Chapter 3

Survey on Waste Composition and Properties of Waste

3. Survey on Waste Composition and Properties of Waste

3.1 Objectives

The Survey on Composition and Properties of Waste was undertaken to determine the composition and physical properties of residential and market waste generated in the Central District. The study focused on determining the following:

- composition
- uncompacted specific weight
- moisture content
- residual ash content
- energy content

a. Composition of Waste

Composition of the waste is necessary for current and future planning. As the economic status of Central District citizens change, the composition of waste will also change, thus resulting in different solid waste management requirements.

Variations in composition affect the feasibility of the introduction of new intermediate treatment and final disposal technologies

Amounts of recyclable materials (aluminum, paper, plastic, and glass) are estimated to assess the feasibility of recycling and reuse programs. Additionally, the amount of combustible and non-combustible material is necessary to assess the feasibility of incineration or energy conversion.

b. Uncompacted Specific Weight

The uncompacted specific weight (USW) is necessary to assess the total mass and volume of waste that must be managed. USW is important for planning the type of collection vehicles, the number and size of containers, and landfill compaction. For example, if MSW has a high USW the effectiveness of compactors is reduced.

c. Moisture Content

Moisture content, along with USW, is important for the design of collection and disposal of MSW. Further, knowledge of moisture content of MSW is necessary when analyzing the energy value of waste as well as its potential for composting.

d. Residual Ash Content

Residual ash content is determined to assess the feasibility of incineration and is used in some formulas for estimating energy content.

e. Energy Content

Energy content of the waste is estimated to assess the feasibility of using MSW as an energy source. Energy content is also important in accessing the combustibility of MSW.

3.2 Methodology

As noted above samples of waste were collected from 60 households and 2 markets over seven consecutive days. These samples in their original uncompacted condition were then analyzed to determine the composition and physical properties of the waste.

As also noted, in this study, emphasis was placed on residential MSW. The following categories of waste were analyzed.

- residential waste from high income areas
- residential waste from middle income areas
- residential waste from low income areas
- market waste

Waste samples collected during the WACS (refer to section 22) were then used for the analyses of composition and physical properties. The frequency of the MSW analysis is shown in Table 3-1.

Samples of market waste from the two main markets were obtained from dump trucks hauling the waste to the disposal site. Waste from the dump trucks was randomly selected.

Table 3-1: Frequency of MSW Analysis

Type of waste	Composition	Physical Properties
· residential waste (High Income) · residential waste (Middle Income) · residential waste (Low Income) · market waste	1 sample/day x 7 days for each type of waste	once for each type of waste

Collected samples from the high income area were mixed together resulting in a sample size of 40- 50 kg. Then the volume of the mixture was reduced as described below until the sample size was approximately 15 liters. This process was repeated for waste from middle and low income areas, and the markets.

a. Reduction Method

Step1 Mixing: When the waste contained large particles (e.g. cardboard, textiles, etc.) those items were cut into smaller pieces and mixed again. Cutting the waste into smaller pieces was carried out to obtain an even mixture.

Step2 Dividing: Once the waste was mixed well, it was divided into four segments of approximately the same size.

Step3 Reduction: The two segments of waste diagonally opposite each other were removed and the remaining waste was mixed again.

Step4 The above steps were repeated till the volume of the remaining waste had been reduced in size to approximately 15 liters.

Step5 The waste sample was then put into a calibrated plastic bucket and dropped 3 times from a height of 30 centimeters. The volume and weight were then recorded.

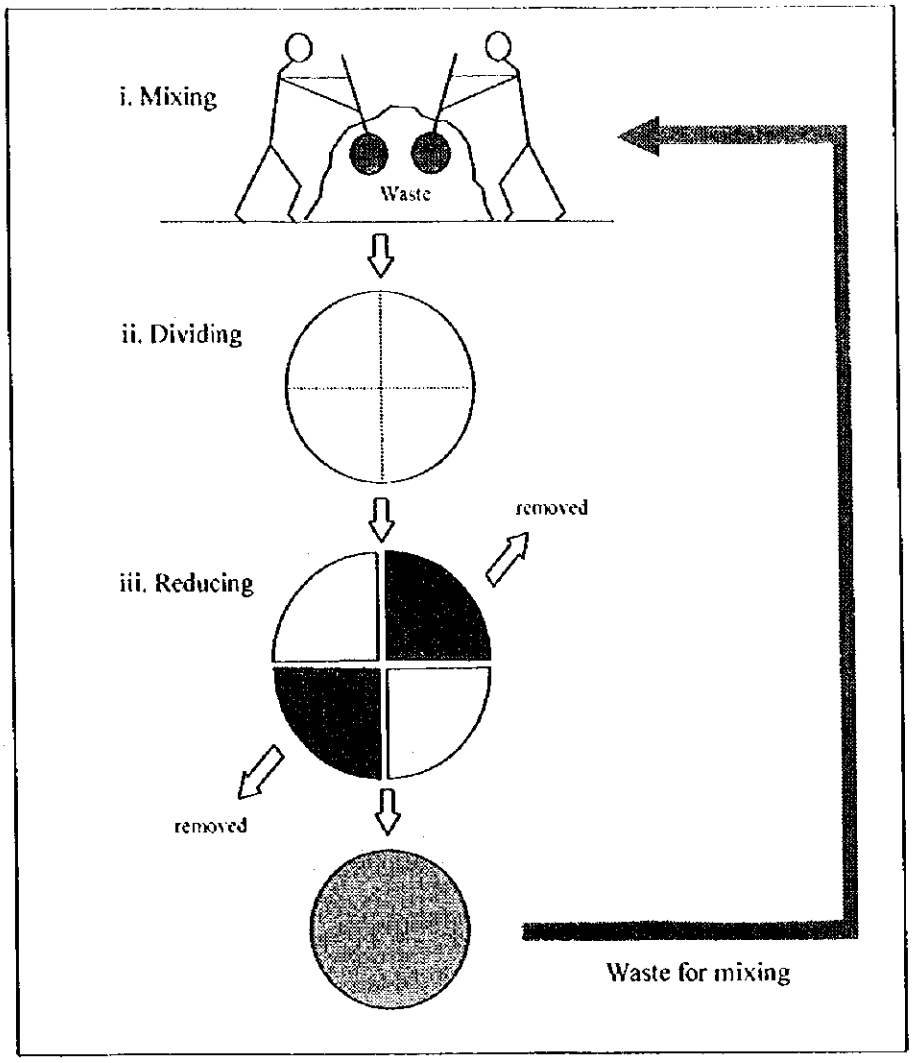

Figure 3-1: Mixing, Reduction, and Separation of Waste Samples

b. Uncompacted Specific Weight

Subsequently the uncompacted specific weight of the waste sample was calculated with the following formula.

$$\text{Uncompacted Specific Weight} = \frac{\text{Wet Weight of Waste}}{\text{Volume of Waste}}$$

c. Composition

The physical composition was measured in the "wet base" (*as discarded* state, before the waste had a chance to dry). The above samples were divided into the following 10 components, and the weight of each measured.

- food waste
- paper and cardboard
- textiles
- plastics

- grass and wood
- leather and rubber
- metals
- glass
- ceramics and stone
- other (dust, dirt, etc.)

After measuring the weight, the samples were dried for three days or in an oven at 105°C, and then the weight of each item was measured again.

The results of the physical composition are presented as percentages by weight.

d. Moisture Content

The moisture content was calculated by the following formula.

$$\text{Moisture Content}(\%)=\frac{\text{Original Weight}-\text{Dry Weight}}{\text{Original Weight}}\times 100$$

e. Residual Ash Content

The components were then incinerated to calculate the percentage of ash that remains following incineration. The residual ash content was calculated by the following formula.

$$\text{Residual Ash Content}(\%)=\frac{\text{Original Weight}-\text{Weight of Ashes}}{\text{Original Weight}}\times 100$$

f. Energy Content

Because it was not possible to measure the energy content of waste using a bomb calorimeter the energy content of residential and market waste was approximated using two formulas: the modified Dulong formula and the Karisato empirical formula.

Modified Dulong formula is a theoretical formula where the energy content is determined based on the chemical properties of the waste. It is therefore sensitive in variations in quantities of particular types of combustible waste.

$$\text{Energy Content} = 81C + 342.5\left(H - \frac{O}{4}\right) + 22.5S - 6(9H + W)$$

C = carbon, %

H = hydrogen, %

O = oxygen, %

S = sulfur, %

W = moisture content, %

The Karisato formula on the other hand is an empirical formula that is basically insensitive to variations in the proportions of combustibles with the exception of plastics, which are highly combustible.

$$\text{Energy Content} = 45B + 8R - 6W$$

E: energy content, calories/gram

B: combustible portion excluding plastic, %

R: plastics portion, %

W: moisture content, %

3.3 Results

Table 3-2 shows the composition as it is generally presented, waste components are included with moisture content.

Table 3-2: Composition and Physical Properties

Category	Components	Residential Waste (%)				Market Waste (%)
		High income	Middle income	Low income	Weighted Average	
Combustibles	Food wastes	51.2	54.4	37.9	47.2	82.8
	Paper and CB	12.9	12.7	10.1	11.5	6.7
	Textiles	2.0	1.9	3.8	2.8	0.0
	Plastic	6.2	8.3	6.7	7.1	2.7
	Grass & Wood	16.5	10.0	10.6	11.6	2.9
	Leather & Rubber	0.4	0.00	4.2	2.2	0.1
	Sub-total	89.2	87.2	73.3	82.4	95.3
Incombustibles	Metal	2.8	1.1	1.9	1.9	0.2
	Glass	4.5	2.3	3.8	3.5	0.1
	Ceramic & stone	3.5	9.3	21.0	12.1	4.4
	Others	0.0	0.2	0.0	0.1	0.0
	Sub-total	10.8	12.8	26.7	17.6	4.7
Uncompacted Specific Weight (kg/l)		0.21	0.20	0.19	0.20	0.3
Moisture Content (%)		52.8	42.8	38.8	46.5	68.5

In Table 3-3 the moisture contents of components have been removed giving the actual dry mass of waste components. Residual ash content results are also given.

Table 3-3: Dry Composition and Residual Ash Content

Waste component	Dry mass of components (%)				RAC (%)
	High income	Middle income	Low income	Market	
combustibles	**37.4**	**44.7**	**35.7**	**27.8**	-
food waste	10.4	21.6	8.9	21.0	5.0
paper & cardboard	10.0	9.2	6.1	3.7	6.0
textiles	1.8	1.6	3.5	0.0	3.2
plastics	5.8	6.7	5.6	1.9	0.4
grass & wood	9.1	5.7	7.8	1.0	6.3
rubber & leather	0.3	0	3.7	0.1	15.0
incombustibles	**9.8**	**12.5**	**25.5**	**3.7**	-
metals	2.6	0.9	1.9	0.2	-
bottles and glass	4.5	2.3	3.7	0.1	-
ceramics and stone	2.6	9.1	20.0	3.4	-
other	0.0	0.2	0.0	0.0	-
moisture content	**52.8**	**42.6**	**38.8**	**68.5**	-

From the dry weights and the chemical composition the lower energy content using the two formulas was calculated.

Table 3-4: Lower Energy Content

Method	High	Middle	Low	Average	Market
Karisato (calories/gram)	1568	1987	1568	1683	908
Dulong (calories/gram)	1522	1956	1668	1615	747

3.4 Findings

Residential Waste

The properties of the composition of residential waste are described as follows:

- Food wastes constitute the greatest portion, 47.2%, of residential waste. The proportion of food wastes in low income areas is the lowest at 37.9%.
- The percentage of paper and cardboard, 11.5%, is approximately equal to the percentage of grass and wood, 11.6%, as the second largest constituent of residential waste. The percentage of grass and wood is noticeably higher in the high income area.
- Ceramics and stone constitutes 21.0% of the waste from low income areas. During the seven days of the survey, ceramics and stone ranged between 14 and 36% of low income waste. Course sands and rocks being the main constituent of this component.
- From Table 3-3 it can be seen that the total amount of recyclable materials (paper and cardboard, plastic, metals, and glass) make up approximately 23% of waste of high income areas, 19% of middle, and 17% of low income areas. Only 6% of waste from markets is potentially recyclable.

Market Waste

- Market waste was found to be predominantly composed of foods waste (i.e. food scraps). The proportion of incombustibles is very low at 4.7%.

Uncompacted Specific Weight (USW)

The USW weighted average for residential waste is about 0.20 kg/l for the three areas, and 0.25 kg/l for market waste. Though the USW is expected to increase during the rainy season the results obtained are consistent with those from other cities in lower income countries.

Moisture Content

Moisture contents of residential waste vary between 39% and 53% having a weighed average of 46.7%. The moisture content of market waste was higher at 68.5%. Higher figures correspond to the higher percentages of food wastes.

Residual Ash Content

Percentages of ashes remaining after incineration ranged between 0.4% for plastics and 15% for leather and rubber. These figures are normal for MSW from lower income countries.

Lower Energy Content

The results of the two formulas correspond with each other. Market waste, with the highest moisture content (68.5%), has the lowest energy content. Residential waste from middle income areas, on the other hand, has the highest percentage of combustibles and the lowest moisture content and thus has the highest energy content.

Chapter 4

Disposal Amount Survey

4. Disposal Amount Survey

The existing disposal site does not have a weighbridge which gives us reliable data of waste disposal amount. The objective of the Disposal Amount Survey (DAS) is, therefore, to determine the amount of municipal waste currently being disposed at the final disposal site. This information is integral for the development of the waste stream.

4.1 Survey in February 1998

4.1.1 Methodology

- The main survey method used to determine the disposal amount was the Vehicle Weighing Survey.
- Cleansing Department disposal records were used to provide information on the number and types of vehicles disposing waste at the final disposal site.

The method of the vehicle weighing survey is simple. Vehicles entering and exiting the landfill were randomly weighed on the portable truck scale in order to determine the average weight of waste being carried by the different types of vehicles disposing waste.

The number of times each type of vehicle was weighed, was estimated based on the frequency each type of vehicle entered the final disposal site.

Table 4-1: Number of Times weighed

Vehicle	Times Weighed
Compactors	74
Dump trucks	141
Arm-roll truck	10
Hoist truck	12
Private vehicles	33

Once each vehicle's average load weight is determined, the amount of waste carried over any period of time can be determined by multiplying average load weight by the number of trips during that period. This process was carried out for all models of vehicles disposing of waste in the final disposal site, and the total amount of waste disposed was determined. Presently there are 8 types of vehicles used by the Cleansing Department for the haulage of waste.

Table 4-2: Vehicles Currently Used for Waste Haulage

Make	Type	Capacity m^3	Number in use
Fiat	compactor	13	9
Fiat	dump truck	6	9[14]
Hino	compactor	15	11
Nissan	dump truck	12	10
Hino	dump truck	8	3
Mercedes Benz	dump truck	5	8[15]
Hino	arm-roll	12	1
Hino	hoist truck	5	1

Also there are a number of private companies and individuals disposing waste at the final disposal site. There are various types being used, from large dump trucks and trays to small pick-ups.

The private vehicles were broadly classified by weight into 3 sizes:

- Large tare of greater than 4000 kg
- Medium tare of between 4000 kg and 1800 kg
- Small tare of less than 1800 kg

a. Vehicle Weighing Survey

Over a four-day period, from the 25th to 27th of February and on the 2nd of March, the weighing took place. It was thought prior to the survey that the weight of waste being carried would vary on different days of the week, i.e., vehicles would be heavier earlier in the week. It was important to verify this so the survey was carried out on a Wednesday, Thursday, Friday, and a Monday.

On the first day of the survey, Wednesday the 25th, both AMDC and private vehicles were selected to obtain a basic idea of load weights. From these results it was determined that AMDC trucks were discharging by far the most waste. Therefore on the following day and the Monday weighing concentrated on AMDC vehicles. On Friday weighing of private vehicles was carried out.

4.1.2 Results

Average load weights of vehicles entering the landfill were calculated and are shown in the following tables.

Table 4-3: Average Load Weights: AMDC Collection Vehicles (Compactors)

Type of collection vehicle	Percentage of total trips (%)	Average Waste Load per Vehicle (kg)
Fiat Compactor	18.3	5,744
Hino Compactor	18.3	6,403
Weighted average		6,074

[14] Includes 5 Cleansing Department and 4 Infrastructure Section trucks that also participate in MSW collection services.
[15] Includes 2 Cleansing Department and 6 leased trucks.

Table 4-4: Average Loads: AMDC Collection Vehicles (Dump Trucks)

Type of collection vehicle	Percentage of total trips (%)	Average Waste Load per Vehicle (kg)
Fiat DT	10.3	2,909
Nissan DT	19.4	3,850
Hino DT	4.8	5,303
M Benz DT	16.6	3,253
Weighted average		3,603

Table 4-5: Average Loads: AMDC Collection Vehicles (Others)

Type of collection vehicle	Percentage of total trips (%)	Average Waste Load per Vehicle (kg)
Hino Arm roll truck	6.5	2,818
Hino Hoist truck	5.7	1,250

- Both of the compactors are of weights comparable to the 6.26 ton per vehicle currently being used by the Cleansing Department to determine disposal amount.
- However, the weight of dump trucks was significantly lower, the average load weight was calculated to be 3.60 ton.
- The arm-roll had an average load weight of 2.82 ton per trip, and the hoist truck 1.25 ton per trip, which are also significantly below the estimated 6.26 tons.

Table 4-6: Average Loads: Private Vehicles

Class of Vehicle	Percentage of total trips (%)	Average Waste Load per Vehicle (kg)
Small	47	322
Medium	23	653
Large	30	1,543

The average load per private vehicle is well below the 3.5 ton/vehicle rate used by the Cleansing Section.

b. Disposal Amount

The disposal amount for 1997 was calculated to obtain the average daily disposal amount in the following way.

Using Cleansing Department disposal records it was possible to estimate the number of trips each type of AMDC vehicle made in a year. Then by multiplying the number of trips by the calculated average load weight, the total amount of waste disposed at the final disposal site was calculated for the year 1997.

During the truck weighing survey a record was kept of the number and size of private vehicles entering the final disposal site. From this information it was possible to determine the proportions of small, medium, and large vehicles.

Table 4-7 shows the waste final disposal amount in 1997 obtained by the survey.

Table 4-7:Average Daily Disposal Amount: 1997

Type of Collection Vehicle	Percentage of Total Trips (%)	Estimated Number of Trips in 1997	Average Load (kg)	Waste Generated (kg/day)
Amount of Waste Disposed by AMDC Vehicles				
Hoist truck	6.5	1,872	1,250	8,154
Arm roll	5.7	1,638	2,818	16,084
Hino Compactor	18.3	5,265	6,403	117,471
Fiat Compactor	18.3	5,265	5,744	105,381
Nissan DT	19.4	5,577	3,850	74,819
Fiat DT	10.3	2,964	2,909	30,045
M Benz DT	16.6	4,758	3,253	53,933
Hino DT	4.8	1,365	5,303	25,223
Totals	100	28,706		431,110
Amount of Waste Disposed by Private Vehicles				
Small	47.4	7,634	322	8,565
Medium	23.1	3,714	653	8,450
Large	29.5	4,745	1,543	25,513
Totals	100	16,093		42,527
Average Daily Disposal Amount, 1997				473,637

The daily disposal amount is calculated taking into account the fact that waste in the Central District is disposed of 5.5 days per week (Monday to Friday and a half day on Saturday)

The same method was repeated using Cleansing Department data for the years 1994, 1995, 1996 and 1997. The total amounts of MSW disposed at the final disposal site are shown in Table 4-8.

Table 4-8: Estimated Yearly Waste Disposal Amount from 1994 to 1997

Year	Estimated Disposal Amount (tons/year)
1994	100,803
1995	131,196
1996	137,449
1997	135,929

The disposal amount calculated by this study was significantly lower than the amount estimated by the Cleansing Department. The difference is attributed to the fact that average truck weights used by the Cleansing Department to estimate waste amount were too high. Table 4-9 shows the average weights by type of vehicle as determined by this study and those currently being used by the Cleansing Department.

Table 4-9: Weights by Type of Vehicles

unit: ton/vehicle

Type of Vehicle	tons/load used by the Cleansing Section	tons/load measured by this study	Difference
Fiat compactor ($13m^3$)	6.26	5.7	-0.56
Fiat dump truck ($8m^3$)	6.26	2.9	-3.36
Hino compactor ($15m^3$)	6.26	6.4	+0.14
Nissan dump truck ($12m^3$)	6.26	3.9	-1.36
Hino dump truck ($8m^3$)	6.26	5.3	-0.96
M. Benz dump truck ($8m^3$)	6.26	3.2	-3.06
Hino arm-roll truck ($12m^3$)	6.26	2.8	-3.46
Hino hoist truck ($5.5m^3$)	6.26	1.3	-4.96
Private vehicles - small	3.5	0.3	-3.2
Private vehicles - medium	3.5	0.7	-2.8
Private vehicles - large	3.5	1.5	-2.0

4.2 Survey in August 1998

A private contractor started the operation for waste collection and haulage work in the beginning of June 1998. In addition, as one of pilot projects a system used by a computer to summarize the final disposal amount of waste started its operation in the middle of August. This section describes the data summarized by using the new system in August.

4.2.1 Final Disposal Amount Data in August 1998

Table 4-10 shows the final disposal amount data of waste collected in August 1998. This data includes all amount of final disposal of waste within this period. The final disposal amount measured is 442.9 tons per day based on 5.5 days working days per week. It implies that on average 348.0 tons of waste per day are being disposed at the final disposal site.

Table 4-10: Waste Disposal Amount Data in August 1998

unit: tons/day

	10 mon	11 tue	12 wed	13 thu	14 fri	15 sat	16 sun	Total	Average ton/5.5days/week	Average ton/7days/week
AMDC	314.60	299.60	279.70	230.00	240.40	164.80	0.00	1,529.00	278.0	218.4
Contractor	140.75	182.02	139.54	129.77	143.02	72.51	0.00	807.61	146.8	115.4
Direct hauler	8.50	16.70	17.70	19.40	16.90	0.00	0.00	79.20	14.4	11.3
Special	2.20	3.40	3.30	4.30	6.70	0.00	0.00	19.90	3.6	2.8
National	0.00	0.00	0.00	0.30	0.00	0.00	0.00	0.30	0.1	0.0
Total	465.95	501.72	440.24	383.77	407.02	237.31	0.00	2,436.01	442.9	348.0

4.3 Conclusions

The final disposal amount measured in August 1998 is 88% of that estimated in February 1998. It has been confirmed by the Cleansing Department's record that the final disposal amount in summer is more than that in winter in general. Therefore the fact that the final disposal amount measured in August is less than that estimated in February is difficult to be justified.

The cause could be attributed to the followings.

1) The data of number of trips recorded by the Cleansing Department which was used for the estimation in February was wrong.

2) The collection and haulage capacity of the Cleansing Department has actually decreased very much since the previous year.

Since it is too difficult to estimate the final disposal amount of waste in the previous year, the final disposal amount measured in August 1998 is adopted for the master plan. It is

- 443 tons/day (based on 5.5 collection days/week)
- 348 tons/day (based on 5.5 collection days/week)

Chapter 5

Survey on Recycling System

5. Survey on Recycling System

Recycling of waste materials is an important method of reducing the amount of waste disposed. Recycling also is important for the conservation of natural resources and landfill space.

5.1 Objectives

- To obtain an understanding of the current recycling systems in the Central District
- To obtain the quantity of materials being recycled at different points on the waste stream

5.2 Methodolgy

Information for the survey on the recycling system was obtained from the following sources:

- Survey of recycling firms and middlemen
- Scavenger Interview Survey
- Scavenging Waste Amount Survey
- Interviews to crews of collection vehicles, Time and Motion Survey
- Waste Amount and Composition Survey
- Public Opinion Survey
- Other relevant recent studies

Recycling occurs at many levels in the Central District, from the recycling of used perfume bottles for refilling and resale at the public markets to the collection and baling of aluminum cans for export to the United States for recycling. However, the Survey on Recycling focuses on those materials being recovered from municipal solid waste in the Central District on a large scale:

- paper
- plastics
- aluminum cans
- glass bottles

5.3 Survey Results

From preliminary investigations and discussions with middlemen and end users in the Central District it was determined that materials are recovered from the waste stream as shown in the following diagram.

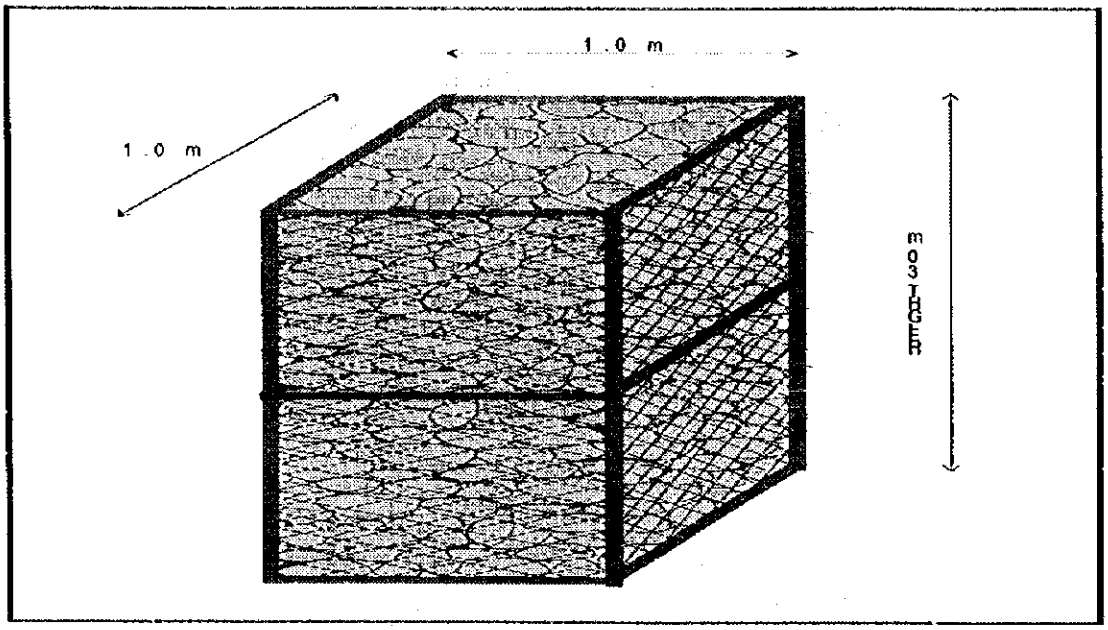

Figure 5-1: Recovery of Materials from the Waste Stream

5.3.1 Paper and Cardboard

a. Recovery Sources

According to the Survey on Composition and Properties of Waste, it is estimated that 79.3 tons of waste paper and cardboard are generated each day – 16.5% of all MSW is paper. The major sources being residential, commercial enterprises, and institutional waste

Paper is recovered at all points along the waste stream.

- According to the POS 30% of households are visited by people wanting to buy or collect paper.
- Collection crews separate paper from other recyclable materials while they are carrying out collection services and then sell to middlemen located near the final disposal site. Each day 2 to 3 bags of paper are collected per vehicle from waste in middle and high income areas.
- Scavengers at the final disposal site collect paper.

Cardboard is chiefly collected from large dischargers.

b. Destinations

There were only two end users found to be purchasing significant amounts of post consumer paper, KIMBERLY-CLARKE HONDURAS and TECHON. Both

companies recycle in San Pedro; Kimberly-Clarke has another plant in El Salvador. Kimberly-Clarke manufactures paper hygiene products and hence mainly purchases paper, while Techon manufactures "Techon™" a laminar roofing material and other materials manufactured predominantly from cardboard.

c. Quantity recovered

Table 5-1: Quantity of Paper Recovered

unit: kg/day

Material	Generation	Collection	Disposal	End users
Paper	negligible	2,100	1,070	2,700
Cardboard	2,900	negligible	negligible	2,900

It is concluded that most of the paper is being recovered by collection vehicles or from the final disposal site and a negligible amount directly from generation and discharge.

Thirty (30) collection vehicles operating in middle and high income areas are collecting on average 3 bags of paper per day (Time and Motion Survey and driver interviews). And the amount obtained from the final disposal site was calculated by weighing the amount of paper leaving the site.

The amount of paper recovered is greater than the amount taken by the end user. It is assumed that approximately 15% of paper is discarded by middlemen when classifying because it is contaminated.

Because of its low cost and the preference for clean cardboard, a negligible amount of cardboard is recovered from the final disposal site or collection vehicles.

Compared to the total amount of waste paper and cardboard generated the portion recovered is very small.

d. Prices of paper

Paper collected by scavengers and collection crews is usually commingled (contains newspaper, printed paper, computer printout, manila folders, etc. excluding cardboard). The price paid mixed by middlemen varies between 0.10 and 0.40 lempiras depending on quality of paper and bargaining skills.

Once purchased, the middlemen classify the paper before transporting the paper to the end users for sale. Paper is sorted and sold according to four classes.

Table 5-2: Classifications of Paper

Class	Description	Price paid by end user (Lps/lb.)
High-grade	blank paper, computer printout (non-impact)	0.8 - 1
1st	heavily printed paper	0.50
2nd	color paper, manila folders, newspapers, magazines	0.30
Cardboard	corrugated cardboard	0.15-0.20

When asked if the price of paper is stable, end users, middlemen, and persons recovering paper all said that it is. Moreover, comparing the prices obtained in this study with the prices in the IPES-IDNS study undertaken in 1996, the prices are almost identical. Therefore taking into account inflation, the prices for paper have actually decreased in real terms.

Interestingly, end users stated that the supply of materials is low or variable. While middlemen complained that there is no market competition to increase prices.

A spokesperson from Kimberly-Clarke complained about the general lack of knowledge about separating materials for recycling.

5.3.2 Plastic

a. Recovery Sources

It was estimated that 33.6 tons of waste plastic is generated each day – 7% of all waste.

Most plastic is currently being recovered at two points along the waste stream:

- Directly from the generator
- From the final disposal site

Plastic recyclers FIBRAPLAST and TECHNIPLASTICOS have agreements with local factories that discard plastic, such as, soap and food plastic packaging that is no longer needed. While another company DURAPLAST has an agreement with scavengers at the final disposal site and obtains most of its plastic directly from there. Techniplasticos also imports plastic recovered from the San Pedro Sula final disposal site, *Centro de Desechables.*

According to the POS, only 2% of high income households said that someone buys or collects plastic directly from them.

b. Quantity Recovered

Table 5-3: Quantity of Plastic Recovered

unit: kg/day

TYPE OF PLASTIC	Generation	Disposal site	End users
high/low-density polyethylene	600	1,140	1,740
polypropylene	30	nil	30
polyvinylchloride	150	nil	150
TOTALS	780	1,140	1,920

The average amount of plastic leaving the disposal site was calculated from the results of the survey on waste leaving the final disposal site.

While the average amounts of plastic recovered from generation was estimated by interviewing end users.

c. Destinations

The three above named companies are recycling plastic obtained from the Central District. Polyethylene products such as polyethylene pipe and fittings are main products manufactured from the recycled plastic. Also plant pot and water containers are produced. The PVC is recycled to make electrical accessories.

d. Price for recovered plastics

The prices for the major types of plastic recycled in the Central District are shown in the table below. End users commented that cleanliness and classification of plastic were important factors in determining the prices, noting that plastic from the final disposal site is often dirty and poorly classified. Using the plastics from the disposal site is product less preferable than discarded plastic from factories, which is homogenous and clean.

Furthermore once cleaned and classified plastic must be ground up before it can be reprocessed. According to the IPES-IDNS study end users would be willing to pay around 3.0 Lempiras for cleaned, classified and ground plastic.

Table 5-4: Prices of Plastic Recycled in Central District

unit: Lps/lb.

TYPE OF PLASTIC	SOURCE		
	scavenger	middleman	factory
high-density polyethylene	0.4-0.8	1-3	1-1.5
low-density polyethylene	0.3-0.4	0.4-0.8	0.3-0.8
polypropylene	-	-	0.5
polyvinylchloride	-	-	1.0

However, there are several negative aspects against the expanded recycling of plastics:

- in nearly all cases recycled plastic can not be used for food packaging because of health regulations;
- most plastic discarded in the Central District is low-density polyethylene and of poor quality;
- plastic has a poor cost to weight ratio meaning that transporting plastic is often uneconomical; and
- processing machines are expensive.

In addition to the above factors and the abundance of plastic, the cheapness of virgin material, there is a lot of pressure keeping prices low. And hence the potential for improving plastic recycling is somewhat restricted.

5.3.3 Aluminum Cans

As is the case throughout Central America the preferred method of selling soft drinks in Honduras is in returnable bottles. Drinks from aluminum cans cost twice as much and make up only between 2 and 5% of annual sales of drinks in the Central District. However, due to the high demand for used aluminum cans and the expected future increase in sales, aluminum cans provide a good example of the potential of recycling in the Central District.

a. Recovery Sources

Aluminum cans are in strong demand in the Central District and are being recovered at all points of the waste stream. The main source of recovered cans is scavenging and collection vehicle crews.

- According to the POS 20% of households are visited by someone wanting to collect or buy used aluminum cans.
- The majority of scavengers interviewed in the urban areas were collecting aluminum cans.
- Collection workers assigned to vehicles operating in middle to high and middle income areas said that they collect between 1 and 2 sacks of cans per day.
- According to the Interview Survey of Scavengers at the final disposal site 71 scavengers collected aluminum cans.

b. Destinations

Three companies were found to be buying aluminum cans in significant amounts in the Central District: INVEMA, FERRETERIA EL DIAMANTE, and INDRESA. All three send the cans to San Pedro Sula for baling and from there they are exported to North America for melting and production of aluminum sheets for recycling into cans.

c. Amount Recovered

From interviews with the three companies buying aluminum cans the total amount of cans recovered per day is estimated in the table below.

Table 5-5: Quantity of Aluminum Can Recovered

kg/day

Material	Discharge	Collection	Disposal Site	End users
Aluminum cans	250	400	210	860

The total amount of cans collected by end users was calculated based on interviews with the three main collectors of cans.

Based on interviews with drivers and the results of the Time and Motion Survey it is estimated that each day 1.5 bags of cans are retrieved per collection truck operating in the high and middle class areas.

The average amount of aluminum cans leaving the disposal site was calculated from the results of the survey of waste leaving the final disposal site.

Scavengers collecting in urban areas were estimated to collect a significant amount of aluminum cans. This was estimated based on the other three results, as it was assumed that these were the only sources.

Considering that 65 cans weigh about one-kilogram, then approximately 56,000 cans are recovered each day. This is roughly equal to the total daily sales of aluminum cans in the Central District, i.e., a recovery rate of close to 100%. A very high recovery rate is not unreasonable considering that the contents of a bag of waste from middle to high income areas may be looked through three times before they are buried at the final disposal site.

d. Price for aluminum cans

Because the cans are sold to companies in the U.S.A. the price received is influenced by international competition, and therefore is generally higher and more variable than materials recycled locally. Presently the demand for aluminum cans is very strong.

Table 5-6: Prices Paid for Aluminum Cans

Lps/lb.

	Price paid to scavengers	Price paid to middleman
Aluminum cans	Lps 2-3.50 /lb	Lps 4- 6 /lb

The international price (London Base Metals Market) for 99.7% pure aluminum is presently around $1,400/ton, or Lps8.34/lb. Taking into account transport and processing costs the prices received by the middlemen and the scavengers are very competitive.

5.3.4 Glass Bottles

As mentioned above soft drinks and beer are mainly consumed from glass bottles. Soft drink and beer bottling companies sell the bottle and the liquid to the retail outlet. For the retail outlet to retrieve the costs it must return the bottles to the bottling company. The policy of bottlers is to only receive bottles from those that return the purchased bottles and not to buy them back. The system is very successful and according to CEVERCERIA HONDUREÑA, the major bottler in Honduras, 99% of bottles are returned.

Broken bottles on the other hand are generally just dumped at the landfill site as there is no demand for this material. The closest cullet processing plant is in Guatemala and it is not economical to transport the broken glass.

a. Recovery Sources

- 54% of residents replied that someone visits their house to buy or collect used bottles. This is the highest percentage of all materials. However, this mainly occurred in the middle and lower income areas, only 5% of households in high income areas replied that someone came to their house to collect or buy bottles;

- Urban scavengers interviewed said that they collect bottles;
- Scavengers at the final disposal site recovered whole bottles, but state that demand is weak.

b. Destinations of recovered bottles

No glass recycling plant exists in Honduras. One exists in Guatemala but according to collectors it is not feasible to transport broken glass there; the broken glass is disposed of at the final disposal site. Only whole bottles that can be sold back to the original owner or another user are recovered. Sauce, rum and other liquor bottles are returned to local manufacturers. Other bottles are sold in the markets for miscellaneous uses such as sauce and relish bottles, while some bottles are sold to pharmacists for storing medicines and chemicals.

c. Amount of bottles recovered

From the POS results it can deduced that a significant amount of bottles are recovered from the generation sites, though this study does not attempt to calculate the quantity as there are no major buyers.

Because not all types of bottles are recycled and the price varies according to type often bottles are simply ignored by scavengers at the final disposal site. On the two days of the Material Recovery Survey an average of 1039 kg of bottles was recovered. Or about 2,100 bottles, assuming the average bottle weighs 500 grams.

5.4 Other Recycling

As mentioned above the emphasis has been placed on paper, plastic, bottles, and Aluminum cans. 'Other' materials (such as, ferrous and non ferrous metals, textiles, wood, bones, sacks, food scraps, tires, etc.) because of their low potential for increases in recycling and because their impact on current solid waste management problems is small have been ignored. Scrap metal, for example, is purchased by local scrap metal merchants and recycled in much the same way scrap metal is recycled in developed countries. There is also a thriving 'pewter' industry that manufactures aluminum alloy ornaments from non-can aluminum.

The impact of these materials on the amount of material leaving the landfill site is, however, important because it affects the amount of waste that is being disposed of at the final disposal site and therefore may affect future landfill design. For this reason the amount of other material leaving the landfill site has been included in calculations.

5.5 Conclusions

A vibrant though small informal recycling system was observed to be operating in the Central District. The system is market driven, and is providing income for various levels of people: from the estimated 500 scavengers to the 100 or so middlemen and the numerous companies that rely on the recovered materials to manufacture various items, or for export dollars.

While aluminum cans are being recovered at a very high rate, problems exist in the cleanliness, classification, and volume of paper and plastic, especially material emanating from the final disposal site. If classification of materials is improved, in particular, voluntary classification in the home, in schools, and in businesses, then the prices offered and quantity of materials will correspondingly increase.

Further, as the wealth of Hondurans increase the number of people willing to recover materials will decrease with a corresponding decrease in the demand that presently exists for some recovered materials (e.g., whole bottles, textiles, certain plastics, wood). Therefore the current informal recycling will have to be gradually replaced with a more formal recycling system, and further efforts made to encourage competition among buyers of recovered materials.

Chapter 6

Survey on Scavenger Activities

6. Survey on Scavenger Activities

Scavengers operate at all points on the waste stream. Going door to door asking residents if they have any recyclable materials, sifting through discharged rubbish in the early hours of morning, collecting bones and burning them for sale as an additive for stock feed, and where they are post prolific, at the final disposal site recovering materials for recycling. Their impact is significant. Therefore, scavenger activities in the disposal site as well as in towns were investigated.

6.1 Objectives

- to understand the present role of scavengers of SWM in the Central District
- to understand the system of scavenging in the Central District and at which points of the waste stream scavenging occurs
- to understand the organization of scavengers and their present working conditions
- to estimate the amount recycled by scavengers at different points of the waste stream
- to facilitate prediction of the social impact of the master plan on the scavengers
- to learn what problems scavengers face and how to best improve conditions with possible improvements to the landfill

6.2 Methodology

The following were used to obtain information:

- Scavenger Attendance Survey (SAS) at the disposal site for 5 days.
- Scavenger Interview Survey (SIS) with 38 scavengers at the disposal site.
- Scavenging Waste Amount Survey (SWAS) for 2 days.
- Scavenger Interview Survey (SIS) with scavengers operating in urban areas of the Central District.
- Conversations with scavengers and general observations.
- Review or other reports.

6.3 Scavenger Attendance Survey at Disposal Site

AMDC Disposal Site Staff (actually a former scavenger) carried out the Scavenger Attendance Survey (SAS) for a period of 5 days from The 2nd of March to The 6th of March 1998. The attendance was recorded twice a day between 7:30 and 11:00 and 13:30 and 16:00. Scavengers were also asked their age.

6.3.1 Attendance Results

The number of scavengers present in each survey period was calculated from the attendance survey records and is shown in Table 6-1. It is plotted against date and time in Figure 6-1.

Table 6-1: Scavenger Attendance Survey Results

	Mon 2/3	Tue 3/3	Wed 4/3	Thu 5/3	Fri 6/3	Mean
7:30-11:00	130	177	153	120	112	138.4
1:30-4:00	158	184	150	144	121	151.4

From Figure 6-1: Scavenger Attendance, March 2nd to 6th, two points are immediately obvious. Firstly the number of scavengers is greatest earlier on in the week decreasing towards the end of the week. And secondly the number of scavengers is larger in the afternoon than in the morning

The reason why the number of scavengers is larger earlier on in the week is thought to be because of the greater amount of recyclable waste being disposed at this time. More residential waste is produced on weekends. Housewives do their weekly shopping, people drink beer, go to restaurants, eat more extravagant meals, etc. The result is more aluminum cans, bottles, and plastic, three of the most recycled materials.

The second point deduced from this survey is that the number of scavengers is larger in the afternoon. This is indicative of a gradual accumulation of scavengers until about mid afternoon when the number decreases.

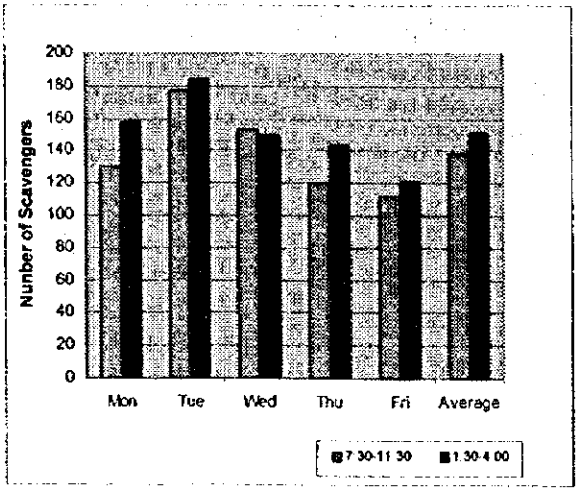

Figure 6-1: Scavenger Attendance, March 2nd to 6th

6.3.2 Other results

The below table shows the number of scavengers that listed as coming to the site during the five days of the survey.

Table 6-2: Five day attendance record

	Number of scavengers	Literacy %	Average Age
Females	88	45	30
Males	185	50	24.8
All Scavengers	273	49	26.4

The literacy rate of 49 % at the final disposal site is well below the estimate for the whole population of 73%[16].

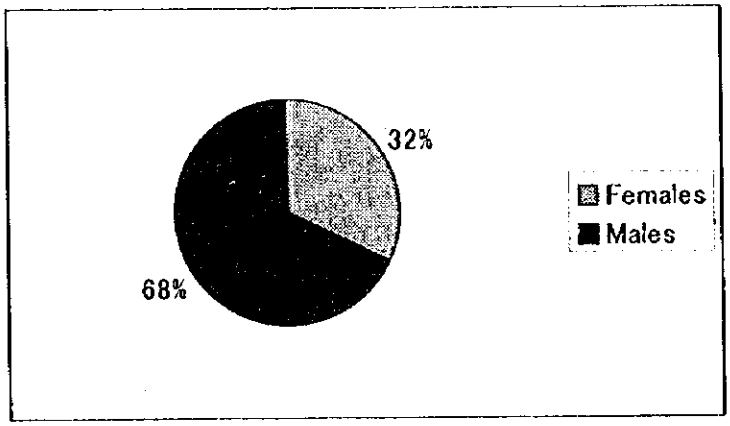

Figure 6-2: Proportion of Male and Female Scavengers

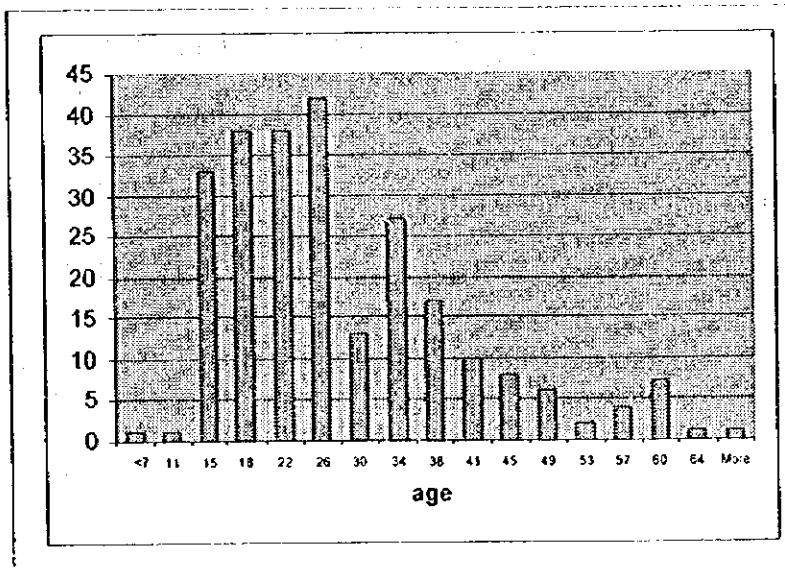

Figure 6-3: Age Distribution of Scavengers

[16] 1990 estimate from The World Fact Book, CIA, 1995

6.4 Scavenger Interview Survey at Landfill

Thirty-eight (38) scavengers of the disposal site were randomly selected and surveyed. Two women and one man from the AMDC Department of Cleansing carried out the surveys between the 11th an 19th of February.

6.4.1 Summary of Results

a. General questions

1) females and 21 males were surveyed. The average age was 33; the oldest surveyed being a sixty-eight (68) year old women.

2) answered that they liked scavenging very much, however, when asked would they prefer to do something else given the opportunity, 87% of those who responded to this question said they would like to do something else.

3) Asked if married: 58% percent said they were, while 87% said they were economically supporting someone. 79% were supporting children, indicating many unmarried parents.

4) The mean number of years that the respondents had been working as a scavenger was between 3 and 6 years. A 36-year-old man said that he had man said that he had been scavenging since he was eleven years old, and a 33-year-old woman replied that she had been scavenging for 23 years.

5) Most people said they scavenged every day of the month. This is confirmed by the Attendance Survey. The roll taken for the Attendance Survey showed that for the scavengers who came to the final disposal site more than once, the were there most mornings and afternoons.

6) of scavengers surveyed said that they live at the final disposal site. The median distance that those not living at the site is between 6 and 8 kilometers.

7) When asked if they would continue to scavenge if the landfill moved 15 kilometers further away, 92% said that would. Indicating a strong desire to scavenge. Though when asked if they would consider living at the final disposal site only 38% said they would.

8) said that they either buy their lunch or bring it with them. It is assumed that the other eighteen 18% obtain their food from disposed waste.

b. Earnings

1) The amount of money earned per day from scavenging varied. 24% stated that s/he earned over 100 Lempiras, while 70% earned 50 Lempiras or less a day. Only 6% earning between 50 and 100 Lempiras. According to this data there is a substantial income gap between scavengers.

2) The average daily earnings were calculated at 51 Lempiras[17]. This value was confirmed by conversations with a scavenger leader who has about 22 scavengers working for him collecting plastic. According to a rough record taken of money

[17] The minimum wage in Honduras is around 35 Lempiras per day

paid to scavengers, the pay per day for his workers ranges from Lps. 35 to Lps. 155; the average between 60 and 70 Lempiras.

3) Also a survey was done of the materials taken from the site each day for recycling (see section 5). Each day an estimated Lps. 5,611 of material exits the final disposal site. If it is assumed that on average there are 145 scavengers at the site then the average amount of money that a scavenger makes is Lps. 38.7 per day.

c. Materials recovered

1) When asked what materials they collected, they generally gave multiple answers. The major materials recovered are:

- paper
- high and low density polyethylene
- whole glass bottles
- aluminum cans
- textiles
- copper and bronze
- scrap iron

2) The quantity of materials recovered varied according to price and demand.

Table 6-3: Prices, Demand and Price Stability

Material	Prices paid to scavengers Lps/lb.	Demand	Price Stability
plastics	0.4 – 1.0	steady (some types)	stable
paper	0.1 – 0.4	low	stable
Al cans	2.0 – 4.0	very strong	varies
whole bottles	5 – 25 cents/bottle	low - medium	stable
scrap metal	0.2 – 0.4	medium	stable
textiles	0.35 – 2.50	varies	stable
copper and bronze	1.5 – 8.0	very strong	varies

d. Problems and suggestions for improvements

1) Many scavengers replied that they had no problems. However those who replied said that problems are[18]:

- No water
- Sickness
- Environmental contamination
- Other workers were rude and did not respect women.
- There is discrimination.
- Dirty.

2) Many more scavengers were, however, keen to offer suggestions on how to improve their work. The main ones are listed below:

- Make the working area larger (8 scavengers suggested this).
- Improve the organization of workers.
- Improve work stability, pay and conditions.

[18] Problems and suggestions are listed with most frequent responses at top.

- Prevent landfill fires.

6.4.2 Other Findings

1) The mood at the final disposal site was good and most scavengers work very hard. Scavengers were very approachable and were pleased to answer questions.

2) Even though the conditions at the final disposal site are very severe, it was observed that only a few scavengers wore any protective clothing such as gloves, masks, or hats.

3) A comprehensive thesis[19] undertaken in 1995 by a final year student of the national university, UNAH, provided supporting data.

4) Some interesting findings of this thesis:

- 76% of scavengers originate from rural areas of Honduras.
- 94% of scavengers did not complete elementary school, of these 78% dropped out before fourth grade.
- 44% of respondents replied that they consumed drugs (not including alcohol or cigarettes).
- 81% said that they had had previous working experience. Scavengers had experience in work such as carpentry, bricklaying, carrying goods in the market, and cleaning cars. 61% said that they left because they did not like their work while the other 39% left because of low pay.

6.5 Scavenger Interview Survey in Urban Areas

Scavengers in the urban area were surveyed to determine how they worked and what materials were recovered. Due to the dispersed nature of their work and the fact that some start working at 2:00 a.m. only 5 urban scavengers were interviewed.

The general consensus is that there are about 300 scavengers working in the middle and high income districts of Tegucigalpa.

Scavengers answered that they made around 50 Lempiras per day. Which is roughly equivalent to what landfill scavengers make. The most popular material of those interviewed was aluminum cans. This is because urban scavengers cover large areas and have to get the materials to a middleman for sale. Cans are approximately 10 times more valuable per pound than paper or bottles, and hence can be easily carried.

6.6 Concluding Remarks

In general scavengers are very committed to their work. On average the daily earnings of a scavenger is comparable and often above low paying jobs in the formal sector. Scavengers have a very free existence, which is reflected in most saying that they liked their work very much.

However, social benefits that come with formal employment are not available to scavengers. Moreover, the final disposal site is a dirty and unsafe place and the

[19] Andrea Diaz Garcia, Conditions de Trabajo y de Vida de los Recolectores de Articulos de Crematorio, M.D.C., 1995.

likelihood of a scavenger falling ill or being injured is high. The average age is 26 years. This indicates that work conditions are severe and the working life of a scavenger rarely extends into middle age, only 8.4% of scavengers were over 45 years.

The high number of unmarried scavengers with children, literacy rates well below the national average, and the high incidence of drug taking further indicate profound social problems.

On the positive side, however, it was found that there exists a strong desire to improve their conditions, through the better organization of scavengers and the improvement of scavenging methods.

Chapter 7

Survey on Private Sector's Participation

7. Survey on Private Sector's Participation

A survey of the current situation concerning private sector's participation in the collection of municipal solid waste in Central District was carried out by interviewing Cleansing Department staff, by inspecting Cleansing Department records and by interviewing private collection companies. Supplementary information was obtained during the undertaking of other surveys.

7.1 Situation as of March 1998

7.1.1 Findings

a. Vehicles leased by the Cleansing Department

- There are six dump trucks and one front-end loader being leased by the Cleansing Department. The dump trucks are used to replace broken down or vehicles in need of servicing, in addition to reinforcing current collection and haulage services. The front-end loader was being used at the landfill to excavate and load cover soil and on other days used to support the loaders belonging to the AMDC.
- The vehicles are all leased on a monthly basis, at Lps. 1,500 /day for the dump trucks, and Lps. 450 /hour for the loader.
- The rate covers everything: maintenance, fuel, driver and crew salaries. Though when a dump truck is assigned to a new route, a crew member from the vehicle being replaced will travel with the leased vehicle to direct them.
- Leased vehicles are generally made to operate for longer periods each day than regular AMDC dump trucks to take advantage of the fixed daily rate. The AMDC crews and vehicles start the day at around 6:00 a.m. and finish around 3:00 p.m. Leased vehicles, on the other hand, start at the same time as the AMDC vehicles but generally finish around 5:00 p.m.
- According to Cleansing Department records (Feb 10th to the 16th) leased Mercedes Benz dump trucks averaged around 11 trips per week (35.75 tons/week) per vehicle, while Fait dump trucks averaged 9 (26.19 tons/week) trips per week per vehicle and Nissan dump trucks averaged 9 (34.65 tons/week).
- There are at least four separate owners. However the Cleansing Department only makes a contract with one owner who represents the others. This representative receives payment from the Cleansing Department and distributes it to the other owners.
- The leased vehicles appear to be well maintained. Two of the six were using a tarpaulin to cover the waste while traveling between the urban areas and the disposal site. The tarpaulin serves two very useful purposes, firstly it prevents waste from blowing off, and secondly, it discourages scavengers from climbing onto vehicles entering the disposal site.

- Crews of leased vehicles also participated in sorting recyclable materials from the other waste while carrying out collection services.

b. Direct Haulage

- A number of large supermarkets, banks, UNAH (the national university) haul waste to the final disposal site using there own vehicles. These vehicles come in a number of sizes from dump trucks and a compactor, which is used by UNAH to a lot of small pick-ups.
- It was found during the four days of the truck weighing survey that the most numerous were the small pick-ups. A small : medium : large ratio of 6:3:4 was calculated. Small being vehicles with a tare under 1800kg; medium having a tare from 1800kg to 4000kg, and large greater than 4000kg.
- According to Cleansing Department disposal records, the average number of private vehicle disposing waste at the landfill each day is around 50. However, this does not include vehicles arriving after about 3:30 p.m., when Cleansing Section staff usually stop counting vehicles, nor vehicles discharging on Sundays.
- The Cleansing Department keeps records of only the name of the discharger, entrance and exit times, and type of vehicle. There are no records taken of the type of material being dumped. This is important because there are a number of factories disposing waste at the final disposal site.
- It was observed during the truck weighing survey that private vehicles became irritated when they were asked to stop to be weighed. Because when they slowed, scavengers had the opportunity to climb on to the tray of the vehicle and start scavenging.

7.1.2 Conclusions

a. Leased vehicles

There are too few leased vehicles to draw any definitive conclusions. However the operation of leased vehicles appears to be good. In regard to trips per day, leased dump trucks are more productive than the AMDC dump trucks.

Information on the operating costs of the AMDC collection vehicles is scarce so it is essential that closer analysis be undertaken to compare the costs of leased and the AMDC vehicles.

However, the attitude to leased vehicles is generally favorable among Cleansing Department staff, as there is there less administrative work, and no maintenance.

Tarpaulins covering the waste are a good idea and more dump trucks should use them. The fact that only leased vehicles were using tarpaulins could be a result of motivation to please their employer (Cleansing Department).

On the other hand, crews of leased vehicles reduce collection efficiency by sorting through waste for recyclable materials. For the Cleansing Department to get greater value for money this practice should cease.

b. Direct Haulage Vehicles

More careful recording of the number of vehicles and the type of waste being disposed of by private vehicles is necessary. It would be relatively easy to dispose of dangerous chemicals at the final disposal site.

Control of the scavengers is necessary to prevent them from climbing onto moving vehicles. Climbing onto vehicles probably results in the injury of scavengers and discourages people from using the final disposal site. And probably results in increased illegal dumping.

7.2 Situation as of August 1998

7.2.1 Situations

There are two significant changes seen in the collection and haulage system and street sweeping system of the Central District since March 1998.

a.1 Contracting a part of Collection and Haulage Work out to a Private Company

The private contractor whose name is Compania Constroctura y Servicio Multiplaza started collection and haulage work in the part of the Central District as a contractor of the AMDC. Instead of the introduction of this contract, all vehicles which were used to be leased by the Cleansing Department were terminated.

The some information on the works done by the contractor are described below.

1) The amount collected by the contractor:

June 1998: approx. 1,800 tons

July 1998: approx. 2,800 tons

2) The contract rate:

Lps. 379 per ton of waste

3) Equipment used by the contractor as of 5th August 1998

15.3m^3 compactor	6 units
4.6m^3 container for compactors	80 nos.
Roll-on roll-off	2 units
15.3m^3 container for roll-on roll-off	24 nos.
21.4m^3 large truck	1 unit
Mechanical street sweeper	2 unit

a.2 Micro Enterprises for Street Sweeping Work

The AMDC started to contract some street sweeping works out to micro-enterprises in March 1998. As of August 1998, 43 micro enterprises, which have average seven members, were working as contractors. The contract rate is Lps.15,500 per month per enterprise.

7.2.2 Conclusions

a.1 Contracting a part of Collection and Haulage Work out to a Private Company

a) The Cleansing Department does not have a proper monitoring and supervision system for private contractors and therefore the performance quality and quantity of their work are not understood by the AMDC.

b) The current contract rate with "Compania Constroctura y Servicio Multiplaza" which is Lps.379 tons per ton is about 1.6 times more expensive than the proposed cost in our master plan and it is also 5 times more expensive than the present cost of AMDC's collection work.

c) Although the contract rate of Lps.379 per ton is too expensive, we think this rate is understandable due to the following reasons.

1) No competition for bidding

2) The contractor's risk is very high.

- The contractor cannot expect to continue the contract more than four years which is a term of the mayor. Therefore, the most equipment bought by the contractor are old and can be used only for a few years. According to our financial calculation, the contractor can depreciate the all equipment by this contract rate in two years.
- Payment by the AMDC is not sure.

d) They are carrying much waste which is very difficult to be carried by their vehicles and which can not be generated in their collection area. The following causes can be suspected.

1) They are carrying market waste which is heavier than residential waste. Uncompacted density of market waste here is 0.3 ton/m^3 while the uncompacted density of residential waste is 0.2 ton/m^3.

2) They are using 24 units of 20 cubic yard containers and 80 units of 6 cubic yard containers in the town. The container collection system has advantages and disadvantages as well. The disadvantages are as follows.

- It is very convenient for large amount waste dischargers to place their waste in them. For example, construction companies can place construction waste in containers.
- The container system is too convenient for resident to place their waste because they can discharge any wastes anytime. Therefore, the container system often encourage people to place more waste which are not discharged at the standard collection system. For example, the container is convenient for people to discharge garden waste, bulky waste, etc.

a.2 Micro Enterprises for Street Sweeping Work

- The contract rate of Lps.15,500/area/month is much more expensive than the former cost done directly by the Cleansing Department. As of March 1998 the

Cleansing Department was employing majority of street sweepers by individual contract basis that is Lps. 1,000 /person/month. This rate Lps. 1,000 /person/month is deemed to be very cheap. The current contract rate which is Lps.15,500/area/month is equivalent to approximately Lps. 2,000 /person/month and this is deemed a reasonable rate. It implies that the new contract rate corrected too cheap former rate. However, this change of contract system has to lead the increase of expenditure for street sweeping work.

- The Cleansing Department street is well supervising the sweeping contractors' works and well planning it. However, the Social Development Department which is involved in the street sweeping work as well is giving training to micro-enterprises and take actions from the point of income generation. Then the policy for the street sweeping work seems to be inconsistent among the AMDC.

Chapter 8

Time and Motion Survey

8. Time and Motion Survey

8.1 Objectives of the Survey

Since the cost of collection and haulage work occupies the largest portion of the total SWM costs in developing countries, improvements in collection and haulage system efficiency is the most effective means to reduce the total SWM cost and to improve the whole SWM system.

Solid waste collection is extremely labor intensive. At the same time, the cost of collection vehicles is high in developing countries compared to labor cost. Therefore, the time and motion survey aims at the following three items.

- Maximum use of the vehicle capacity
- Maximum use of legal working hours
- Improvement of working conditions for collection workers

The survey included the following items.

- Bearing of time, distance and weight on collection and haulage.
- Type of dustbin and container used
- Work efficiency of waste collectors
- Level of user cooperation in waste collection activities
- Service level
- Maintenance and condition of equipment

8.2 The Survey Schedule

The time and motion survey was conducted on twelve separate occasions as shown in Table 8-1.

Table 8-1: Actual Schedule of the Time and Motion Survey

Date	Type of Vehicle	Name of Collection Area	Type of Collection Area	Data Sheet
Feb. 17	15m³ compactor vehicles	Cerro Grande Zone 3 and 4	Middle income residential area	1
18	15m³ compactor vehicles	Comayaguela	Combination of middle income residential and commercial areas	2
18	15m³ compactor vehicles	Guanacaste, El Arbolito, Ejecutivo, Calle 13 and 14, Barrio Abajo, Olos Dolores, Delicias, Concordia, Ministries	Combination of middle income residential and commercial areas	3
19	15m³ compactor vehicles	Castanos, Alameda	High income residential area	4
19	8m³ dump trucks	San Fransisco, Altos de San Fransisco, Buena Aventura	Low income residential area	5
20	8m³ dump trucks	La Pagoda, Boulevard Suyapa, Colonia las Mercedes	Middle income residential area	6
20	8m³ dump trucks	Torocagua	Low income residential area	7
23	8m³ dump trucks	Flor de Campo 1, Rodas, Delicias, Olmos, Merrian	Low income residential area	8
23	12m³ arm-roll truck	Suyapa, El Obelisco, San Felipe, Gimnacio, Hato de Enmedio	Various	9
24	12m³ arm-roll truck	Reparto Abaj, San Felipe, Zonal Belen, Prison, Isla, Gimnacio,	Various	10
24	5m³ hoist truck	San Pablo Market, Plaza San Pedro, Colonia las Brisas, Colonia Kennedy, Jacaleapa Market, Villa la Union	Various	11
25	5m³ hoist truck	Colonia Country Club, Brisas del Corfijo, Hato de Enmedio	various	12

8.3 Summary of Survey Records

Table 8-2 shows the summary of the Time and Motion Survey records.

Table 8-2: Summary of Time and Motion Records

		unit	No.1	No.2	No.3	No.4	No.5	No.6	No.7	No.8	No.9	No.10	No.11	No.12
Number of Trips	Tr	trips	3	2	2	2	2	2	2	2	5	6	4	4
Travel Distance	D	km	59.3	31.8	58.1	72.6	38.8	30.2	50.8	42.2	152.6	116	85	76.7
Vehicle Velocity	V	km/h	27.8	14.2	24.7	36.3	13.9	14.0	20.7	17.3	28.3	25.2	14.4	14.5
Travel Time	t0	m	128	134	141	120	168	129	147	146	323	276	354	318
Actual Working Hours	t1	m	481	458	589	446	468	428	514	376	380	355	451	386
Service Time	t2	m	41	7	37	0	0	6	6	3	0	5	7	4
Collection Time	t3	m	303	291	275	319	289	285	348	220	36	38	51	51
Discharge Time	t4	m	9	9	9	7	11	8	13	7	21	36	9	13
Lunch	t5	m	38	26	3	47	0	0	16	0	0	0	0	0
Idling Time	t6	m	0	17	127	0	0	0	0	0	0	0	0	0
Other purpose	t7	m	0	0	0	0	0	0	0	0	0	0	30	0
Efficiency	E	-	1.00	0.96	0.78	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

8.4 Findings

a. General

1) A daily briefing on collection and haulage work is not carried out either before or after a working day.

2) Administrators at the office are not given a daily summary of the collection work by the drivers.

3) The schedule of collection districts is compiled at the office.

4) The collection routes are not fixed and therefore left to the drivers' discretion. Sometimes the route taken is inappropriate.

5) Collection vehicles pick up collection workers on the way to the first collection area and drop them on the way back.

6) Collection workers wear a uniform but no gloves. They change from the uniforms into their clothes outside, following the final trip to the landfill.

7) Attendance of collection workers and drivers is not recorded by the office.

8) The trucks are refuelled at a specific private gas station. A driver is given an order sheet for diesel by the office on the previous day.

9) Collection workers mainly sort paper and aluminum and occasionally plastics and bottles that are sold onto middlemen.

10) Collection vehicles leave the depot between 5am and 6:30am and return between 2pm and 3:30pm on average.

11) However, the office opens around 6:30am.

12) The legal working hour is 6.5 hours per day excluding lunch break, while during the survey eight out of twelve cases exceeded the legal limit.

13) The approximate trend in the type of container used were observed to be the following.

Residential area	High Income	Middle Income	Low income
100-200 l plastic containers	10	10	5
Metal drums	0	3	10
Plastic bags	65	70	50
Plastic bags on a cage stand	20	10	0
Cartons	1-2	1-2	10
Returnable sacks	0	0	15
Baskets	0	1-2	10
On-site garbage storage	1-2	1	0

b. 13 m^3 Compactor Truck Collection

1) Between 2 to 3 trips are made per day.

2) The work is assessed to be quite efficient.

3) Collection workers assigned to compactor trucks are generally skilled and use techniques to collect waste quickly. One of methods used is where a collection worker gathers waste bags along a street with very little traffic before a truck arrives, thus changing the curb collection to a point collection system to minimize the stopping and starting time of a truck. Another method is where a collection worker shifts waste bags from one side of the curb to the other so that the truck does not have to make a round trip to collect waste along the other lane.

4) Some compactor trucks ring a bell to inform people of their arrival. However this practice is not necessary as people are well aware of the collection days.

5) A 13 m^3 compactor truck is slightly too large in the places where roads are generally narrow and also busy, like the downtown districts. A 8 m^3 compactor truck is considered to be more suited to these areas.

6) The time that collection workers spend to sort wastes is estimated to be about 10 % of the total. It, therefore, does not seriously affect the overall productivity of the collection work.

7) Collection workers cannot spend much time sorting waste in areas where traffic is heavy like the downtown districts. However, they can still collect a large amount of paper and aluminum for recycling because these areas have many shops and offices, some of which discharge a large amount of paper separately.

8) Compactors are used in the high and middle income residential areas and commercial areas where the roads are all paved.

9) In the center of Comayaguela and near the central park of Tegucigalpa, waste collection becomes arduous after 7 am due to the heavy traffic and narrow streets.

10) The attitude of residents in the middle income residential areas toward the collection workers is generally considerate as they provide the workers with refreshments.

11) Residents' waste discharge manner is generally good.

c. 6 Ton Dump Truck Collection

1) Two (2) trips are made daily.

2) The work is assessed to be inefficient.

3) Most dump trucks operate under a bell collection system. This system reduces the productivity of garbage collection. If regular collection is reliable, this system should be abolished; the AMDC should request people to discharge waste on fixed collection days before a truck arrives.

4) Most collection areas where dump trucks operate have narrow inaccessible roads.

5) Productivity of the dump truck collection system is assessed to be low due to the bell collection method, poor accessibility, and excessive height of the vehicle for loading waste, etc.

6) Most of the unpaved places in the low income residential area except marginal areas are not so far from paved roads. Residents are willing to carry waste to their nearest road.

7) Residents from the dump truck collection area often request collection workers to return their garbage container such as plastic bags, gunny sacks, cartons, etc.

8) Less valuable materials are contained in the waste discharged in the areas where dump trucks operate.

9) A large volume of waste spills from the top of dump trucks during haulage, as there is no cover sheet.

10) Garbage collection work for those assigned to dump trucks is extremely unhygienic and very labor intensive.

d. Arm-roll Truck with 12 m^3 Container Collection

1) On average 6 trips are made per day.

2) The work is assessed to be quite efficient.

3) A large amount of waste overflow from the top of the trucks during transportation due to the lack of a cover sheet.

4) Garbage is scattered around the containers. The following two reasons are suspected.

- The height of container (1.8 m) is too high for people to place their garbage.
- Commercial dischargers dispose their waste improperly.

e. Hoist truck with 5 m^3 Container

1) Approximately 4.5 trips are made daily. The present work is inefficient.

2) The number of trips made could be increased, if there are more skips. In Tegucigalpa, a hoist truck is estimated to handle 15 skips.

3) The hoist truck is sometimes used instead of a dump truck, such as transporting workers and collecting waste.

4) The area surrounding skips is relatively clean unlike the area around the 12 m^3 containers.

5) A large volume of waste is scattered from the skips during transportation as cover sheets are not being used.

Chapter 9

Public Opinion Surveys

9. Public Opinion Surveys

Public Opinion Surveys for the urban area of the Central District was conducted between February 7th and February 25th, 1998 by a team of 9 surveyors.

9.1 Description of the Survey

The objectives of the survey were to determine: (1) whether the residents are satisfied with the current solid waste management services; (2) their needs; and (3) storage and discharge manners. The questionnaire focused on:

- General questions
- Present situation of public services
- Waste discharge from premises
- Garbage collection services
- Recycling and waste reduction
- Collection fee and financial matters
- Public cooperation
- Grave issues regarding solid waste management

9.2 Survey methodology

The Engineer gave instructions on survey methodology to the surveyors, who asked questions directly to the interviewees. Three hundred people from different families in the study area were interviewed, as indicated in Table 9-1. The population ratios by income levels were not taken into account to determine the number of samples due to the limited number of participants.

Table 9-1: List of Participants

Sub-category	Discharger	N° of participants
High income	Col. Palmira	25
	Col. Florencia	25
	Col. Miramonte	25
	Col. America	25
Middle income	Barrio Lempira	25
	Barrio Villa Adela	25
	Col. Kennedy	25
	El Hato de Enmedio	25
Low income	Col. Suazo Córdova	25
	Col. San Miguel	25
	Col. Alemania	25
	Col. 3 de Mayo	25

9.3 Analysis of the Public Opinion Survey

9.3.1 General Questions

1) In the high and middle-income areas, the average family size is five persons.

2) In the low-income area, the number of people per household varies between one and twenty-one. However, the average family size is five persons.

3) In the high-income area, 89% of the respondents replied that they live in a detached house. In the middle and low-income areas, 75% and 97% replied that they live in a detached house, respectively .

4) In the high-income area 81% replied that they owner-residents. In the middle and low-income areas, 63% and 90% replied that they live in the house they own.

5) In the high-income area, 58% of households have less than 100m^2 of garden space.

6) In the middle and low-income areas, 52% and 41% do not have a garden.

7) In all of the areas surveyed, the father is the bread-winner of the family.

8) In the high-income area, 24 households replied there are one or two children with a source of income. In the middle and low-income areas, 19 and 35 households, respectively, replied the children have an income.

9) In the high-income area, 39% replied that their monthly family expenditure is between Lps 5,000.00 and Lps 9,999.00; only one household has a monthly expenditure of less than Lps 1,000.00. In the middle-income area, 29% of the households have a monthly expenditure ranging from Lps 2,000.00 and Lps 2,999.00 and 29% between Lps 3,000.00 and Lps 3,999.00. In the low-income area, 54% of the households have a monthly expenditure within the Lps 1,000.00 to Lps 1,999.00 bracket.

10) In the high-income area, 74% replied that they have lived in the Central District for more than 20 years; only 4% replied that they have lived in the Central District for less than 5 years. In the middle and low income areas, 67% and 77% replied they have live in the city for more than 20 years; 12% and 2% have lived in the Central District for less than 5 years.

9.3.2 Present Situation of Public Services

1) In the high and middle-income areas, all respondents have a water supply and in the low-income area the figure was 99%.

2) In the high-income area, 99% of the households have flush toilets connected to sewage pipes, in the middle-income area this rate is 95%, and in the low-income area the figure is down to 56%.

3) All of the households in the high-income area have electricity; 96% in the middle-income and 99% in the low-income area have an electrical supply. ENEE is the sole provider of this service.

4) In the high-income area, 94% of the roads have asphalt/ concrete/ brick paving, but all residential buildings have an access road and only 1% is unpaved. In the middle-income area 84% of the surveyed households have an access road; 89% of the roads are paved, 1% has gravel and 10% are unpaved. In the low-income area 80% replied that they have an access road; 6% of the roads are paved, 15% have gravel and 79% are unpaved.

5) Of the various public services (water supply, stormwater drainage, sewer pipe network, wastewater collection, garbage collection, electricity supply, access road) the highest priority was given to garbage collection.

9.3.3 Waste Discharge from Premises

1) In the high-income area, 92% of the respondents discharge their waste to a specific location.

2) In the middle and low-income areas, 81% and 64% replied that they discharge their waste to a specific location.

3) The most common container used to dispose waste in all three categories is the plastic bag; the main reason being the ease in handling.

4) Fifty six percent of the respondents of the high-income area replied that they generate garden waste.

5) The majority of the surveyed households replied that they take their waste to a collection point.

9.3.4 Refuse Collection Services

1) Nearly all the respondents have a garbage collection service in their area and only 29% in the low-income area do not receive this service.

2) The main collector of garbage in the CD is the AMDC, only 3% hand their waste to private collectors.

3) In the high and middle-income areas, nearly 30% of the respondents are dissatisfied with the collection service; the figure is only 21% for the low-income area.

4) Almost all the respondents say they carry their refuse to the front of the house.

5) In the high and middle-income areas, the frequency of the collection service is twice a week. In the low-income area 57% receive the service once a week.

6) Most of the collection service is conducted at a fixed time; most of the respondents answered they want a collection service.

9.3.5 Recycling and Waste Reduction

1) Overall, 91% of the respondents said that they would cooperate if the AMDC changes the system.

2) The main reasons for not cooperating with the new system were that the new system would require more effort that may increase collection and discharging costs.

3) Ninety nine percent of all the respondents thought that recycling is necessary for Tegucigalpa. However, 49% of the respondents say that no one collects their recyclable waste.

4) The most commonly collected recyclable materials are bottles, paper and aluminum cans.

5) Ninety seven percent of the respondents do not sell recyclable materials to shops.

6) Among those who sell recyclable materials the most commonly sold items are bottles, paper and aluminum cans.

7) In all the areas, 81% expressed their willingness to contribute to community fund raising activities.

8) Eighty nine percent of the respondents do not use kitchen or garden waste for compost.

9.3.6 Collection Fee and Financial Matters

1) In all the areas, the majority responded that they believe the AMDC is responsible for solid waste management.

2) Seventy four percent of the respondents are satisfied with the present solid waste management system being carried out by the AMDC.

3) Almost all the respondents replied that they do not know how much they pay for the collection service; among those who know the amount paid for collection, the average is Lps 200.00 per year.

4) Eighty one percent of the respondents from all areas consider the collection fee to be appropriate, 12% think it is expensive, 6% think it is cheap and only 1% think it is not fair.

5) The maximum amount of waste collection fee people are willing to pay are as follows.

- High income residents: 40 Lps/month
- Middle income residents: 30 Lps/month
- Low income residents: 20 Lps/month

6) The most preferred method of payment is a lump sum for the year followed by monthly installments.

7) Fifty six percent of the respondents do not accept the present billing system, nearly 100% would not accept joint billing along with either income tax, water supply or electricity bill. Fifty six percent of the respondents would prefer an independent billing system.

9.3.7 Public Cooperation

1) In the high-income area, 52% of the respondents have not been instructed on proper waste discharge. In the middle and low-income areas, 42% and 72% respectively have not been taught methods of proper waste discharge.

2) Seventy five percent of the respondents in the high-income area answered that someone in their household cleans the road shoulder or adjacent public area in

front of their premises; this percentage rises to 88% and 79% in the middle and low-income areas.

3) Ninety-eight percent of the respondents in all areas believe public cooperation is essential to maintain a cleaner city and environment, and are willing to cooperate.

4) Almost all of the respondents think that public education and campaigning is necessary to maintain a cleaner city and environment, and that the AMDC is responsible for such actions.

9.3.8 Grave Issues Regarding Solid Waste Management

1) The main concern among respondents related to solid waste management is that illegally dumped garbage causes offensive odor followed by the high incidence of pests (mice and rats).

9.4 Results of the Survey

The tabulated results and graphs for the Public Opinion Survey distributed to Households are included in the Data Book.

Chapter 10

Large Dischargers' Opinion Surveys

10. Large Dischargers' Opinion Surveys

10.1 Description of the Survey

The objectives of the survey were: (1) to understand the present solid waste collection system; (2) to determine whether the large dischargers are satisfied with the current solid waste management services; (3) their needs; and (4) storage and discharge manners.

The questionnaire focused on various different issues depending on the type of discharger.

10.2 Survey methodology

The method followed by the surveyor was instructed by the Engineer, who asked questions directly to the interviewees. Fifty-seven large dischargers from the study area were interviewed, as indicated in Table 10-1.

Table 10-1: List of Samples of Large Dischargers

Sub-category		Discharger
Markets	4	• Zonal Belén • San Isidro • YIP • Mas x Menos
University	1	• UNAH
Large offices	10	• CELTEL • BAYER de Honduras • CINSA • Banco Atlántida • Min. de Educación • Min. de Salud • Banco de Occidente • Banco Ficohsa • Banco BCIE • Biblioteca Nacional
Restaurants	5	• Burger King • China Palace • El Corral • Bigos • Pizza Hut
Hotels	5	• Honduras Maya • Nan Kin • Kosta Sula (Ritz) • Plaza San Martin • Alameda
Shops	20	• Sala de Belleza Maine • Farmacia Central • Utiles de Honduras • Pani • Tempo Kids • Foto Angel • Silenciadores Auto Sport • Tiendas Diunsa • Xerox • Super Donuts • Chinda Diaz • Super Telas • Dimesa • Dunkin' Donuts • Lady Lee • Alphagraphics • Angel, Foto Studio • Delicatessen • Larach & Cia. • Gasolinera Texaco Guanacaste
Factories	10	• Pepsi • Cervecería Hondureña • Lido • Quimicas Dinant
		• Textiles Río Lindo • Hondulit • Derimasa • FAMAGRO • Monsina • Quiñonez Industrial
Hospitals	2	• San Felipe • IHSS

10.3 Results of the Survey

The tabulated results and graphs for the Public Opinion Survey distributed to Large Dischargers are included in the Data Book.

Chapter 11

Market Research on Compost

11. Market Research on Compost

11.1 Introduction

The production of compost from organic waste, used to enrich soil, is a waste treatment option and is sometimes used in developing countries because it requires relatively simple technology.

When the financial feasibility of composting is assessed, the most important issues to be examined are:

- the haulage cost of compost from a compost plant to the users.
- the prices of competing products such as chicken manure, chemical fertilizer, etc.

The above mentioned issues can often be serious hindrances for utilizing compost, and therefore the study team investigated these matters.

11.2 Current Status of the Demand for Compost in Francisco Morazan Province

Table 11-1 shows the extent of agricultural activities that may require some kind of fertilizer in Francisco Morazan Province covering the Central District.

Table 11-1: Species Cultivated in Francisco Morazan Province

Species cultivated	Horticultural	Fruit Cultivation	Floriculture
Beet (Beta Vulgaris)	+		
Achiote (Bixa Orellana Linn)	+		
Cotton (Gossyplum Hirsutum)			+
Anise (Pimpinella Anisum)	+		
Annona (Annona Cherimola Mill)		+	
Anturium (Anthurium Andraenum)			+
Celery (Apium Graveolens L)	+		
Chinese Pea (Pisum Sativum)	+		
Paradise bird (Strellitzia reginae, strelitzia augusta)			+
Brocoli (Brassica Oleracea)	+		
Peanuts (mani)		+	
Sweet potato (Ipomea Batatas)	+		
Sugar cane	+		
Onion	+		
Sweet pepper, tabasco pepper, jalapeño pepper	+		
Carnation (Dianthus Caryophyllus)			+
Brussels sprout (Brassica Olearacea)	+		
Cauliflower (Brassica Oleranea)	+		
Chrysanthemum			+
Asparagus (Asparagus Officinalis)	+		
Strawberry		+	
Cattail			+
Granadilla		+	
Soursop		+	
Guava		+	
Lettuce	+		
Litchi		+	
Sweet corn	+		
Mandarin		+	
Apple		+	
Maracuyá		+	
Peach		+	
Quince		+	
Black Berry		+	
Sweet Orange		+	
Potato	+		
Papaya		+	
Loofah (Luffe Cylindrica)		+	
Pataste (Lufla Cylindrica)	+		
Pear		+	
Parsley	+		
Pimento gorda	+		
Carrot	+		

Source: the Private Investment in the Honduran Economy, Agricultural Sector, Planning Unit (A.S.P.U.), Livestock and Agricultural Ministry

The use of compost produced from waste is often limited to floriculture in industrialized countries because of the difficulty in eliminating the possibility of contamination by toxic matters in waste. In Francisco Morazan Province, it has been confirmed that there are some floricultural activities that could use compost made from waste.

11.3 Status of Existing Compost Competitors

11.3.1 Chemical Fertilizer

Table 11-2 shows the types and prices of chemical fertilizers that are currently used in Francisco Morazan Province.

Table 11-2: Prices of Chemical Fertilizer used in Francisco Morazan

Fertilizer	Formulae	Price
Urea	46%	Lps. 100 /qq[20] Lps. 2,200 /ton
12.24.12	Nitrogen, Phosphorous, Potassium	
18.46.0	Ammonium Phosphate	Lps. 173 /qq Lps. 3,190 /qq
15.15.15	Nitrogen, Phosphorous, Potassium	Lps. 152 /qq Lps. 3,344 /ton
Aminocat	Nitrogen, Phosphorous, Potassium	Lps. 3,125 /25liter
Biocat 15	Humic Acid	Lps. 90 /liter
Kelik Boro al 15%	Soluborato, Poluborato	Lps. 138 /liter
Kelik Ca-B	Calcium and Boron	Lps. 156 /liter
Kelik Mix	Calcium, Boron, Iron and Manganese	Lps. 188 /liter
Kelik Zinc	Zinc (Zn)	Lps. 200 /liter
Plantifol 12-6-36	Nitrogen, Phosphorous, Potassium	Lps. 220 /5kg
Plantifol 20-20-20	Nitrogen, Phosphorous, Potassium	Lps. 190 /5kg
0.0.60 Standard Potassium Nitrate	Potassium	Lps. 110 /qq
Bloom Plus 10-60-10	Nitrogen, Phosphorous, Potassium	Lps. 43 /10 ounces
Plant food 20-30-20	Nitrogen, Phosphorous, Potassium	Lps. 37 /10ounces
Humus forte LT	14% Humic Acid	Lps. 40.00 /gallon

Some of the fertilizers mentioned above, are made by hydrolyzing the bark of almond trees.
Source: Fertica, Agromosa and Fumitec.

The economic use of fertilizers is imperative, and in particular inappropriate and excess use of it, not only represent wastage but it can also damage the soil and environment. The types and quantities to be used depend on the type of soil and crop. Nitrogen is often the main element, but phosphorus and potassium are required frequently; it may also be necessary to use lime for acidic soil. Observation and testing of soil and fertilizers, could determine the type and class of fertilizer to be use.

11.3.2 Chicken Manure

The price of chicken manure is around Lps.2.00 per qq, excluding transportation from the farm, according to information from the Aviasa poultry farm in La Paz City and the National Association of Poultry Farmers.

Currently, there are 36 egg producers and 24 chicken producers in Francisco Morazan Province, representing more than 2.3 million birds.

[20] qq stands for quintales. It is equivalent to approximately 45 kg.

Table 11-3: Number of Poultry Yards by Category in Francisco Morazan Province

	Number	Number of yards
Roosters	36,910	
Hens	573,931 (produces 317,000 eggs per day)	
Pullet	1,481,046	
Chicks	248,682	17,973
Turkeys	4,896	1,056
Ducks, geese	10,539	2,319
Total	2,636,094	18,022

c. Humus

In Francisco Morazan, nurseries make humus for sale, which is produced by adding sawdust and dry leaves to peat. The average amount of humus produced per month is 25 m^3. The current prices of humus excluding transportation costs are:

- Lps. 100 /m^3; and
- Lps. 4/20 lb.

Chapter 12

Project Cycle Management (PCM) Workshop on Final Disposal

12. Project Cycle Management (PCM) Workshop on Final Disposal

12.1 Introduction

During the course of selecting the contents of the pilot project, the Project Cycle Management (PCM) method can be useful as an effective tool. It provides a basic structure for specifying the components of a project and the logical links between a set of means and a set of ends.

In the workshop, the first three analyses of the PCM method were carried. This is because the objectives of the workshop were limited to ascertaining the current state of final disposal and to understand the needs of the people concerned; the outcome of the workshop was reflected in one of the pilot projects, that is, the improvement of the final disposal site.

The first three analyses comprised of:

- Participation Analysis
- Problem Analysis
- Objectives Analysis

In the PCM method, identification of the people who may be affected by the projects is a requirement as a starting point (participation analysis). Secondly, problems should be identified as the subject or focus of the analysis, by first listing all major existing problems through a discussion with the people selected in the participation analysis. After the core problem is set, the cause/effect relationships between them, in the form of a "problem tree diagram" is developed, as shown in

. This problem tree is to be transformed into an "objectives tree" by altering the negative expressions of the problem tree into positive statements, that are analyzed in the third stage.

One of the advantages of a workshop using the PCM method is that it enables the opinions of the people concerned with the projects to be reflected, by inviting them as participants of the discussion.

The workshop was held at the Hotel Krystal located in the city center, from 11:30am to 4:30pm on Friday, February 6, 1998. The conference venue was carefully selected taking into account accessibility and suitability for the workshop. Since a broad spectrum of people (different social status, backgrounds, etc.) were to attend the workshop, such as representatives of residents, scavengers, AMDC officials, and the JICA Study Team, a medium-class hotel was assessed to be most appropriate. In order to give the participants the opportunity to get acquainted with each other and feel more at ease, so that they can articulate their opinions during the workshop, lunch was served just before the workshop began.

Two Nicaraguans, who not only have experiences in the PCM method but also expertise in the solid waste management field, were chosen as a moderator and a co-

moderator. Because the two moderators are supposed to take a neutral stance during the discussion, neither Hondurans nor Japanese experts were chosen. This reason being that there is a possibility Honduran experts, if selected, may subconsciously sway from an objective standpoint, as their lives are apt to be affected by issues related to solid waste management in the Central District. Similarly, Japanese experts were not considered for a position as moderators, in order to eliminate all possibilities of partiality as an aid agency representative.

Spanish was the language of the workshop, however, an English/Spanish interpreter was available for non-Spanish speakers and participants.

Questionnaires were distributed to the participants three days in advance to prepare them for the workshop. The two questions asked were:

1) What is the main problem of the present landfill site?

2) In your opinion, what would be the solution to the problem?

Prior to the beginning of the discussion, a brief explanation on the present situation of the final disposal site was given by the JICA Study Team, as a basis for the subsequent discussion.

Each participant was requested to follow the PCM rules listed below.

- To write only one idea per card
- To describe using clear and brief sentences
- To obtain a consensus when removing cards from the board

12.2 Participation Analysis

Individuals, groups, and organizations that may be affected by the improvement of the present landfill site were identified by the JICA Study Team and thirteen people were invited to the workshop as participants as shown in the table below. When selecting the participants, an even balance between the number of participants associated with the municipal authority and the residents, including scavengers, was taken into account to avoid a one-sided discussion.

Representatives from the municipality, such as from the Urban Development and Social Development Departments, and Cleansing and Environment Sections were invited. The improvement of the landfill site has a great impact on various members of society; one example is the loss of livelihood experienced by scavengers, who are currently picking waste at the site, when they are restricted from entering the sanitary landfill site. Therefore, the representatives from the Social Development Department were invited. The officials from the municipality were categorized as "decision makers" and/or "implementing agency".

Specialists of the final disposal site planning, and collection and haulage plan in the JICA Study Team participated in the discussions with the JICA Study Team. They are categorized as members of the "cooperation agency".

As for the residents, a community leader representing those that live near the disposal site, categorized as a "beneficiary" and "community leader", was also invited.

Representatives of residents living far from the disposal site, were simply categorized as a "beneficiary".

A scavenger leader, who employs 20 scavengers that collect metals and plastics, was invited as an "affected group", and a "potential opponent". In consideration of the gender issues, two women scavengers with children were also invited.

Table 3- 1 : List of Participants

Category	Representatives (Number of Participants)
"Decision Makers" "Implementing Agency"	• Urban Development Department (1) • Social Development Department (1) • Cleansing Section (1) • Environment Section (1) • Inspector working at the final disposal site (1)
"Cooperation Agency"	• JICA Study Team (2)
"Beneficiary"	• Community Leader representing neighbors of the disposal site (1) • Resident living far from the disposal site (1) • Scavengers (4)
"Affected Group"	• Scavengers
"Community Leader"	• Community Leader, representing neighbors of the disposal site
"Potential opponent"	• Scavengers

12.3 Problem Analysis

Many problems with regard to the present disposal site were raised from the participants as shown below:

- Landfill site operations are inadequate
- Propagation of vermin
- Water contamination
- Air pollution (bad odor, smoke)
- Soil pollution
- Landscape deterioration
- Scavengers are working at the landfill site (unauthorized)
- Entry of domestic animals is permitted
- Medical wastes are also disposed
- Soil cover is not carried out promptly
- Occupational and public health hazards imposed on scavengers and residents near the disposal site, caused by smoke generated from burning of waste

"Landfill site operations are inadequate" was then selected as the "core problem" throughout the discussion. The main substantial and direct causes/effects of the core problem were identified as follows;

(Causes)

1) Cover soil is not carried out promptly

2) Spare parts are not readily available to repair broken vehicles

3) Municipal staff at the disposal site are not familiar with proper landfill operations

(Effects)

1) Scavengers are exposed to hazards
2) Generation of unpleasant odor and smoke
3) Vector proliferation
4) Water & air pollution are becoming critical

In the problem analysis, the cause/effect relationship was carefully examined when developing the "problem tree".

Using all the items mentioned during the problem analysis, including the grass-root causes and effects, the problem tree was constructed as shown in Figure 12-1.

12.4 Objectives Analysis

Through dialogue during the workshop, the problem tree was then transformed into an "objectives tree", that describes the means to solve the problems and envisaged results of the solutions. The objectives tree identifies desirable conditions after the problems are solved. This helps examine the various approaches to improve the situation. By carefully examining the "means/ends" relationship of the cards, the objectives tree was constructed as shown in Figure 12-2.

Problem Tree

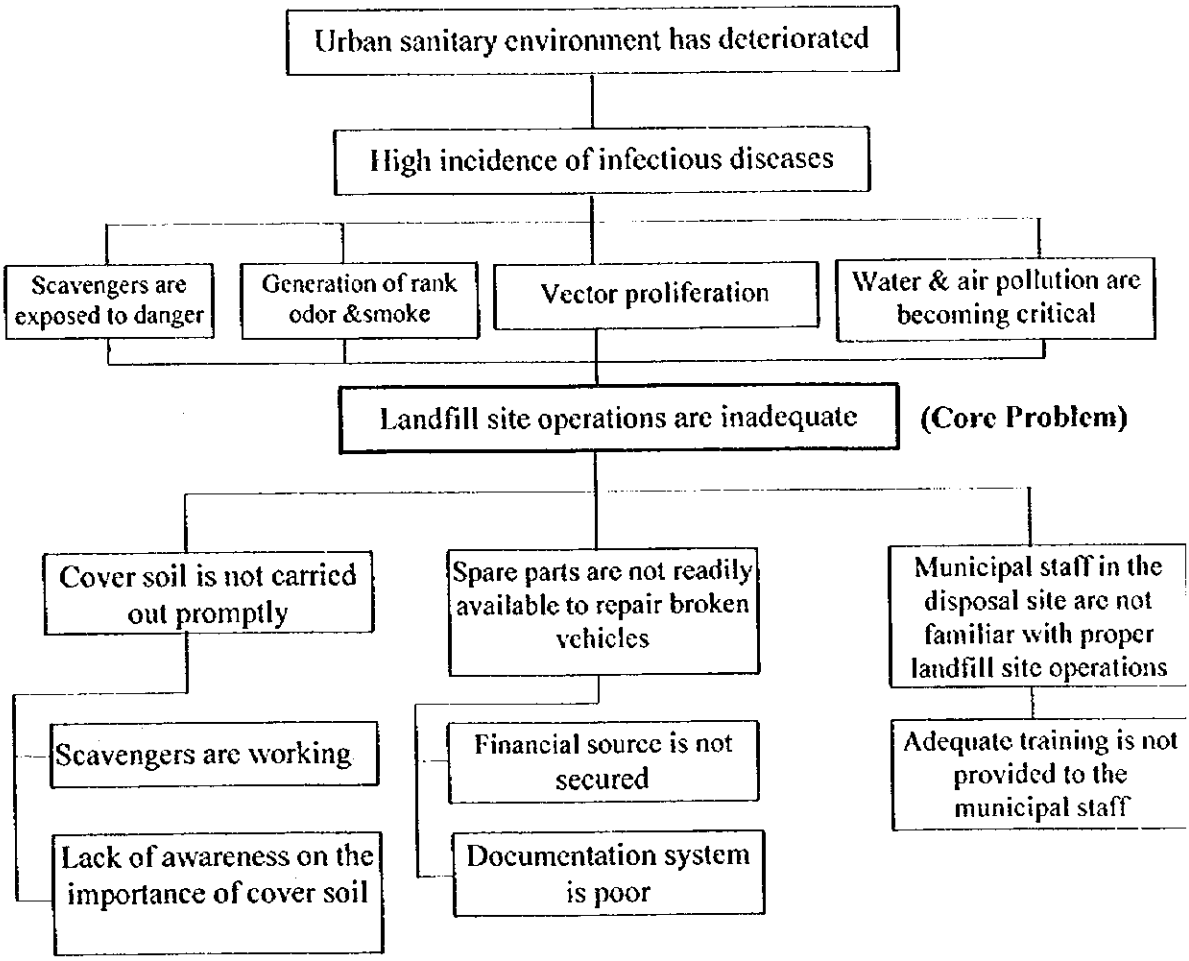

Figure 12-1: Problem Tree

Objectives Tree

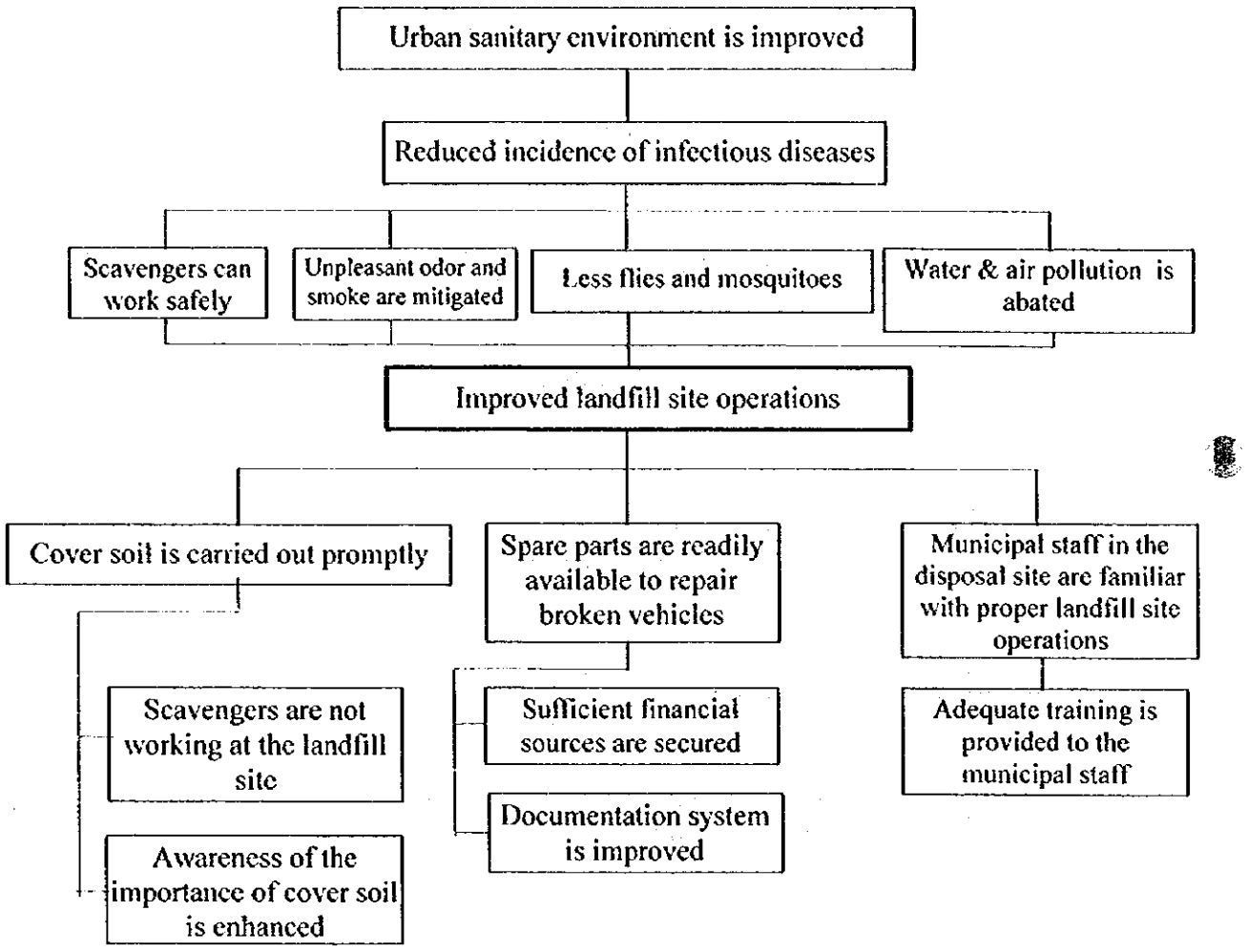

Figure 12-2: Objectives Tree

12.5 Conclusions and Remarks

Through a fruitful discussion, problems related to the present final disposal and the needs of the people were identified. It was evident that everyone perceived the importance of taking some decisive measures to improve the present situation of the final disposal site, as quickly as possible. The biggest concern expressed was the grave health risk associated with the operation of the current disposal practices at the site. In particular, the community leader representing neighbors of the disposal site reiterated the concerns voiced by the residents about the air and water pollution resulting from the current disposal site.

Participants agreed that better landfill operations would contribute to the improvement of the present landfill site state, and consequently the sanitary environment. Improvement of cover soil application procedures, making spare parts for repair of broken down vehicles readily available, and effective provision of vocational training to municipal staff at the disposal site on proper landfill site operations, are suggested as being solutions to the present problems.

Feedback from the participants was very positive. Participants appreciated the opportunity to frankly exchange views on the improvement of the final disposal site, which is one of the most urgent issues that need to be dealt with in the Central District. At the end of the workshop, participants agreed that their overall awareness of critical issues related to waste was raised through discussions with the people concerned.

It was also very encouraging to see that a large number of people expressed their interest in participating in the workshop. Although the number of those wishing to attend the workshop exceeded twenty people, the number had to be restricted in order to carry out the discussion more smoothly.