fire, flooding and navigation hazards. Dangerous situations can arise when there is a lack of control over the types of waste placed in landfills and open dumps. Many wastes now considered hazardous have been buried in landfills. Safeguards requiring hazardous waste landfills to use water-impermeable liners and leachate collection systems have not yet been applied to all sanitary landfills. (WHO, 2002).

2.8 Solid waste collection

Collection cost has been estimated to represent about 50 to 70 percent of the total cost of solid waste management, depending on the disposal method. Because the cost of collection represents such a large percentage of the total cost, the design of collection systems must be considered carefully. The type of service provided, the frequency of service, and the equipment used for collection are considered in the following discussion.

2.8.1 Type of Service

The type of collection service provided will depend on the community solid waste management program. Typical examples of the types of collection service provided for the collection of (1) commingled and (2) source-separated and commingled wastes. It should be noted that numerous other variations in the service provided
have been developed to meet local conditions. In addition to routine collection services, annual or semiannual special collections for appliances, tires, batteries, paints, oils, pesticides, yard wastes, glass and plastic bottles, and “spring cleaning” have proven to be an appreciated community service while at the same time providing environmental protection. (Buenrostro et. Al., 2001).

2.8.2 Collection Frequency

The frequency of collection will depend on the quantity of solid waste, time of year, socioeconomic status of the area served, and municipal or contractor responsibility. In residential areas, twice-a-week solid waste collection during warm months of the year and once a week at other times should be the maximum permissible interval. In business districts, solid waste, including garbage from hotels and restaurants, should be collected daily except Sundays (see Figure 5-6). Depending on the type of collection system, the containers used for the on-site storage of solid waste should be either emptied directly into the collection vehicle or hauled away emptied and returned or replaced with a clean container. Solid waste transferred from on-site storage containers will invariably cause spilling, with resultant pollution of the ground and attraction of flies. If other than curb pickup is provided, such as backyard service, the cost of collection will be high. Nevertheless, some property owners are willing to pay for this extra service. Bulky wastes should be collected every three months. Most cities have also instituted
ongoing programs for the collection of household hazardous wastes, typically every three months. (Augenstein et. al, 1996).

2.8.3 Types of Collection Systems

Solid waste collection systems may be classified from several points of view, such as the mode of operation, the equipment used, and the types of wastes collected. Collection systems can be classified, according to their mode of operation, into two categories: (1) hauled container systems and (2) stationary container systems. The individual systems included in each category lend themselves to the same method of engineering and economic analysis.

2.8.4 Hauled Container Systems (HCSs)

These are collection systems in which the containers used for the storage of wastes are hauled to a materials recovery facility (MRF), transfer station, or disposal site, emptied, and returned to either their original location or some other location.

2.8.5 Stationary Container Systems (SCSs)

In the stationary container system, the containers used for the storage of wastes remain at the point of generation, except when they are moved to the curb or other location to be emptied. Stationary container systems may be used for the collection of all types of wastes. The systems vary according to the type and quantity of wastes to be handled as well as the number of generation points.
2.8.6 Transfer and transport

The urban areas around cities have been spreading, leaving fewer nearby acceptable solid waste disposal sites. The lack of acceptable sites has led to the construction of incinerators, resource recovery facilities, or processing facilities in cities or their outskirts or the transportation of wastes longer distances to new landfill disposal sites. However, as the distance from the centers of solid waste generation increases, the cost of direct haul to a site increases. A “distance” is reached (in terms of cost and time) when it becomes less expensive to construct a transfer station or incinerator at or near the center of solid waste generation where wastes from collection vehicles can be transferred to large tractor-trailers for haul to more distant disposal sites. Ideally, the transfer station should be located at the centroid of the collection service area. (USA, 2003).

2.8.7 Economic Analysis of Transfer Operations

A comparison of direct haul versus the use of a transfer station and haul for various distances is useful in making an economic analysis of potential landfill sites. The transfer station site development, transportation system, and social factors involved in site selection should also be considered in making the comparison.

2.8.8 Service Coverage for Waste Collection

MSW collection schemes of cities in the developing world generally serve only a
limited part of the urban population. The inhabitants who are left without waste collection services are usually in the low-income population. Lack of financial resources and planning capacity to cope with increasing urban population growth affects the availability or sustainability of a waste collection service. Operational inefficiencies, inappropriate technologies, or deficient management capacity of the institutions involved also give rise to inadequate service levels. With regard to the technical system, often the conventional collection approach—developed and used in industrial countries is applied. The vehicles are sophisticated, expensive, and difficult to operate and maintain, and after a short time of operation usually only a small part of the fleet remains in operation.

More and more, involving private companies in SWM is seen as an easy way out. However, an important factor in the success of private sector participation is the ability of the client—usually a municipal administration—to write and enforce an effective contract. Three key components of successful arrangements are competition, transparency, and accountability. As an alternative to large (often international) companies that can provide most or all of the solid waste services in a city, microenterprises, small enterprises, or community-based organizations (CBOs) can provide services at the community level (neighborhoods or the small city administrative zones). They use simple equipment and labor-intensive
methods; therefore, they can collect waste in places where the conventional trucks of large companies cannot enter. (World Bank, 2008).

2.8.9 Access to Waste for Collection

Many sources of waste are inaccessible, reached only by roads or alleys unsuited for certain methods of transport because of their width, slope, congestion, or surface. Those barriers are especially critical in unplanned settlements, such as slums or low-income areas, and thus largely affect the selection of equipment.

2.8.10 Awareness and Attitudes

Public awareness of and attitudes toward waste can affect the entire SWM system. All steps in SWM from household waste storage to waste segregation, recycling, collection frequency, amount of littering, willingness to pay for services, and opposition to the siting of treatment and disposal facilities—depend on public awareness and participation. Thus, awareness and attitudes are crucial to the success or failure of a SWM system.

2.8.11 Institutions and Legislation

Institutional issues include current and anticipated legislation and the extent to which laws are enforced. Standards and restrictions may limit the technological options that can be considered. Government policy on the role of the private sector (formal and informal) should also be taken into account. The strength and concerns
of trade unions can also have an important influence on what can be done.(who.eh.2002).

2.9 Solid Waste Management

The systematic administration of activities that provide for the collection, source separation, storage, transportation, transfer, processing, treatment, and disposal of solid waste.

2.9.1 Source Reduction

Refers to reducing the amount of waste generated that must eventually be discarded, including minimizing toxic substances in products, minimizing volume of products, and extending the useful life of products. Requires manufacturers and consumers to take an active role in reducing the amount of waste produced.

2.9.2 Source Separation

The segregation of various materials from the waste stream at the point of generation for recycling. For example, householders separating paper, metal, and glass from the rest of their wastes.

2.9.3 Transfer Station

A facility with structures, machinery, or devices that receives deliveries of solid waste by local collection vehicles and provides for the transfer of the waste to
larger vehicles that are used to deliver the waste to a recycling, treatment, or disposal site. (John, 2003).

2.9.4 Waste to Energy Incineration

Disposal method in which municipal solid waste is brought to a plant where it is burned either as received or after being processed to a more uniform fuel to generate steam or electricity. Waste-to-energy plants can decrease volume by 60 to 90 percent while recovering energy from discarded products. Mass burn, modular combustion units, and solid-waste-derived fuel are the three basic waste-to-energy plants used. (John, 2003).

2.10 Integrated Solid Waste Management

Integrated Solid Waste Management (ISWM) is a comprehensive waste prevention, recycling, composting, and disposal program. An effective ISWM system considers how to prevent, recycle, and manage solid waste in ways that most effectively protect human health and the environment. ISWM involves evaluating local needs and conditions, and then selecting and combining the most appropriate waste management activities for those conditions. The major ISWM activities are waste prevention, recycling and composting, and combustion and
disposal in properly designed, constructed, and managed landfills. Each of these activities requires careful planning, financing, collection, and transport, all of which are discussed in this and the other fact sheets.

2.10.1 Waste Prevention is a low-waste approach

Waste prevention—also called “source reduction”—seeks to prevent waste from being generated. Waste prevention strategies include using less packaging, designing products to last longer, and reusing products and materials. Waste prevention helps reduce handling, treatment, and disposal costs and ultimately reduces the generation of methane. That tries to reduce the amount of solid waste by reusing, recycling, or not using in the first place. To achieve this, the public should be educated to see solid waste as a resource for useful materials and wealth. The economic system is utilized to discourage waste production and encourage pollution prevention. The main goal of this approach is to reduce the depletion of resources and environmental pollution caused by resource extraction, manufacturing and use. Its goals are ordered, i) prevent creation of waste, ii) reuse things as much as possible, iii) recycle and compost as much as possible, iv) incinerate, or treat what cannot be utilized and v) bury what is left after the first four goals have been met.
2.10.2 Disposal (landfilling and combustion)

These activities are used to manage waste that cannot be prevented or recycled. One way to dispose of waste is to place it in properly designed, constructed, and managed landfills, where it is safely contained. Another way to handle this waste is through combustion. Combustion is the controlled burning of waste, which helps reduce its volume. If the technology is available, properly designed, constructed, and managed landfills can be used to generate energy by recovering methane. Similarly, combustion facilities produce steam and water as a byproduct that can be used to generate energy. (EPA, 2009).

2.10.3 Incineration of solid waste

The coupling of waste incineration with energy recovery is gaining increasing attention, where incinerators are used to burn waste as a fuel to produce steam or electricity. In most of these incinerators, waste is burned without separating hazardous or noncombustible materials. This can interfere with incineration conditions and pollute the atmosphere. Hazardous wastes should be burned alone, where traps for particulates, scrubbers for toxic gases, like chloride and high combustion efficiencies are required. Incineration of waste kills microorganisms and reduces its volume by 60% or more. Yet, it is not, without problems. Even in the presence of air pollution control equipment, incinerators release toxic
materials, which are hazardous to health and produce diseases such as cancer and neurological disturbances. (WHO, 2002).

2.10.4 Dealing with Solid Waste

We can deal with solid waste through waste management and waste prevention.

Waste management is an approach that encourages waste production and then attempts to manage this waste in ways that reduce environmental harm by burning or burying. This approach is also called the high waste approach. Its efficiency is, however, not so high. The best designed, waste incinerators release toxic products into the air and leave toxic residue that must be buried in landfills. Even the best designed landfills, produce leachates that seep into the groundwater. In time, we will run out of affordable or politically acceptable sites for burying or incinerating.

The basic problem is that modern economic systems reward those who produce waste instead of those who try to use resources more efficiently. Subsidies such as tax writeoffs are given to timber, mining and energy companies to cut trees, discover and mine metals and energy sources. At the same time, such subsidies are seldom given to companies that recycle materials, or use energy resources more efficiently or find alternatives to fossil fuels. (world bank, 2008).
2.10.5 Recycling

Recycling can be done by high or low-technology methods. In high-technology methods, machines are used to shred and automatically separate mixed waste to recover valuable materials such as iron, glass, etc. These materials are sold to manufacturers to be used as raw materials. Combustible wastes such as: paper, plastics, wood, etc., can be recycled or burned. The resulting heat is used to produce steam or electricity. In low-technology methods, separation of solid waste is done manually. Homes and businesses put different kinds of wastes into separate containers. Compartmentalized collection trucks are used to pick up the segregated wastes to be sold. Recycling is an important step in waste prevention, yet it reinforces the "throw-away" mentality. (World Bank, 2008).

2.10.6 Reuse

An important step in waste prevention is the repeated reuse of a product in its original form. Refillable glass bottles, for example can be used tens of times. If collected and refilled at local plants, they save on transportation and energy costs. To encourage the reuse of refillable glass bottles, companies have a beverage container deposit fee. In some places, reuse of refillable glass bottles has been so successful that bottles as old as 10 years continue to circulate. Metallic or plastic, lunch boxes once used by workers and students are another reusable container.
Nowadays, however, most people carry their lunches in throwaway plastic bags. At the workplace, we can make use of reusable glasses, cups, utensils, tissues and other reusable items. Other reusable containers are; plastic, metallic or straw, garbage cans, which can be rinsed out as needed, eliminating the need for throwaway plastic liner bags.(world bank, 2008).
3.1 Study area

Sudan is a country in North Africa that is often considered to be part of the Middle East as well, it is bordered by Egypt to the north, the Red Sea to the northeast, Eritrea and Ethiopia to the east, South Sudan to the south, the Central African Republic to the southwest, Chad to the west, and Libya to the northwest.
Location

Omdurman (Standard Arabic Umm Durmān) is the second largest city in Sudan and Khartoum State, lying on the western banks of the River Nile, opposite the capital, Khartoum. Omdurman. It consider is the national centre of commerce. With Khartoum and Khartoum North or Bahri, it forms the cultural and industrial heart of the nation.

1) Alahfyah Bridge          (12) Dr.Sallma Street
2) Bahri Bridge              (13) Karror Street
3) Kharoum Bridge           (14) Al-khala Street
4) Alfteehab Bridge         (15) Alwadi Street
5) Sabbrin Markert          (16) Alahfyah Street
6) Alshinqueety Market      (17) Alshinqueeti Street
7) Omdurman Market          (18) Dungla Street
8) Alshapy Market           (19) Alwagha Street
9) Libiya Market            (20) Alaarda Street
10) Alnil Street
11) Bannat Street

Fugre(3.2) Map of Omdurman city, sudan
Table 3.1 population of Omdurman city by localities

<table>
<thead>
<tr>
<th>Locality</th>
<th>Number of block areas</th>
<th>population</th>
</tr>
</thead>
<tbody>
<tr>
<td>ombdh locality</td>
<td>250</td>
<td>1,304,437</td>
</tr>
<tr>
<td>Omdurman locality</td>
<td>196</td>
<td>555,131</td>
</tr>
<tr>
<td>karary locality</td>
<td>201</td>
<td>1,500,000</td>
</tr>
<tr>
<td>Total</td>
<td>647</td>
<td>3,359,568</td>
</tr>
</tbody>
</table>

It divided into three localities, divided them-self into administrative units includes (647) residence area, as the following
Table (3.2) population for Omdurman city by Administrative unites

<table>
<thead>
<tr>
<th>administrative unit</th>
<th>Number of block areas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alameer</td>
<td>29</td>
</tr>
<tr>
<td>Alsalam</td>
<td>66</td>
</tr>
<tr>
<td>Albugah</td>
<td>37</td>
</tr>
<tr>
<td>Soog leebya</td>
<td>46</td>
</tr>
<tr>
<td>Alreef algarby</td>
<td>72</td>
</tr>
<tr>
<td>Wad-nobawi</td>
<td>17</td>
</tr>
<tr>
<td>Almouradah</td>
<td>14</td>
</tr>
<tr>
<td>Abo-annga</td>
<td>15</td>
</tr>
<tr>
<td>Alfiteehab</td>
<td>14</td>
</tr>
<tr>
<td>Abo-siead</td>
<td>48</td>
</tr>
<tr>
<td>Hy-alarab</td>
<td>68</td>
</tr>
<tr>
<td>Alreef aljanobi</td>
<td>20</td>
</tr>
<tr>
<td>Alreef alshurgy</td>
<td>69</td>
</tr>
<tr>
<td>Karary</td>
<td>93</td>
</tr>
<tr>
<td>Althawra</td>
<td>39</td>
</tr>
<tr>
<td>total</td>
<td>647</td>
</tr>
</tbody>
</table>

(Omdurman, obadah, and Karary locality, 2012).
3.2 Study design

This study descriptive cross-sectional localities-based.

3.3 study Period

The time period of this study was began from February 2012 and completed to June 2012.

3.3 Data collecting

- interviews targeted a total of (3) key person at localities, many questions were designed in order to get information about budget, workers, method of final disposal, and other information relating the study (see 7-2)
- two questionnaires yet simple, were designed, pretested, and modified to collect data. the first one was for households in order to get the public opinion on the problems of municipal solid waste management in Omdurman city. The questionnaire covered sociodemographic variables as well as variables related to knowledge, attitudes, and practices on management of solid wastes among people living in the district. The interviews were conducted from door to door and questions were targeted to either the head of the household or the spouse. In situations where none of them was present, either the oldest child or a relative (provided he\she will be above 15 years). the second questionnaire targeted the operation officer
in administrative units in order to get information about the present situation of MSW quantities, composition, generation, handling, environmental impacts, treatment and disposal, in the district. A total of (19) key person were interviewed, as total covered.

- Report refer to reports at the level of localities and administrative units in Omdurman city, that for get information about population, families, collection vehicles, staff, and quantity of product solid waste.
- Observation used checklist According to standard which consider on solid waste management system for workers, and Transfer stations, and landfill.

Table 3.3 Determination material of data collection method

<table>
<thead>
<tr>
<th>Target method</th>
<th>Manager of locality</th>
<th>Operation officer at administrative units</th>
<th>locality</th>
<th>population</th>
</tr>
</thead>
<tbody>
<tr>
<td>interview</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Questionnaire</td>
<td></td>
<td>19</td>
<td></td>
<td>400</td>
</tr>
<tr>
<td>Report</td>
<td></td>
<td></td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>Observation and checklist</td>
<td>According to standard which consider on domestic solid waste management system</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
3.4 Determination of Sample Size

Type of sampling used was stratified random sample.

Table (3.4) Population and number of households for omdurman city by localities 2012

<table>
<thead>
<tr>
<th>Locality</th>
<th>Households</th>
<th>Population</th>
</tr>
</thead>
<tbody>
<tr>
<td>Karary locality</td>
<td>270314</td>
<td>1,304,437</td>
</tr>
<tr>
<td>Omdurman locality</td>
<td>138782</td>
<td>555,131</td>
</tr>
<tr>
<td>Ombdh locality</td>
<td>298921</td>
<td>1,500,000</td>
</tr>
<tr>
<td>Total</td>
<td>708017</td>
<td>3,359,568</td>
</tr>
</tbody>
</table>

The formula for determination of sample size is

\[ n = \frac{z^2 \times p \times q}{d^2} \]

Where

- \( n \) is the desired sample size.
- \( z \) is the standard normal score from the normal distribution at 95% level of confidence. It is 1.96 or approximately 2.
P is the anticipated proportion of the concepts (knowledge and awareness of the families towards the domestic solid waste management system (50%).

q is completion proportion (50%).

d is marginal size of error (5%)

\[ n = \frac{2^2 \times 50 \times 50}{5^2} = 400 \]

Table (3.5) The formula for determination of sample size include localities by name, number of families in population, Percent of families in population and number of families in sample

<table>
<thead>
<tr>
<th>Locality</th>
<th>No. Households in population</th>
<th>Percentage</th>
<th>Sample size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Karary locality</td>
<td>270,314</td>
<td>38%</td>
<td>153</td>
</tr>
<tr>
<td>Omdurman locality</td>
<td>138,782</td>
<td>20%</td>
<td>78</td>
</tr>
<tr>
<td>Ombdh locality</td>
<td>298,921</td>
<td>42%</td>
<td>169</td>
</tr>
<tr>
<td>Total</td>
<td>708,017</td>
<td>100%</td>
<td>400</td>
</tr>
</tbody>
</table>
3.5 Data Analysis

Data will be summarize into tables and analyze using suitable computer techniques.
(4.1) results of interviews with localities managers of solid waste management in Omdurman city.

☑ The workers collection in localities without any training and they do not train later to do their job.

☑ Landfill was far about 20 kilometers north Omdurman city to get rid of waste.

☑ Available budget for operation about 70%.

☑ Localities dose not easily find workers when needing.

(4.2) Observed check-list on workers collection in localities and landfill and Environmental consideration in Omdurman city.

☑ workers were not wear special uniform during collection process.

☑ Dumpsite was unprotected from the entrance of people and animals.

☑ open dumps without any further treatment and segregation of domestic slold waste.

☑ Localities not used containers as method for keeping waste.
4.3. Reviewing results of reports

Table (4.1) Income (according to stratified distribution of Omdurman city)

<table>
<thead>
<tr>
<th>Locality</th>
<th>No. Families in population</th>
<th>Percent of Families in population</th>
<th>Income level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Omdurman locality</td>
<td>138,782</td>
<td>20%</td>
<td>upper</td>
</tr>
<tr>
<td>Karary locality</td>
<td>270,314</td>
<td>38%</td>
<td>middle</td>
</tr>
<tr>
<td>Ombdh locality</td>
<td>298,921</td>
<td>42%</td>
<td>lower</td>
</tr>
<tr>
<td>Total</td>
<td>708,017</td>
<td>100%</td>
<td></td>
</tr>
</tbody>
</table>

The table above showed that, approximately 20% of population were from upper and high social economic status, and 38% were from middle social economic status, while 42% were from the low social economic status respectively.
Table (4.2) Quantity daily produced of domestic solid wastes management in Omdurman locality in the year 2011.

<table>
<thead>
<tr>
<th>Total daily produced Quantity (Ton)</th>
<th>Average household daily production (kg)</th>
<th>Average daily production per capita (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>566.230</td>
<td>4.08</td>
<td>0.68</td>
</tr>
</tbody>
</table>

The table above showed that, total daily produced of garbage in Omdurman locality was 1040 ton, 3.48 kg per household per day and the average daily produced per capita about 0.58 kg.
Table (4.3) Quantity daily produced of domestic solid wastes in Karary locality in the year 2011.

<table>
<thead>
<tr>
<th>Total daily produced Quantity (Ton)</th>
<th>Average household daily production (kg)</th>
<th>Average daily production per capita (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1005.568</td>
<td>3.72</td>
<td>0.62</td>
</tr>
</tbody>
</table>

The table above showed that, total daily produced of garbage in Karary locality was 1005.568 ton, 3.72 kg per household per day and the average daily produced per capita about 0.62 kg.
Table (4.4 ) Quantity daily produced of domestic solid wastes in ombadah locality in the year 2011.

<table>
<thead>
<tr>
<th>Total daily produced Quantity (Ton)</th>
<th>Average household daily production (kg)</th>
<th>Average daily production per capita (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1040.245</td>
<td>3.48</td>
<td>0.58</td>
</tr>
</tbody>
</table>

The table above showed that, total produced of garbage per day in Obadah locality was 1040 ton, 3.48 kg per household per day and the average daily produced per capita about 0.58 kg.
Table (4.5) Quantity daily produced of domestic solid wastes management

(Omdurman city by localities, 2011)

<table>
<thead>
<tr>
<th>Locality</th>
<th>Total daily produced Quantity (Ton)</th>
<th>Average household daily production (kg)</th>
<th>Average daily production per capita (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Omdurman</td>
<td>566.230</td>
<td>4.08</td>
<td>0.68</td>
</tr>
<tr>
<td>Karary</td>
<td>1005.568</td>
<td>3.72</td>
<td>0.62</td>
</tr>
<tr>
<td>Ombadah</td>
<td>1040.245</td>
<td>3.48</td>
<td>0.58</td>
</tr>
<tr>
<td>Total</td>
<td>2662.143</td>
<td>3.76</td>
<td>0.63</td>
</tr>
</tbody>
</table>

Results in table above shows that, average daily produced garbage per household (kg) in Omdurman locality household produced 4.8 kg per day, in karary locality 3.72 kg per day, and in ombadah locality 3.48 kg per day.
Table (4.6) domestic solid waste management collection workers street scavenges workers. (Omdurman city by localities, 2011)

<table>
<thead>
<tr>
<th>Locality</th>
<th>Collection workers</th>
<th>street scavenges workers</th>
<th>Total of workers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Omdurman</td>
<td>533</td>
<td>59</td>
<td>533</td>
</tr>
<tr>
<td>Karary</td>
<td>608</td>
<td>67</td>
<td>608</td>
</tr>
<tr>
<td>Ombadah</td>
<td>683</td>
<td>75</td>
<td>683</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1824</strong></td>
<td><strong>201</strong></td>
<td><strong>1824</strong></td>
</tr>
</tbody>
</table>

shows that the number of domestic solid waste management collection workers was 1824 divided between the localities work as collectors to keep the city clean, and the number street scavenges workers 201.

<table>
<thead>
<tr>
<th>Locality</th>
<th>Number of collection Vehicles</th>
<th>Vehicles drivers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Omdurman</td>
<td>45</td>
<td>62</td>
</tr>
<tr>
<td>Karary</td>
<td>57</td>
<td>69</td>
</tr>
<tr>
<td>Ombadah</td>
<td>65</td>
<td>75</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>167</strong></td>
<td><strong>206</strong></td>
</tr>
</tbody>
</table>

The results to the table above revealed that, the number of collection vehicles in Omdurman city was 167 vehicl and number of vehicles drivers was 206 driver.
The table above shows that, the number of Health officer is 34, technical is 71, and adjacent supervisor 150.
4.1.2 results of questionnaires

Table (4.9) Distribution of survey respondents

<table>
<thead>
<tr>
<th>Type of respondents</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Head of the house</td>
<td>133</td>
<td>33</td>
</tr>
<tr>
<td>Adult sons over 18 years</td>
<td>204</td>
<td>51</td>
</tr>
<tr>
<td>Children between 15 and 18 years</td>
<td>63</td>
<td>16</td>
</tr>
<tr>
<td>Total</td>
<td>400</td>
<td>100%</td>
</tr>
</tbody>
</table>

The result showed by the table above that, distribution of survey respondents, whither

Exactly 33% of respondents were heads or spouses of the households, while

children between 15 and 18 years represented 51%, and adult sons above 18 years

represented 16%. with their willing to separate domestic solid waste into organic

and inorganic.
Table (4.10) Distribution of respondents according to educational level

<table>
<thead>
<tr>
<th>Level of education of respondents</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Illiteracy</td>
<td>1</td>
<td>.25</td>
</tr>
<tr>
<td>Primary</td>
<td>37</td>
<td>9.25</td>
</tr>
<tr>
<td>Secondary</td>
<td>157</td>
<td>39.25</td>
</tr>
<tr>
<td>Undergraduate</td>
<td>189</td>
<td>47.25</td>
</tr>
<tr>
<td>Postgraduate</td>
<td>16</td>
<td>4</td>
</tr>
<tr>
<td>Total</td>
<td>400</td>
<td>100</td>
</tr>
</tbody>
</table>

shows that approximately Illiteracy .25% Primary 9.25% Secondary 39.25% Undergraduate 47.25 Postgraduate 4%, between respondents. were cross tabulated with other factors. such as Willingness to separate domestic solid waste into organic and inorganic percentage 93% . and also possibility to volunteer percentage 7% of respondents were participate to better services.
Table (4.11) Willingness to separate DSW into organic and inorganic

<table>
<thead>
<tr>
<th>Willingness to separate waste into 2 components</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>328</td>
<td>82</td>
</tr>
<tr>
<td>No</td>
<td>72</td>
<td>18</td>
</tr>
<tr>
<td>Total</td>
<td>400</td>
<td>100%</td>
</tr>
</tbody>
</table>

The table above shows that, possibility of respondents if they were Willingness to separate domestic solid waste (DSW) into organic and inorganic in (DSW) system for better services, 82% said yes, and just 18% refuses to participate and said no.
Table (4.12) Residents participate in DSWM for better service

<table>
<thead>
<tr>
<th>Do you participating</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>372</td>
<td>93%</td>
</tr>
<tr>
<td>No</td>
<td>28</td>
<td>7%</td>
</tr>
<tr>
<td>Total</td>
<td>400</td>
<td>100%</td>
</tr>
</tbody>
</table>

Results in table above shows that, possibility of respondents if they were participate in domestic solid waste (DSWS) for better services, 93% said yes, and just 7% refuses to participate and said no.
Table (4.13) Types of activities If residents participate

<table>
<thead>
<tr>
<th>Type of participation</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>By work</td>
<td>7</td>
<td>2.0</td>
</tr>
<tr>
<td>By money</td>
<td>372</td>
<td>100</td>
</tr>
<tr>
<td>other</td>
<td>0</td>
<td>0.0</td>
</tr>
<tr>
<td>total</td>
<td>372</td>
<td>102%</td>
</tr>
</tbody>
</table>

The table above showed that, 2% of residents said they participated by work, 100% of residents bay money.
### Table (4.14) Satisfaction with the existing MSW services

<table>
<thead>
<tr>
<th>Satisfaction with the existing MSW services</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>146</td>
<td>63.5</td>
</tr>
<tr>
<td>No</td>
<td>254</td>
<td>36.5</td>
</tr>
<tr>
<td>Total</td>
<td>400</td>
<td>100%</td>
</tr>
</tbody>
</table>

The table above shows that, 38.6% of household served by waste collection are satisfied with the existing system but they would prefer a higher frequency of collection, 63.5% of households are relatively satisfied and they wish for a better improvement in the existing services, 36.5% of households are not satisfied with the existing services.
Table (4.14) Reasons of un satisfaction with the existing MSW services

<table>
<thead>
<tr>
<th>Reasons of un satisfaction with the existing MSW services</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Irregular collection of waste</td>
<td>38</td>
<td>14.9</td>
</tr>
<tr>
<td>They do not splash the streets</td>
<td>21</td>
<td>8.3</td>
</tr>
<tr>
<td>Absent of waste containers</td>
<td>173</td>
<td>68.2</td>
</tr>
<tr>
<td>Other</td>
<td>3</td>
<td>0.01</td>
</tr>
<tr>
<td>Every thing mentioned</td>
<td>19</td>
<td>7.5</td>
</tr>
<tr>
<td>Total</td>
<td>254</td>
<td>100%</td>
</tr>
</tbody>
</table>

The table above illustrate where 14.9% say locality had Irregular collection of waste, 8.3% say they do not splash the streets, 68.2% Absent of waste containers, 0.01 Other, 7.5% of respondents say all resont mentioned make them un satisfied.
Table (4.16) Road condition that reach the household

<table>
<thead>
<tr>
<th>Road condition</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paved</td>
<td>174</td>
<td>71.5</td>
</tr>
<tr>
<td>Not paved</td>
<td>226</td>
<td>28.5</td>
</tr>
<tr>
<td>Total</td>
<td>400</td>
<td>100%</td>
</tr>
</tbody>
</table>

The above table noticed that, 71.5% of the roads condition that reach houses were paved, while 28.5 was unpaved.
**Table 4.17 Periodical visit of transportation vehicle per week**

<table>
<thead>
<tr>
<th>Visit per week</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>once</td>
<td>74</td>
<td>18.5</td>
</tr>
<tr>
<td>Twice</td>
<td>136</td>
<td>34</td>
</tr>
<tr>
<td>Three time</td>
<td>184</td>
<td>46</td>
</tr>
<tr>
<td>More than three</td>
<td>6</td>
<td>1.5</td>
</tr>
<tr>
<td>Total</td>
<td>400</td>
<td>100</td>
</tr>
</tbody>
</table>

The above table showed that 18.5% of household in Omdurman city had once visit by vehicle per week, 34% twice, 46% three time and 1.5 of houses had more than three visit per week.
Table (4.18) Satisfaction of reasons about services

<table>
<thead>
<tr>
<th>Level of cleaning</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excellent</td>
<td>52</td>
<td>13</td>
</tr>
<tr>
<td>Good</td>
<td>192</td>
<td>48</td>
</tr>
<tr>
<td>Bad</td>
<td>136</td>
<td>34</td>
</tr>
<tr>
<td>Unknown</td>
<td>20</td>
<td>5</td>
</tr>
<tr>
<td>Total</td>
<td>400</td>
<td>100</td>
</tr>
</tbody>
</table>

The table above illustrate 48% of residents said services was good and 34% assessing services bad.
The table above illustrate that, ownership of the land of the dumpsite was owned to government.
Figure (4.20) resources of budget of domestic solid waste in Omdurman city

The figure above revealed that, sources of support DSWS in Omdurman city was 70% bayed by citizens and 30% comes from localities.
Figure (4.21) components of domestic solid waste by volume

The figure above showed that, majority of components of domestic solid waste by volume in Omdurman city was 54% dust and ashes, while 32% organic waste.
Figure (4.22) Composition of domestic solid waste by volume in Khartoum state

Result in figure above showed that, the volume of organic waste was 32%, and non organic was 68% in Khartoum state.
Figure (4.23) percentage of household covering by services

The result showed to the figure above that the services of domestic solid waste covered 95% of households in Omdurman city.
Discussion

Table (4.1) shows that approximately 20% of the population were from upper and high social economic status, and 38% were from middle social economic status, while 42% were from the low social economic status respectively. The result of table (4.5) shows that average daily produced garbage per household (kg) in Omdurman locality household produced 4.8 kg per day, in Karary locality 3.72 kg per day, and in Ombadah locality 3.48 kg per day. From this table observed that garbage generation rate in localities was approximate. This is attributed to approximate in living standards, economical activities in the city, population density, and approximate in income too.

Table (4.10) shows that approximately Illiteracy 25% Primary 9.25% Secondary 39.25% Undergraduate 47.25 Postgraduate 4%, between respondents were cross tabulated with other factors such as Willingness to separate domestic solid waste into organic and inorganic percentage 93% and also possibility to volunteer percentage 7% of respondents were participate to better services. (A comparison of direct haul versus the use of a transfer station and haul for various distances is useful in making an economic analysis of potential landfill sites. The transfer station site development, transportation system, and social factors involved in site selection should also be considered in making the comparison). (World Bank, 2008)
Results in table (4.9) shows Distribution of survey respondents, whether Exactly 33% of respondents were heads or spouses of the households, while children between 15 and 18 years represented 51%, and adult sons above 18 years represented 16%. with their willing to separate domestic solid waste into organic and inorganic. this practice is familiar in household. Local authorities should explore the possibility of the potentially high willingness of people towards home composting as revealed in this study. If implemented properly, home composting would be a sustainable solution for small local authorities with waste generation, (Public awareness of and attitudes toward waste can affect the entire SWMS), (WHO,2002).

Table (4.11) shows that possibility of respondents if they were Willingness to separate domestic solid waste (DSW) into organic and inorganic in (DSW) system for better services, 82% said yes, and just 18% refuses to participate and said no. with higher education between citizens they were willing to separate waste into five components. So education factor plays a positive parameter. table (4.14) shows that 38.6% of household served by waste collection are satisfied with the existing system but they would prefer a higher frequency of collection, 63.5% of households are relatively satisfied and they wish for a better improvement in the existing services, 36.5% of households are not satisfied with the existing services because of the reasons shown in table (4.15), where 14.9% say locality had
Irregular collection of waste, 8.3% say they do not splash the streets, 68.2% Absent of waste containers, 0.01 Other, 7.5% of respondents say all resont mentioned make them unsatisfied. Table (4.16) shows that 93% of respondents contribute to solid waste management system by pay the money, officials estimate this amount about 70% of the required budget per month, which developing waste management activities to provide better services, and this unagree with the (Augenstein et. al, 1996). (The frequency of collection will depend on the quantity of solid waste, time of year, socioeconomic status of the area served, and municipal or contractor responsibility).

Discussion with local authority's staff responsible of domestic solid waste revealed difficulties in finding workers who accept to work in waste collection; said salary is low, so many persons refuses to work in such a job due to its low salary and because most sudanese consider this job a low status job, and people were Shamed of the career.

Analyzing the questionnaire of the local authority revealed that the percentage of households covered by domestic solid waste management collection service, ranges between (90%) where the average percentage of households covered by DSW collection service of omdurman city was 95%. MSW collection schemes of cities in the developing world generally serve only a limited part of the urban population. (Word Bank, 2008) the non-coverage of the remaining households is
due to the lack of a requisite number of equipment and vehicles and the absence of paved roads to reach these households. That mains about 5% of households non-coverage in sites areas of Omdurman city about 148 ton daily of garbage were careless, this would soon cause many problems, Odors, flies, rats, roaches, crickets, wandering dogs and cats, and fires would dispel any remaining doubts of the importance of proper solid waste management. (John, 2003). transportation of MSW includes carrying wastes from transfer stations for disposal to processing units. Observation dumpsite found on distance estimated about 20km, was very large do allow further treatment estimated 300m. controlled dumping may be the only option available at the moment, but officers said they were working to establish an effective strategy to make the disposal sites have the longest possible life estimated about 50 years. should focus not only on technical operation at the site, but also on waste diversion that will include source reduction, recycling, and waste transformation through composting, aim to save the public and the environment at risk from underground and surface water contamination, toxic smoke and waste blown by the wind, vectors, etc. Such a practice should not continue because it is not environmentally acceptable, and it makes the useful life of a disposal site even shorter. (EPA, 2009) The economic reason for taking care that disposal sites have the longest possible life is that, once these sites are filled new ones usually can be found only at a greater distance and this increases
transportation cost considerably, which accounts for the major share of overall cost. Still, however, burning of waste releases toxic gases such as dioxins, that pollutes the air and contaminates the ground water (WHO, 2000).

Moreover, during our visit to the dumpsite we noticed that the dumpsite is not protected from the entrance of people and animals, and this is a serious problem, because animals eat polluted waste from the dumpsite, and children searching the waste for metal, but we know that localities dispose their medical waste with MSW without treatment, which puts the animals and children under the risk of being infected with many diseases.

**Key persons at localities** affirmed that the cost of waste management is covered by a direct fee on households that is collected monthly about 70% of general budget collected with a special tariff, then local managers asked; said that it is not enough because the majority of that money is spent as salaries to staff and laborers, fuel for vehicles and vehicle maintenance. Because the localities have very limited financial estimated about 30% of general budget. Receiving late From table (4.7) shows that the number of collection vehicles in Omdurman district was 167 vehicles and drivers of collection vehicles was 206. From the table it is observed that the vehicles serve less people in the city than, due to the higher collection frequency in the city, better life style, high living standards and economical activities in the city. Moreover it was noticed that in the city the
municipality use larger collection vehicles capable of serving more people than the smaller vehicles used by the villages and this technique helps in better service and according to (World Health Organizationm,2002).

From table (4.16) it was noticed that 28.5% of the roads are not paved and this phenomenon make it difficult for the waste vehicle to enter these roads and increase the maintenance fees and pollutes the air and the surrounding houses with dust, but some of these roads with a small width and prevent the vehicles to enter, also we can notice that 100% of households do not have a container even far away from the household all localities do not use containers and collect the waste from door to door, and the citizen puts the waste sacks out of the house without knowledge about the collection time which may be more than once a week ,the table (4.17) shows the difference between answers of respondents. This practice may be the reason of wide spread of insects, rodents, wild animals and may cause disease. Proper management practice should ensure that hazardous wastes are collected, stored, transported and disposed off seprately, preferably after treatment to make them harmless.,(Givil, 2009).
(6.1) Conclusion:

Although of motive in dumpsite selected were appropriate in terms of location and space, with primary segregation waste in two components organic and non-organic; The study found that, little consideration of environmental impacts. The method of disposal by covers the waste with a thin layer of soil. None of the dumpsites meet the basic requirements in protecting ground water from pollution by leachate as they have no liners, Inspection and monitoring of the dumpsites was not consistent, dumpsite is not protected from the entrance of people and animals, and this is serious problem, because animals eats polluted waste from the dumpsite, and children searching the waste for metal, which puts the animals and children under the risk of being infected with many diseases.

Local authorities employ workers in the MSW services without any training and they do not train them later to do their work but they obtain the experience from experiment and from their companion, so they are usually exposed to a great danger.

The local authorities often are faced with financial difficulties in meeting the large payment of wages, fuel and maintenance of vehicles, and the to complete the loss of equipment, machinery, and staff.

Rapid population growth has overstretched the capacity of local authorities to adequately provide services often provided. In spite of the high coverage rate of
waste services to all citizens, MSW collection frequency in some blocks is around or below 2 times per week. The improvement of MSW collection and disposal capacity needs a broader approach to address the improvement of local infrastructure; including the need to upgrade roads leading to station dumpsite. Community involvement through neighborhood groups of people regardless of income can pay money, and provide the needed solution in mobilization of community-based efforts. Other measures include cultivation of a sense of clean environment through clean community awareness programming. These can go a long way in sensitizing people to keep the environment clean. Regular activities such as clean up of the neighborhoods, schools, parks and roadsides can be effective in changing the citizen's attitudes even among the poor communities. Socio-economic characteristics may determine attitudes such as the ability, willingness to recycle MSW. These attitudes, however, may be positively influenced by awareness-building campaigns and educational measures. In a word, it is the desire of the people that can keep the locality clean.

One of the objectives of the project was to provide information on the arisings of potentially recyclable or compostable materials contained in domestic solid waste system in Omdurman district. The results obtained indicate that still now not been application to processes recyclable or compostable materials.
(5.2) **Recommendations**

1. Collection frequency must be increased and organizing house to house collection of garbage through any of the methods, like containerized collection, central bin collection, house to house collection, collection at regular pre-informed timings and scheduling.

2. For Segregation of domestic solid waste local authorities shall organize awareness programs for segregation of wastes to ensure full community involvement of waste segregation and shall encourage recycling, reuse of segregated materials.

3. Vehicles transportation shall meet criteria such as complete to required number to fill shortage, disclose of vehicles, the storage facilities shall be daily attended for clearing and shall be covered to prevent flying of wastes out of the vehicle.

4. Storage facilities shall be designed that waste stored is not exposed to open atmosphere and being covered to prevent flying of waste out of the waste container and to keep animals far from waste and must be designed to be easy to handle for the collection vehicle.

5. Public participation: Involvement of public and private sector in waste management is required in order to develop public understanding to reduce the treatment cost, and increasing the MSW fees because most citizens are willing to pay more for better services.
6. Education and safety of DSW employees: Localities should provide to their employees an education about personal hygiene and protective measures and learn them about hazards and their reduction and prevention to raise awareness about health and safety so to decrease the risk in their job.
References


20. وزارة البيئة والتنمية العمرانية ادارة المخلفات المنزلية بمنطقة الخرطوم الكبرى- ا. م سعيد حاج النور احمد

Appendices (1)

جامعة الجزيرة
كلية العلوم الصحية والبيئية
ماجستير العلوم في الصحة العامة وصحة البيئة
استمارة استبانة علي مستوي الأسر
حوّل تقييم نظام إدارة النفايات المنزلية بمدينة أم درمان

رقم الاستبانة (  )

اخي المواطن الكريم اخي المواطنة

انا الطالب علي احمد عبدالله، طالب ماجستير في الصحة العامة والطروحة الماجستير التي اعمل علي دراستها تتعلق بكيفية نظام ادارة النفايات المنزلية بمدينتكم – مدينة أم درمان.

ان استجابتك وموضويعتك في الإجابة علي هذه الاستبانة سوف تساعد في جعل هذا البحث العلمي دقيقا وتوصلنا علي افضل النتائج، فقم بالمشاركة في خبراتك.

شكرا لمساعدتي ........................................................ مع خالص تقديري لكم

1. الاسم .................................................................

2. النوع  
- ذكر ( )  
- اثلي ( )
3. السكن
   - الحارة رقم ( )
   - مربع رقم ( )

4. المستوى التعليمي للمجيب على الأسئلة؟
   أ- أمي ( )
   ب- خلوة ( )
   ج- ابتدائي ( )
   د- مرحلة اساسية ( )
   ه- ثانوي ( )
   خ- جامعي ( )
   ف- فوق الجامعي ( )

5. هل تشارك في حملات النظافة بالحي؟
   - نعم ( )
   - لا ( )

6. إذا كانت الإجابة نعم، ما هو نوع المشاركة؟
   - بالمال ( )
   - بالجهد ( )
   - غير محدد ( عبر اللجان )

7. هل الطريق المؤدي إلى المنزل؟
   - معبد ( )
   - غير معبد ( )

8. هل الطريق المؤدي إلى المنزل؟
   - أقل من 2متر ( )
   - من 2-3متر ( )
   - من 3-4متر ( )

9. كم يبلغ عرض الطريق المؤدي إلى المنزل؟ (بالمتر)
   - أكثر من 4متر ( )

10. ما هي وسيلة حمل النفايات؟
    - اكياس نايلون ( )
    - جوالات ( )
    - أخرى ( )

11. كيف يتم حفظ النفايات المنزلية؟
    - أمام المنزل ( )
    - حافة الرصيف ( )
    - حاويات ( )
    - أخرى ( )
12- ما هي وسيلة نقل النفايات؟

ا- ترلات
ب- عربات كابسة
ج- عربات كاشفة
د- اخرى

13- ما هو عدد المرات التي تزوركم فيها العربة؟

ا- مرة في الأسبوع
ب- مرتين في الأسبوع
ج- ثلاث مرات في الأسبوع
د- أكثر من ذلك

14- كيف تتعرف علي زمن وصول عربة النفايات؟ اسهم صافرة

15- هل الرسوم التي تدفعها مقابل خدمة التخلص من النفايات؟

ا- مناسبة
ب- أقل من الخدمة المقدمة
ج- باهظة

16- في حالة تأخر عربة النفايات

ا- احتفظ بالقمامة داخل المنزل
ب- القيها امام المنزل
د- اخرى

17- هل ترى مستوى النظافة بالحي؟

ا- ممتاز
ب- جيد
ج- رديء

18- هل انت راض عن الخدمة؟

ا- نعم
ب- لا

19- هل يتم تكهن شارعكم?

ا- نعم
ب- لا

20- هل تقوم بفرز النفايات المنزلية الى نفايات عضوية ونفايات غير عضوية

ا- نعم
ب- لا
جامعة الجزيرة
كلية العلوم الصحية والبيئية
ماجستير العلوم في الصحة العامة وصحة البيئة
استمارة استبانة علي مستوي قطاعات محلية كرري
حول تقييم نظام إدارة النفايات المنزلية بمدينة ام درمان
رقم الاستبانة (     )

انا الطالب علي احمد عبد الله، طالب ماجستير في الصحة العامة واطروحة الماجستير التي اعمل على دراستها تتعلق بكيفية نظام إدارة النفايات المنزلية بمدينتمك - مدينة ام درمان. ان استجابتك وموضوعيتك في الإجابة علي هذه الاستبانة سوف تساعد في جعل هذا البحث العلمي دقيقا وتوصلنا علي أفضل النتائج، فقم بالمشاركة في خبراتك.
شكرا لمساعدتي
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اسم المصلحة الحكومية: محلية القطاع

1. منصب المجيب على الاستبانة هو: ..............................................................

2. عدد المنازل المستهدفة .................................................................

3. متى يتم عملية الجمع؟
   أ - صباحا ( )    ب - ظهرا ( )    ج - مساءا ( )    د - غير ذلك ( )

4. هل تم إعلام السكان بمواقع الجمع من قبل الوحدة الإدارية؟
   أ - نعم ( )    ب - لا ( )

5. ما هي الأسس التي تم الاعتماد عليها في تحديد وقت الجمع؟
   أ - حالة الشوارع ( )    ب - بناءاً على طلب السكان ( )    ج - غير ذلك ( )

6. ما هو متوسط كمية النفايات التي تجمعوها؟...........................................

7. كيف تم عملية جمع النفايات؟ عن طريق
   أ - التفريغ المباشر للحاوية ( )    ب - تبديل الحاوية المعبئة بحاوية خالية ( )
   ج - الجمع من منزل لمنزل ( )    د - أكثر من طريقة وضع ذلك ( )

8. كيف تم اعتماد خطة سير سيارة النفايات أثناء عملية الجمع؟
   أ - عشوائيًا ( )    ب - بناءاً على دراسة ( )    ج - غير ذلك ( )
10. ما هو عدد النقلات في يوم جمع اعتيادي؟

أ- نقلة واحدة (  )  ب- نقلتين (  )  ج- ثلاث نقلات (  )  د- غير ذلك (  )

11. هل تقومون بتوزيع معدات لجمع النفايات بالمنازل؟ أ- نعم (  )

12. إذا كانت الإجابة نعم ما هي؟ أ- أكياس بلاستيكية (  )

13. كم يبلغ العمر الافتراضي لادوات الجمع (المقاطف،المكبات، الكرك)

أ- أسبوع (  )  ب- اسبوعين (  )  ج- ثلاث اسابيع (  )  د- أكثر حدد (  )

15. كيف يتم التخلص من النفايات في المحلية بعد جمعها؟

أ- حرق (  )  ب- دفن (  )  ج- مكبات مفتوحة (  )  د- غير ذلك (  )

17. إذا كانت الإجابة نعم كيف يتم جمع هذه الرسوم؟

أ- شهريًا مع رسوم الماء والكهرباء (  )  ب- سنويًا (  )  ج- فاتورة خاصة بالنفايات (  )  د- غير ذلك (  )

18. كيف يتم توزيع الحاويات؟

أ- بشكل عشوائي (  )  ب- بناءً على المخطط الهيكلي (  )  ج- بناءً على التجمعات السكنية (  )  د- غير ذلك (  )

19. ما هو معدل المسافة بين الحاوية والآخر؟

أ- من 20 – 50 متر (  )  ب- 50 – 100 متر (  )  ج- غير ذلك (  )

20. هل يتم حرق الحاويات من قبل المواطنين؟

أ- نعم (  )  ب- لا (  )  ج- أحياناً (  )

21. عند تفريغ الحاوية هل تكون؟

أ- ممتلئة جداً (  )  ب- ممتلئة (  )  ج- نصفها (  )  د- ربعها (  )

22. عند تفريغ الحاوية هل يكون هناك نفايات متناثرة حولها؟

أ- نعم (  )  ب- لا (  )  ج- أحياناً (  )

23. هل يتم رش الحاويات بالمبيدات الحشرية المناسبة؟

أ- نعم (  )  ب- لا (  )  ج- أحياناً (  )