社会開発調査部報告書

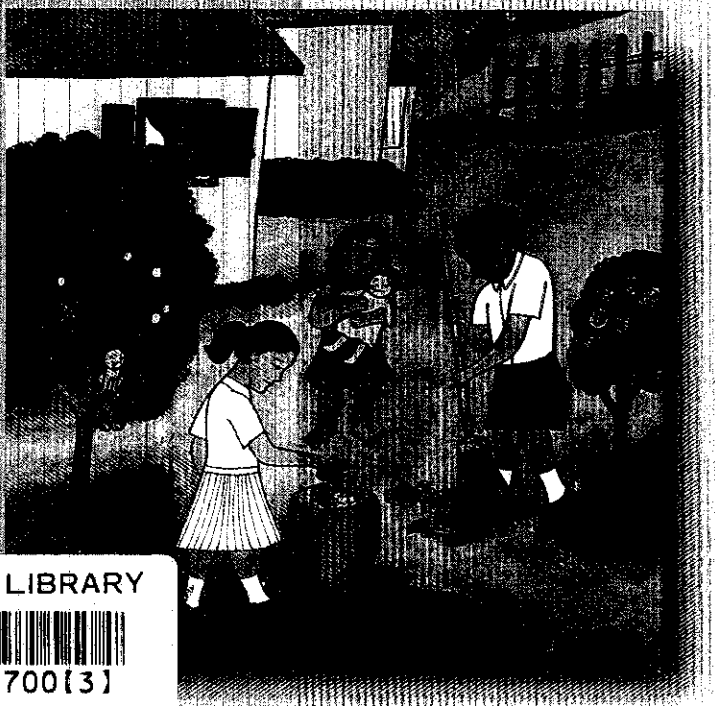
NO. 2

JICA

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
Ministry of Home Affairs, Provincial Councils and Local Government
Democratic Socialist Republic of Sri Lanka

THE STUDY ON IMPROVEMENT OF SOLID WASTE MANAGEMENT IN SECONDARY CITIES IN SRI LANKA

ACTION PLAN FOR MATALE
FINAL REPORT
Volume V-5B
SUPPORTING REPORT



JAPAN INTERNATIONAL COOPERATION AGENCY(JICA)
Ministry of Home Affairs, Provincial Councils and Local Government
Democratic Socialist Republic of Sri Lanka

THE STUDY ON IMPROVEMENT OF SOLID WASTE MANAGEMENT IN SECONDARY CITIES IN SRI LANKA

ACTION PLAN FOR MATALE

FINAL REPORT

Volume V-5B

SUPPORTING REPORT

DECEMBER 2003

KOKUSAI KOGYO CO.,LTD.

List of Volumes

Volume	Name of Reports
I	Summary
II	Main Report
III	Supporting Report
IV	SWM Guideline for Local Governments
V-1A	Action Plan for Badulla, Main Report
V-1B	Action Plan for Badulla, Supporting Report
V-2A	Action Plan for Chilaw, Main Report
V-2B	Action Plan for Chilaw, Supporting Report
V-3A	Action Plan for Gampaha, Main Report
V-3B	Action Plan for Gampaha, Supporting Report
V-4A	Action Plan for Kandy, Main Report
V-4B	Action Plan for Kandy, Supporting Report
V-5A	Action Plan for Matale, Main Report
V-5B	Action Plan for Matale, Supporting Report
V-6A	Action Plan for Negombo, Main Report
V-6B	Action Plan for Negombo, Supporting Report
V-7A	Action Plan for Nuwara Eliya, Main Report
V-7B	Action Plan for Nuwara Eliya, Supporting Report

This is Action Plan for Matale,

Supporting Report.

In this report, the project cost is estimated using the September 2003 prices and at an exchange rate of 1 US$ = 117.02 Japanese Yen = 95.28 Rupees

Contents

List of Abbreviations

CDA	Community Development Assistant
CDO	Community Development Officer
CEA	Central Environmental Authority
DEO	Divisional Environmental Officer
DF/R	Draft Final Report
EIA	Environmental Impact Assessment
F/S	Feasibility Study
GDP	Gross Domestic Product
IC/R	Inception Report
IDP	Infectious Disease Prevention
IEE	Initial Environmental Examination
JBIC	Japan Bank for International Cooperation
JICA	Japan International Cooperation Agency
MMA	Matale Municipal Area
MMC	Matale Municipal Council
MOH	Medical Officer of Health
M/M	Minutes of Meeting
MOHALG	Ministry of Home Affairs, Provincial Councils and Local Government
MSW	Municipal Solid Waste
MSWM	Municipal Solid Waste Management
NGO	Non-Governmental Organisation
O&M	Operation and Maintenance
PDM	Project Design Matrix
PHI	Public Health Inspector
POS	Public Opinion Survey
P/R	Progress Report
S/W	Scope of Work
SWM	Solid Waste Management
WTP	Willingness to Pay

Chapter 1

Matale Waste Stream Data

Contents

Page:

List of Tables

List of Figures

Chapter 1 Waste Stream Data

1.1 Introduction

This section summarises information collected from field investigations carried out from May-July 2002, undertaken primarily to quantify the waste stream for the Matale Municipal Area (MMA). It complements and provides further information concerning the waste stream data, assists in understanding the present MMA solid waste management (SWM) system and identifies some issues that do or may need to be addressed at some stage in the future.

1.2 Households

Household statistics were obtained from the provisional results of the July 2001 Census (total MMA population of 36,331 people in 7,329 households[1], equivalent to 5.0 people per household) and average population compound growth rate of 1.0% over 1981-2001, giving a 2002 population of 36,696. There is an additional estimated 9,500 "floating" population, representing people who come into the city to undertake their daily activities, but then return to their homes at night, which are outside the city limits.

Information on household waste generation and management practices was obtained from a survey of 120 households in six different areas of the city, covering two high, two middle and two low income areas and a Waste Amount and Composition survey (WACS) of 90 households in the same six areas. All of these households were located in areas where the garbage is collected by MMC, while the overall MMA garbage collection service coverage is ~85%. Hence, these survey results were adjusted to account for other parts of the city not provided with a garbage collection service in order to estimate the proportions of garbage disposed of by different means for the entire MMA. The corresponding results are tabulated below and give a household waste generation rate of 0.45kg/person.d, equivalent to 16.5T/d.

Table 1-1: Household Waste Management

Waste Management Method	Households in Survey Area (%)	Households in MMA (adjusted %)	Waste Amount (T/d)
Self-disposal	21.5	29.1	4.80
Discharge for MMC collection	70.3	59.7	9.88
Home composting	2.7	3.6	0.60
Recycling	3.7	5.0	0.83
Illegal dumping	1.9	2.6	0.42
Total	100.0	100.0	16.54

Notes:

1. Average household waste discharge rate = 0.422kg/person.d, representing garbage that is normally discharged for collection, illegally dumped or disposed of on-site (WACS survey).
2. Average household waste generation rate = 0.422/((0.215+0.703+0.019) = 0.451kg/person.d.
3. Estimated 2002 population = 36,331 x 1.010 = 36,696.
4. Total household waste generation = 36,696 persons x 0.451kg/person.d = 16.5T/d.
5. Waste amounts disposed of by different means calculated using total waste generation x adjusted percentages in above table, which relate to the entire MMA.

[1] Source = Matale Divisional Secretariat

Household waste is mainly organic, comprising 81-84 wt% organic waste (food/kitchen and garden/wood), 4-9 wt% paper and 10-12 wt% inorganic materials.

1.3 Commercial Sector

1.3.1 Commercial Enterprises

Commercial enterprises covers all commercial operations (e.g. restaurants, bakeries, retail shops, communications centres, banks, hotels, etc.) except for markets, which is classified as a separate category. This includes government or semi-government enterprises that operate commercial oriented businesses and services (e.g. banks, Post Office, Water Board, etc.)

According to 1997 UDA data, only 2.1% (18.4ha) of MMA is used for commercial activities, most of which is concentrated in the town centre along Trincomalee St, King St, Gongawela Rd, Dharmapala Mw and a number of small connecting roads (Town ward and part of Gongawela ward). There are also three main bus stands in the central city area (Nugagahamula, Ambagahamula and Gongawela bus stands).

Matale trade licence data provides an over-estimate of the total number of commercial enterprises within the city, as trade licences are issued on an "activity" rather than shop basis, meaning that one shop may have a number of trade licences. The total number of trade licences is 2,090[2]. This includes at least 65 local hotels[3], restaurants and bakeries.

Limited specific investigations were undertaken for commercial enterprises as part of this study, involving interview surveys of 14 small and 10 large commercial enterprises, covering six retail/wholesale shops, six small hotels/restaurants, two hotels (accommodation), two pharmacies, one butcher, two tailors, one salon, two communications centres, one bank and the Main Post Office. Estimated garbage generation and composition, based on the four most common waste types, are summarized below.

Table 1-2: Commercial Enterprises Waste Generation and Composition

Source	Estimated waste generation (kg/d)	Most common waste types
Small enterprises (14)	0.5 – 20	Pa > F/K > In > Ca > Te
Large retail/wholesale/ service (2)	10	Pa > Ca > F/K > Ga/Pl
Large hotels (eating)/ restaurants (5)	25 – 100	F/K > Pa >> In > Pl > Ca
Butcher (1)	30	F/K > Pa > In
Hotels (accommodation) (2)	10 - 70	F/K > Ga > Pa/Ca

Notes:
1. Waste generation amounts were estimated by the survey respondents. Such estimates are generally not very accurate, but give an indication of the amount of waste generated.
2. Waste types: Ca = cardboard, F/K = food/kitchen, Ga = garden, Gl = glass, In = inerts, Pa = paper, Pl = plastics, Te = textiles.

Commercial waste generation was estimated to be 6.5T/d, based on MMC night-shift collection records (average of 1.9 trips/night) and data collected from labourers during the time and motion

[2] Actual number = 2,147, subtracting 57 for Central market stalls, which are covered under market waste.
[3] Local hotels refers to small canteens/eating places with no accommodation, as distinct from hotels which provide accommodation.

study. This is equivalent to 3.1kg/(trade licence).d. Waste generation increases approximately 0.5-2 times on average during festivals/ special occasions (e.g. Poson, Vesak, Asala and Theru festivals, school holidays).

Three commercial enterprises produce very small quantities of hazardous waste, comprising ~1kg/mth of used razor blades from a salon and some unspecified hazardous wastes from two hotels/restaurants, all of which are disposed of with their normal garbage.

Most of these enterprises discharge their garbage for collection by MMC, except for a few places that burn some or all of their waste on site. The Rock House (hotel) composts around 20kg/mth of garden waste, while several small hotels/restaurants and CWE give recyclable items to individual collectors (primarily polysacks, gunny and sugar bags and tins) who visit their premises generally on a daily-weekly basis. Based on this information, it was estimated that 93.6% of commercial waste is collected by MMC, 5.4% is disposed of on-site primarily by burning (e.g. paper waste), 0.1% is composted and 0.8% is recycled.

1.3.2 Markets and Slaughterhouse

Matale has two main public markets – the Central market and Gongawela market, both located in the city centre, comprising a total of 79 active stalls (see table below). The former contains meat/fish, fruit and vegetable stalls, while the latter is more a retail market.

There are also some other "markets", which mainly contain retail shops, comprising the new Gongawela Shopping Complex (public market) and two private markets – Weezan Trades and Wazir Building. The Gongawela Shopping Complex has 100 stalls and opened in July 2002. However, only three stalls are currently active, due to no electricity supply and overdue payments by shop owners.

Table 1-3: Market Details

Market	Number of stalls						SWM Collection
	Meat/ fish	Vege/ fruit	Goods	Fancy goods	Others	Total	
Mainly meat/fish, fruit and vegetables							
Central market	8	12	21	10	3	54	MMC
Mainly retail							
Gongawela market	2	1	19	0	3	25	MMC
Gongawela Shopping complex		3				3	MMC
Meezan Traders (Pvt)	0	0	Unknown				MMC
Wazir Building	0	0	Unknown				MMC
Total	10	16	40	10	6	82	

Note: Stall numbers are based on currently functioning market stalls, as determined during JICA field surveys. More stall space is available at some of these markets but is not currently being utilized, including 2 stalls at the Gongawela market and 97 stalls/shops at the Gongawela market.

A "Pola" (daily market) is held daily near Gongawela market along the Gongawela Rd from early morning to around 8pm. This typically comprises around 100 stalls, increasing to 250 stalls on Sundays. Every trader has to pay 20Rs/d to buy a ticket from MMC allowing them to take part in the Pola.

Matale used to have a slaughterhouse but this has now been demolished with a new police station being constructed on the site. At present, MMC has given licences to three butchers, allowing them to slaughter animals. These licences are renewable on a monthly basis. The licensed butchers kill around 6 cows/day, peak kill rates rising during festivals rising to ~7 cows/day.

Market waste generation is made up of an average of 0.375 tractor loads/day (0.82T/d) from the Central market and average Pola market waste generation of 1.9 T/d.

Fish/meat/poultry offal/waste of 0.11T/d collected from the Central and Gongawela markets (72kg/d) and licensed butchers (34kg/d) by the MMC two wheel tractor.

This gives a total market waste generation amount of 2.8T/d[4]. During the festival season, market waste generation may increase by 50-100%.

Market waste is highly organic, with Central market waste comprising 82.4 wt% food/kitchen/garden and 9.7 wt% paper waste, while Gongawela market waste comprises 76.4 wt% food/kitchen/garden and 12.3wt% paper waste, the remaining waste being made up of inorganic materials.

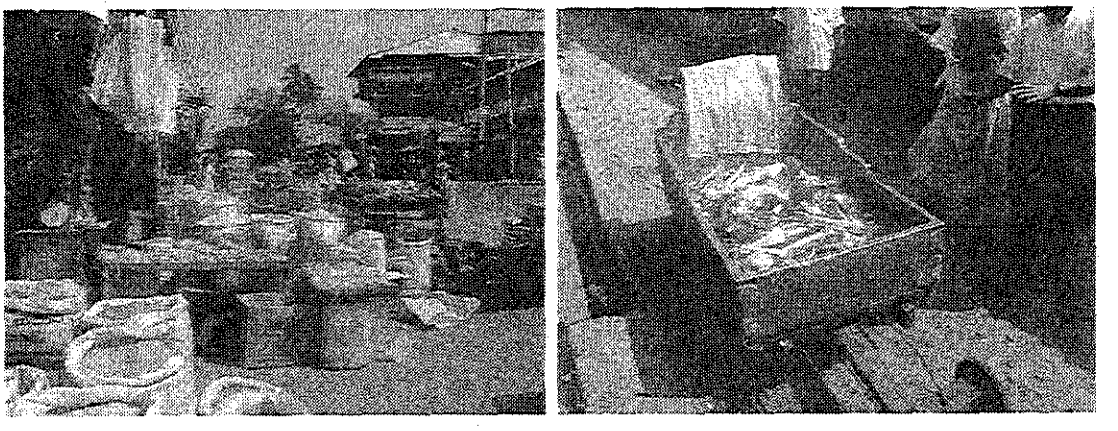
Fish/meat waste is supposed to be stored in a closed container at the Central market and on the floor in the Gongawela market, from where it is collected by MMC two wheel tractor.

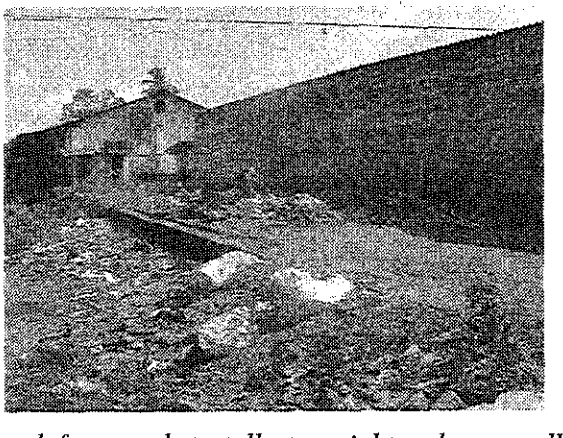
Animal bones are collected separately for recycling, being transported to Colombo through middlemen where they are used to manufacture "catlopaste" (filling agent) and fertilizer. Some animal body parts are also being sold as dog food. There is no other significant recycling activity at the two markets.

Additional information on the Central and Gongawela markets is set out below.

[4] Gongawela market waste (one handcart per day) has been included with commercial waste, due to this mainly being a retail market.

Central market meat stall and bin for meat/fish waste.





Gongawela market: Top left – market stall; top right – bones collected for recycling; bottom – Gongawela market bin.

1.3.3 Central Market

The Central market is primarily a retail market, comprising 54 stalls. The market is open seven days per week, except for Poya days, from 6:30am – 8:00pm. The PHI (Western Zone) is responsible for market waste collection and cleaning, with these tasks being undertaken by a Market Overseer, Caretaker and three labourers, working in two shifts (two labourers from 6am–2pm; one labourer from 2-7pm).

Meetings are held with market traders to discuss any issues of concern. Market by-laws require every trader to have a "plastic garbage bucket" in front of their stall. However, only a few stalls comply with this by-law.

MMC has provided some half barrels for garbage discharge, but despite this, most traders discharge their waste to the drain in front of their stalls, as they know it will be collected from here. MMC labourers collect market waste, using baskets and discharge it to a "collection point" within the market, from where it is collected daily by one of MMC's compactor trucks. Meat/fish waste are collected separately and stored in a covered plastic barrel (one barrel/d), from where it is collected daily by the MMC two wheel tractor.

Market garbage collection problems include:

- Poor trader cooperation
- Labourer management problems: market labourers are MMC employees and are often absent.
- Irregular/infrequent collection by MMC, causing market waste to stockpile, sometimes over several days, including some highly putrescible meat/fish waste. This is a major problem and market management has complained to the MMC SWM authorities on numerous occasions about this in recent years.
- The waste discharge, collection and transfer system needs improvement. Market traders should provide garbage bins for their stalls, while they should also be educated about appropriate waste discharge behaviour.

1.3.4 Gongawela Market

This retail market contains 24 stalls. Another two retail stalls are currently closed, this partly being due to their poor design. It is open seven days/wk from 6.30 to 8.00 pm, except on Poya days. The Senior Supervisor is responsible for market waste management and cleaning, with these tasks being undertaken by an Overseer, Caretaker and one labourer. Waste is collected three times/day by handcart and taken to the Gongawela market bin.

The main SWM problem at this market is poorly designed stalls, making it difficuilt to collect garbage.

1.4 Institutions

In this category, the focus of our investigations was on hospital waste, primarily due to the hazardous nature of some hospital waste (e.g. clinical, waste, sharps, body parts). Interviews were also conducted with some schools, other educational institutes, religious institutions, Police and government offices in order to estimate the amount and composition of waste generated by these sectors.

1.4.1 General

Interview survey results for institutional waste generation and composition data are set out below.

Table 1-4: Institutional Waste Generation and Composition

Source	Waste generation (kg/d)	Most common waste types
Schools (5) and other educational institutes (5)	5-500	Ga > Pa > F/K > Ca
Hospitals (3)	3-680	F/K > Ga/Ca > Pa > Pl/HH
Religious institutes/temples (3)	10-25	F/K > Ga/Pa > Pl
Police (1)	200	F/K > Ga > Pa > Ca > Pl
Government offices (3)	1-30	Pa > F/K > Ga > Ca

Notes: Waste types: F/K = food/kitchen, Pa = paper, Ca = cardboard, Ga = garden, Pl = plastics, In = inerts, Te = textiles, HH = hazardous healthcare waste

Institutional waste generation increases approximately 1-2 times on average during festival times and other special occasions. One tuition centre reported a 10 times increase in its waste generation at weekends.

Three institutions produce very small quantities of unspecified hazardous wastes.

1.4.2 Schools

Matale has a total of 17 schools, comprising 11 Type 1AB[5] schools, one Type 1C school, three Type 2 schools and one Type 3 school. The total estimated number of students and school staff are 18,929 and 863 respectively, giving a combined total of 19,792 students and staff. The student population amounts to 54% of the total MMA population (36,331), this being attributed to a large number of students commuting daily to schools within Matale from the surrounding area.

Interview surveys were conducted with five schools, including four of the largest schools, whose staff and students comprise 48% of the total school population. All of these five schools burn most of their garbage on-site, while three schools compost some garden waste and one school discharges some waste for collection by MMC. Based on this data, total school waste generation was estimated to be 1.8T/d, with 9.3% of this waste collected by MMC, 12% composted and 78.7% burned/buried on site. This equates to a waste generation rate of 0.091kg/(students+staff).d.

1.4.3 Other Educational Institutes

There are four other significant educational institutes within MMA, comprising two International Schools (Royal, Cambridge) and two tuition centres (Panhinda, Wasair) together with a smaller technical college (Affiliated Training Institute, ATI) and a number of other smaller institutes. The total estimated number of students and school staff at the five named institutes are 4,200 and 137 respectively, giving a combined total of 4,337.

Interview surveys were conducted with all five institutes. The Royal International School and ATI burn/bury all of their garbage on site, except for some of ATI's waste which they compost. The other institutes discharge all their garbage for collection by MMC. Based on this data, total other educational waste generation was estimated to be 0.08T/d, of which 27.8% is disposed of on-site,

[5] Type 1AB = Years 1-13 (sometimes 6-13) with A level science/commerce/arts; Type 1C = Years 1-13 (sometimes 6-13) with A level commerce/arts; Type 2 = Years 1-11 (up to O-level only); Type 3 = Years 1-5 (sometimes 9) primary.

3.5% is composted and the remaining 68.8% is collected by MMC. This equates to a waste generation rate of 0.018kg/(staff+students).d.

Waste generation was not increased to account for the other small institutes, nor any of the pre-school facilities present within Matale[6].

1.4.4 Hospitals

There are three (one government and two private) hospitals within MMA, as well as a number of medical centres/dispensaries. The main survey results, including hospital statistical data are set out in the following two tables and summarized below:

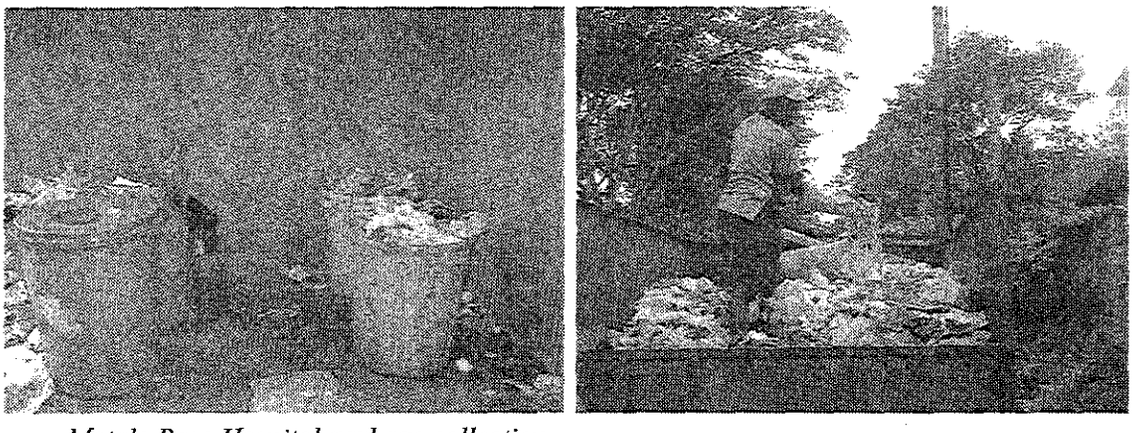
- The combined hospital facilities in Matale comprise:
  - A total of 535 beds.
  - Average bed occupancy equivalent to 483 beds per day.
  - Average total clinical patients and out-patients of 998 patients/day.
  - Total staff of 641.

  Corresponding hospital waste generation is estimated to be 0.70T/d, equivalent to 0.328kg/(staff+patients).d.
- Hospital waste is highly organic with food/kitchen waste being the most common waste type, followed by cardboard and garden waste, paper, plastic and healthcare hazardous waste.
- Most of the normal waste is collected by MMC.
- Inadequate collection and disposal of healthcare hazardous waste is a serious problem, with small but significant quantities of healthcare hazardous waste being produced by Matale Base Hospital. Currently, most of these wastes are normally disposed of by burning/burial, although a very small quantity is sometimes discharged for collection by MMC (e.g. body parts, placentas for burial at the cemetery). No hospitals have an incinerator.
- The Base Hospital reuses waste containers. For example, penicillin bottles are re-used for blood and urine specimen collection, cardboard boxes are used as sharps storage containers and savlon bottles are collected and return to suppliers for refilling.
- The Base Hospital recycles some of their used plastic, some glass bottles/containers tins and cans. These items are stored and then advertised for sale by auction at intervals ranging from two to five years. X-rays are kept for five years and then also sold by tender. However, no data could be obtained to verify these comments. Instead, recycling quantities were estimated on a pro rata basis from Peradeniya Teaching Hospital data, multiplied by a 0.5 factor to account for less materials being recycled here than at Peradeniya hospital.
- The three hospitals are dissatisfied with the existing garbage collection service, the main reasons being:

[6] There are at least 10 pre-schools and a number of other private pre-schools within MMA.

- Garbage collection/sweeping is not properly done (3).
- Irregular garbage collection/sweeping (3).
- Poor discharge system (2).
- Collection time is too early or too late (2).
- Problems of handling healthcare hazardous waste (1).
- No proper collection and disposal system (1).

- Desired SWM improvements ranked in descending order are:
  - Improved collection frequency (weighted average rank (WAR) = 5).
  - Shorter distance to garbage collection point (WAR = 3.5)
  - Greater recycling/composting of garbage = Improved garbage discharge system = control of stray animals (WAR = 2).
  - Special methods for handling for healthcare hazardous waste (WAR = 1.5).
- None of the hospitals were willing to pay for improved SWM services but all three hospitals are very willing to cooperate in separating their waste into different categories.



Matale Base Hospital garbage collection

Table 1-5 : Hospital General Statistics and Waste Generation

Hospital	Type	No of Beds	Bed occup-ancy (%)	Out-patients (no/d)	Clinical patients (no/d)	Staff	Waste composition	Normal waste (kg/d)	Clinical waste (kg/ mth)	Body parts (kg/ mth)	Sharps (kg/mth)	Highly infectious (kg/mth)	Other
Base hospital	Govt	520	90	704	292	632	F/K > Ga>Ca.Pa> Pl>Gl>HH	668	96	12	60 (12 boxes)	Small	MT (small)
Majan Medical Centre	Pvt	6	100	1	0	3	Ca>Pa>F/K >Pl>HH	2	1	1	30	1	DM, AC (small)
K.M.P. Nursing home	Pvt	9	100	1	0	6	F/K > Ga>HH	5	1	0.2	25	0	DM, MT, P (small)
Total		535	90.3	706	292	641		675	98	13.2	115	small	Small

Notes:

1. Data for hospitals obtained from interviews with relevant staff members of each institute.
2. Average *total number of beds occupied = Sum of (number of beds x bed occupancy rate)* for all hospitals = 483
3. Other : F/K = food/kitchen waste, HH = healthcare hazardous waste, Ca = cardboard, Pa = paper, Pl = plastic, Gl = glass, Ga = garden, DM = discarded medicines, MT = mercury thermometers, P = paint, AC = aerosol cans.
4. An accuracy check has only been made on the amount of normal waste for the Base Hospital, with survey data being amended based on MMC waste collection data.

Table 1-6: Hospital Waste Disposal Practices

Hospital	Normal waste	Clinical waste	Body Parts and/or placentas	Sharps	Highly infectious	Other	WWTP	Incin-erator	Comments
Base Hospital	Collected by MMC except for plastic/metal tins/containers and x-rays, which are sold by auction	Buried on site	Placentas and body parts buried on site or taken to cemetery	Collected separately in cardboard boxes and burned	As for clinical waste		No	No	Incinerator desired, training
Majan Medical Centre	Collected by MMC	Collected by MMC	No data	Collected separately in bags and burned	Burned	Discarded drugs burned	Yes	No	Recycling, legal actions against law breakers
K.M.P Nursing Home	Take to MMC Collection point	As for normal waste			None	No data	No	No	Recycling

1.4.5 Government Offices

There are approximately 23 central government departments and 17 provincial council ministries/authorities with offices in MMA, most of which are located immediately to the south and west of the city centre. Together with the Police station[7] and MMC, these offices employ approximately 1,643 workers. Interview surveys were conducted with four of these offices, including the Police and MMC.

Three offices discharge their garbage for collection by MMC, with one of these also burning some garbage on site, while the fourth office burns/buries all of its waste on site. Based on this data, the government office waste generation rate was estimated to be 0.228kg/worker.d giving a total waste generation amount of 0.37T/d, with 95% of this waste being collected by MMC and 5% burned/buried on site.

The following points should be noted:

- MMC have adopted a "polythene free" office policy, with posters on display throughout the office advertising this fact. However, inspection of MMC dustbins shows that this policy has had limited success to date.
- A very large new police station is currently under construction within MMA, which will house both the Matale Police and the Superintendant of Police.

1.4.6 Religious Institutes

The total number of religious institutes in Matale is approximately 34, comprising 16 buddhist temples and other institutes, 8 mosques, 4 churches and 6 hindu temples (kovils). The associated number of religious workers is estimated to be 151.

The most well known religious institute in the city is the Aluvihare Temple, where Buddha's preachings were put into writing on ola leaves (tripitakaya). The Patthini Dewalaya (Muttu Mari Amman Kovil) is also a prominent religious centre. There is also a Buddhist seminary (Widyananda Pirivena) and Buddhist centre located within MMA.

Interview surveys were conducted with three of the Buddhist institutions. The Aluvihare Temple disposes of most of its waste by open dumping outside their premises, with the remaining waste being collected by MMC or burnt on site. Waste from the other two institutions is collected by MMC, although one institute also burns some waste on site. Based on this data, the religious institute waste generation rate was estimated to be 1.01kg/clergy.d, giving a total waste generation amount of 0.15T/d, of which 80% is collected by MMC, 10% disposed of on site and 10% illegally dumped.

[7] Police has been included in this category rather than under Forces as in most other cities, as there are insufficient Forces within Matale to justify a separate category (i.e. there is no army, navy or prison within MMA and only a small lockup comprising two cells which is used only for holding people prior to their court appearance.

1.5 Industries

Industry plays a very small role in the Matale city economy, constituting 0.5% (4.6ha) of total land use in 1997 and comprising four lime kilns, five sawmills and the Diana Chocolate factory within MMA.

Preliminary investigation of a lime kiln operation found that they produce very little waste with most of this being reused or disposed of on site. Hence, this sector was not investigated further.

The chocolate factory is located on Pullegar Kovil Rd and discharges ~20kg/d of garbage for collection by MMC.

Interview surveys were conducted with all five sawmills to find out about their waste disposal practices and their willingness to co-operate with the MMC in giving/selling their sawmill wastes for use in composting as an amendment/bulking agent. The results of these interview surveys are tabulated below and summarized here:

- All five sawmills produce significant quantities of wood wastes, comprising around 30.5T/mth of sawdust, 15.4-16.4T/mth of woodchips and 8.7T/mth of bark.
- Most sawdust is currently given away to farmers for free, including use in mushroom farming, or burnt, although one sawmill disposes of most of its sawdust by transportation to the disposal site[8].
- Woodchips are sold by three sawmills at prices varying from 0.45-1.0Rs/kg, while the other two sawmills dispose of their woodchips by burning or transporting to the disposal site.
- Bark is produced in significant quantities by two sawmills and is generally given away to workers, neighbours or other people for use as firewood for cooking. One sawmill sells its bark at 1.2Rs/kg.
- All five sawmills were willing to give or sell all their sawdust and 67-100% of their woodchips to MMC, while one sawmill was willing to give all its bark to MMC. Quantities available for free amounted to 18.8T/mth of sawdust, 1.1T/mth of woodchips and 4.0T/mth of bark.

[8] Not independently verified.

Table 1-7: Sawmill Interview Survey Results

Sawmill Name and Location (Respondent)	Waste Quantities (T/month)			Waste disposal	Willing to give/sell to MMC for composting	Comments
	Saw-dust	Wood chips	Bark			
Chandrarathne Sawmill, 1070 Aluvihare (Mr Chandrarathne, Manager; Tel: 066 33977)	11.25	5.0 – 6.0	Small quantity; mixed with wood chips	Sawdust is given to farmers for free or burnt; woodchips and bark are sold as firewood at 500Rs/T (one load).	Willing to sell all sawdust at 250-300Rs/0.75T and woodchips/bark at 750Rs/T.	Willing to cooperate in introduction of new technology for using sawmill wastes for other purposes (e.g. electricity generation).
Mandandawala Sawmill, 791 Trincomalee St, Mandandawala (Mr Wijerathne, Manager; Tel 066 31122)	0.50	3.0	0.2	Sawdust is burnt; woodchips are sold as firewood at 100Rs/100kg; bark is usually given to workers for use as firewood for cooking, or sometimes burnt.	Willing to sell all sawdust at 2,000Rs/T and 2T/mth of woodchips to MMC at 5,000Rs/T.	Not willing to give/sell bark due to use by workers.
Jamaldeen Sawmill, 786 Trincomalee St (Mr Isadeen, Partner; Tel: 066 23236)	0.75	6.3	Negligible	Sawdust is given to farm houses and mushroom farmers for free; woodchips is sold as firewood at 400Rs/0.9T (load); bark is given to their neighbours for use as firewood for cooking.	Willing to give all sawdust to MMC free of charge and to sell all woodchips at 400Rs/0.9T (load).	Not willing to give/sell bark due to use by neighbours.
Abeyrathna Mills, 161 Nagolla Rd (Mr Rathnayake, Manager; Tel 066-31524)	10.00	1.0	4.0	Sawdust is given away to farmers or burnt, woodchips are disposed of on site; bark is given to people for use as firewood for cooking.	Willing to give all wastes to MMC free of charge.	Willing to co-operate with MMC provided MMC collects the wastes from their sawmill.
Sampath Mills, 28 Sangananda Mw (Tel: 066 23911 or 074 460456)	8.00	0.13	4.5	Sawdust is mainly taken to the MMC disposal site, apart from a small quantity given to people; woodchips are burnt or taken to the MMC disposal site; bark is sold as firewood at 60Rs/50kg.	Willing to give all sawdust and woodchips to MMC free of charge; not willing to give bark.	Willing to reuse their wastes if given information/training and assistance (e.g. for composting); also willing to cooperate with MMC, including loading their wastes into MMC vehicles.
Total	30.5	15.4 – 16.4	8.7			

Notes:

1. Loads refers to four wheel tractor loads unless otherwise stated. Loads data was converted to tonnes for tractors based on information supplied by survey respondents, with one load of sawdust being equivalent to 0.75T and one load of woodchips to 0.9-1.0 T.
2. For the last two sawmills, the quantity of bark also includes some firewood.

- Another 11.2T/mth of sawdust was available at 250-300Rs/0.75T and another 0.5T/mth was offered at 2,000Rs/T. Additional quantities of woodchips were also available: 5-6T/mth at 750Rs/T, 3T/mth at 5,000Rs/T and 6.3T/mth at 400Rs/0.9T.
- One sawmill was willing to co-operate in introducing any new technology for using sawmill wastes for other purposes (e.g. electricity generation), while another was willing to reuse their wastes if given information/training and also had a more general interest in setting up a compost facility, as they own 10.5ha of farmland about 30km from Matale.

In addition, a 3.2ha industrial estate, administered by the Industrial Development Board (IDB) is located adjacent to the Kaludewala landfill site. This industrial estate has 200 sites for small-medium enterprises of which only nine have been developed, as set out below.

Table 1-8: IDB Kaludewala Industrial Estate Details

Nature of Enterprise	No of workers	Investment (M Rs)
Power loom	45	6.0
Dolomite processing	17	3.0
Shopping bag manufacture	22	6.0
Steel furniture manufacture	8-13	1.0
Aluminium goods manufacture	8	0.9
Wooden furniture manufacture	13	0.4
Garment manufacture	2	0.2
Grinding mill	4	0.7
Agricultural	4	0.2

This industrial estate was not surveyed as it lies just outside the city limits. However, it is possible that some of these industries discharged their garbage to the Kaludewala disposal site at night time when it was being used by MMC.

1.6 Other Waste

Other waste accounts for waste collected from public places such as parks, streets, drains and canals and from other "informal" sources that are not registered with the relevant authorities and hence not included in official statistics. It may also include some of the waste that is illegally dumped around the city and subsequently collected by MMC.

Parks, playgrounds and sportsgrounds are the responsibility of the Works Department. The V.T. Nanayakkara Park (6-7ha) generates ~15 tractor loads/mth of garden waste (0.26T/d), which is collected approximately daily and composted in one of two large pits, which are interchanged at three month intervals, with the resulting compost being used within the park. An estimated 30kg/d of inorganic waste is collected within the Park by MMC for disposal.

Other public places (cemetery, Kiddies Paradise, Millenium Park, Hockey ground, etc.) make up approximately another 8.3ha of public space. Waste generation and disposal from these places was estimated by comparison with V.T. Nanayakkara Park and taking into account the relative areas and different natures of these public spaces. On this basis, another 0.11T/d of garden waste is estimated to be collected daily for composting, while 42kg/d of inorganic waste is collected by MMC for disposal.

According to the 2002 budget, the total length of roads maintained by MMC is 47.7km (Class A = 8.15km, Class B = 24.56km, Class C = 15.02km). MMC is responsible for cleaning all roads within the city limits, including weeding and drain cleaning. It is also responsible for cleaning two major "drains" within Matale – the Brahmana Ela and Godapola Ela. It also undertakes regular Infectious Disease Prevention (IDP) programmes. All of these activities generate wastes requiring disposal.

Most of the weeding, cleaning and IDP works are carried out on Saturday, using more than 20 labourers, while additional works may be undertaken during the week on request. An average of 29 "cleaning" programmes are carried out each month, with an estimated 1.2T/d of waste being generated which is taken to the disposal site.

1.7 Recycling

1.7.1 General

Informal reuse and recycling is relatively active in Matale, with there being many shops in the city selling used items and/or recyclables for a wide range of purposes, while there are also some micro-enterprises operating using recyclables as their raw materials. These include:

- Shops selling used newspapers/exercise books, bottles, containers, tins, shoes, bags, bikes, umbrellas, books, etc.
- Waste paper is used to make paper bags for wrapping purposes (e.g. medicines, food, small goods, etc.).
- Glass and PET bottles are sold as containers for local products (e.g. sauce).
- Empty metal tins are used to make the metal band on ekel brooms or for making toys and other items (e.g buckets).

1.7.2 At Source

This section focuses on household recycling at source, as recycling at source from other waste generators has previously been described.

Household at source recycling was estimated from the household survey results (120 households), with the relevant results being summarized in the following table. These indicate that 82% of households have recyclables collected from them by individual collectors, 38% take some recyclables to shops for refund/sale, and 7.5% compost kitchen and/or garden waste.

Table 1-9: Household Survey Recycling Results Summary

Waste Type	Composting	Individual collects from House	Resident takes to shop
Yes	9	98	45
No	111	22	75
Food/kitchen	3	1	0
Garden/wood	6	0	0
Paper/cardboard	0	80	12
Plastic	0	0	0
Glass	0	88	36
Metal	0	43	4
Textile	0	8	4
Leather/rubber	0	0	0
Other	0	0	0

The total amount of materials recycled or composted from households at source was estimated using this data together with household waste composition data, 85% average MMA garbage collection service coverage and assuming an 80% recycling/composting rate. This gives household home composting and recycling quantities of 0.60T/d (3.6% of total household waste generation) and 0.82T/d (5.0%) respectively. It is difficult to verify how realistic these values are, particularly in the case of home composting. However, the middleman survey indicated around 0.39T/d of recyclable materials purchased by them originate directly from households. As many recyclable materials collected from homes are expected to be taken to other places (e.g. paper bag making enterprises) rather than just middlemen, the recycling quantity estimate is considered reasonable.

1.7.3 During Collection

Both handcart and collection vehicle workers collect recycable materials in Matale, with the handcart labourers collecting recyclables on an individual basis, while the collection vehicle labourers and drivers work as a team, collecting recyclables in polysacks, which they store near the disposal site for subsequent sale. Most items are sold every 1-2 months except for metals, which are usually sold daily.

The collection worker survey found that 10 out of 33 labourers interviewed are involved in recycling. These ten labourers collect an estimated total of 609kg/mth, comprising mainly bottles (394 in number, 260 kg[9]), broken glass (50kg/mth), iron (257kg) and various other metals, earning an average of 231Rs/mth, as tabulated below. Total quantities of recyclables recovered during collection by all SWM labourers are estimated to be 2,011kg/mth (1,300 bottles and 1,153kg/mth of broken glass and metals).

[9] Average bottle weight = 0.66kg, obtained by measuring a mixture of 10 arrack and beer bottles, these being the most common bottles recycled.

Table 1-10: Recyclable Materials Recovered by Collection Workers

Item	No of labourers collecting	Quantity (kg/mth)	Price	Estimated Total Quantity (kg/mth)
Bottles	9	(No = 394) 260	1-5Rs ea	(No = 1,300) 858
Broken glass	1	50	1-4Rs/kg	165
Cardboard	0	0	N/A	0
Ferrous metal	8	257	2-5Rs/kg	849
Metal can	2	35	2-2.5Rs/kg	116
Aluminium	5	6	20-60Rs/kg	21
Brass	1	0.3	65Rs/kg	1
Copper	1	0.3	50Rs/kg	1
Total	10	609		2,011
Average earnings		231		
No of labourers interviewed	33			

Notes:
1. MMC labourers = 104 SWM labourers + 5 drivers.
2. Estimated total quantity/mth = 109/33 x survey quantity.
3. Paper, plastics, brown bottles and coconuts are not collected by the labourers for recycling. Clean cardboard is sometimes collected, which can be sold at 5Rs/kg.

1.7.4 At Final Disposal

The MMC disposal site labourers are also involved in collecting recyclables, working as a team and storing recyclable materials at the same place as the collection workers for subsequent sale. These labourers are estimated to collect around 273kg/mth of recyclables, or 9kg/d.

During the landfill residents' survey, only one other person was identified who collects recyclable materials from the landfill, amounting to ~10kg/d of metals.

This gives a total recycling rate of 19kg/d, which is consistent with field observations, which noted very few recyclable items remaining in the waste discharged at the final disposal site.

1.8 Disposal Quantities

Current trip (load) data and corresponding disposal quantities over the seven month period September 1999-March 2000 and six month period January-June 2002 are summarized in the following two tables with more details being provided in the relevant appendix. Monthly tonnage data is illustrated in the following figure. Some key points from this data are summarized below:

- The average number of trips undertaken during September 1999-Mar 2000 was 266 trips/mth using only four wheel tractors, compared with 283 trips/month during Jan-Jun 2002 using a mixture of two and four wheel tractors, small and large lorries, small and large compactor trucks, and during May 2002, some borrowed vehicles over several days. It is not possible to conclude from this data whether collection performance has improved over this period, due to the different vehicles used in each period and the abnormal circumstances existing from Dec 2001-Apr/May 2002.

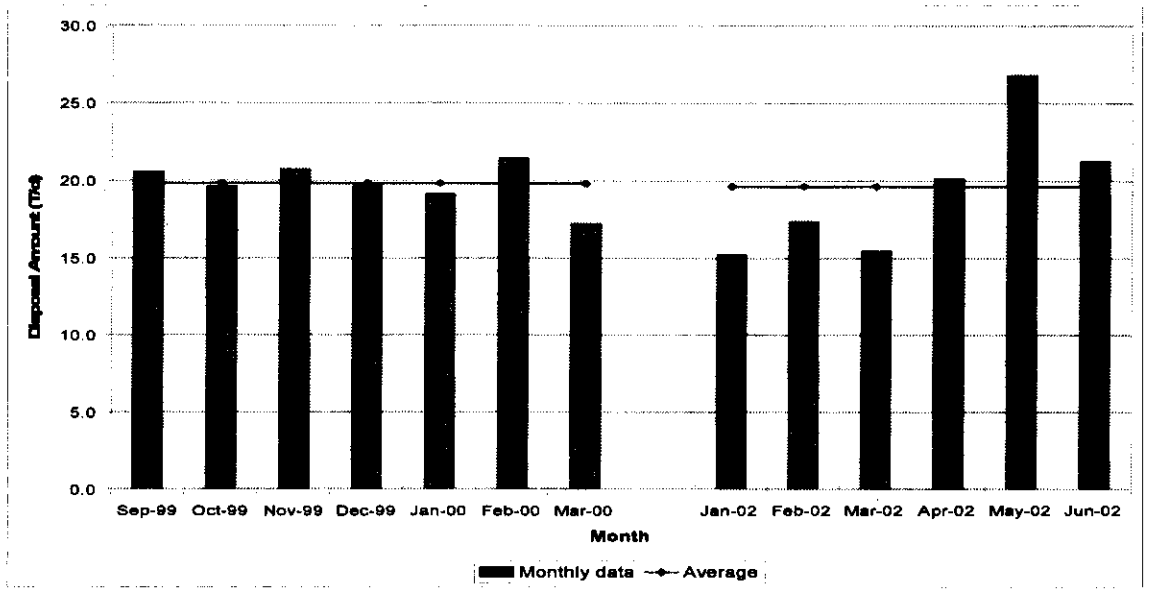


Figure 1-1: Kaludawela Disposal Site – Final Disposal Quantities

- During this time, both compactors were out of action with mechanical/electrical problems[10], the long outage being due to this being an inter-election period (i.e. between national and local body elections) when no one was willing to take responsibility for getting them repaired. Once local authority elections were conducted in late March 2002, the large compactor was soon repaired and back in operation from the start of April, while the small compactor resumed operation on May 20. During the Dec-Apr/May period, the Works tractor and two MMC lorries were used for garbage collection to cover for the compactors. Then in May, heaps of garbage that had accumulated around the city during this inter-election period, were removed using two additional compactors borrowed from Colombo Municipal Council and a four wheel tractor borrowed from UPC, Matale.
- The average number of collection vehicle trips currently made to the disposal site is estimated to be 10 trips/d (Jan-Jun 2002 average), it being assumed that the total number of trips over this period is representative of normal behaviour despite the abnormal behaviour that occurred for different months during this time. The June 2002 average of 10.2 trips/d supports the above figure, as June is the most normal month over this six month period.
- Night tractor records from September 2000 – November 2001 indicate a monthly average of 1.9 trips/night.
- Gully sucker trips data is incomplete, but gully sucker income data indicates an average of 25 trips/mth[11], equivalent to 5.8m^3/d.

[10] Small compactor – auto-circuit breakdown problem; large compactor – clutch plate/washers problem.
[11] Gully sucker average trips/mth equates to less than one trip/d, which suggests the recently acquired new gully sucker truck was not necessary. However, the PHI indicated that the new gully sucker is for outside MMA, as MMC provide gully sucker services over a wide area, involving some overnight trips away. Loads collected from outside MMA are not brought to the Kaludewala disposal site. Instead, they are disposed of in a pit near the point of removal, which the septic tank/latrine owner must provide.

The average tonnage of garbage taken to the Kaludewala disposal site over the period Jan-Jun 2002 is estimated to be 19.6T/d, which is very similar to the average tonnage disposed there over the period Sep 99-Mar 00 (19.8T/d). This suggests that MMC collection performance has not improved over this period, despite it having acquired two compactor trucks. However, this result may partially be due to the abnormal conditions that prevailed during the first five months of 2002. The average monthly tonnage for June 2002 is 21.2T/d, which may be more representative of current garbage collection performance under normal conditions.

1.9 Resource Recovery

This section describes the present status of composting and recycling activities within Matale, including some recent initiatives that have been undertaken in the city.

Composting focuses on a discussion of a home composting programme conducted by MMC since 1999, while efforts to set up a centralised SWM composting facility are also described. However, there is now no centralised composting facilities within the city.

Recycling quantities have been summarised previously, while the MMA composting/recycling system is illustrated in Figure 1-2. Hence, this section provides a summary of the recycling sector within MMA in relation to middlemen and NGOs.

Table 1-11: MMC SWM and Gully Sucker Waste Disposal Trip Data

Item	Area Vehicle	Sep 99	Oct	Nov	Dec	Jan 00	Feb	Mar	Tot		Jan 02	Feb	Mar	Apr	May	Jun	Tot
Total monthly trips	Two wheel tractor	0	0	0	0	0	0	0	0		31	49	49	62	67	60	318
	Four wheel tractors	282	278	284	279	271	284	181	1859		106	177	178	163	171	119	912
	Small lorry (41-9452)	0	0	0	0	0	0	0	0		10	7	9	0	3	0	29
	Large lorry (26-3501)	0	0	0	0	0	0	0	0		26	39	35	2	0	0	102
	Small compactor (GI-1602)	0	0	0	0	0	0	0	0		0	0	0	0	22	55	77
	Large compactor (227-6727)	0	0	0	0	0	0	0	0		0	0	0	58	72	58	188
	Works	0	0	0	0	0	0	0	0		8	12	7	1	10	13	51
	Other	0	0	0	0	0	0	0	0		1	0	0	0	18	1	20
	Total trips	282	278	284	279	271	284	181	1859		182	284	278	286	363	306	1697
	Liquid wastes	ND	ND	ND	ND	ND	ND	ND	ND		15	2	ND	ND	ND	ND	ND
Daily average trips	Days of record	30	31	30	31	31	29	23	205		20	28	31	30	31	30	170
	Solid waste	9.4	9.0	9.5	9.0	8.7	9.8	7.9	9.1		9.1	10.1	9.0	9.5	11.7	10.2	10.0

Notes:

1. Partial month records for March 2000 (23days) and January 2002 (20 days) – hence total monthly trips are lower than normal for these months.
2. Accumulated heaps of garbage around the city were removed using two borrowed compactors and one four wheel tractor in May 2002.
3. Additional loads by Works in June 2002 relate to accumulated soil, sediment and drain cleanings removed by the MMC JCB on June 10th and taken to the final disposal site.
4. Both 1999/2000 and 2002 trip records include night shift trips.
5. Gully sucker data is largely missing (ND = no data), with only 20 days of disposal site records being available for January 2002. The gully sucker has continued to use the Kaludewala landfill site for waste disposal since then, but without the number of trips being recorded. Gully sucker income records indicate an average of 25 trips/mth.
6. Daily average trips per month (bottom row) based on number of days per month.

Table 1-12: MMC SWM Waste Disposal Tonnage Data

Item	Area Vehicle	Sep 99	Oct	Nov	Dec	Jan 00	Feb	Mar	Tot		Jan 02	Feb	Mar	Apr	May	Jun	Tot
Total monthly solid waste tonnage	Two wheel tractor	0	0	0	0	0	0	0	0		12.9	20.3	20.3	25.7	27.8	24.9	132
	Four wheel tractors	616	607	620	609	592	620	395	4,060		232	386	388	355	372	259	1,992
	Small lorry (41-9452)	0	0	0	0	0	0	0	0		5.9	4.1	5.3	0.0	1.8	0.0	17
	Large lorry (26-3501)	0	0	0	0	0	0	0	0		44.1	66.2	59.4	3.4	0.0	0.0	173
	Small compactor (GI-1602)	0	0	0	0	0	0	0	0		0	0	0	0	49.3	123	172
	Large compactor (227-6727)	0	0	0	0	0	0	0	0		0	0	0	218	270	218	706
	Works	0	0	0	0	0	0	0	0		5.9	8.9	5.2	0.7	7.4	9.6	38
	Other	0	0	0	0	0	0	0	0		2.2	0	0	0	101	2.2	105
	Total tonnage	616	607	620	609	592	620	395	4,060		303	485	478	603	830	637	3,336
Liquid wastes (m^3)		ND	ND	ND	ND	ND	ND	ND	ND		105	15	ND	ND	ND	ND	ND
Daily average tonnage	Days of record	30	31	30	31	31	29	23	205		20	28	31	30	31	30	170
	Solid waste	20.5	19.6	20.7	19.7	19.1	21.4	17.2	19.8		15.2	17.3	15.4	20.1	26.8	21.2	19.6

Notes:

1. Partial month records for March 2000 (23days) and January 2002 (20 days) – hence total monthly tonnages are lower than normal for these months.
2. Monthly tonnages during Jan-Feb 2002 were lower than normal while May-Jun 2002 figures were higher, this being due to the compactor trucks being out of action during Jan-Mar, heaps of accumulated garbage being removed in May using borrowed vehicles and accumulated soil, sediment and drain cleanings removed by the MMC JCB in June.
3. Both 1999/2000 and 2002 data includes night shift tonnages.
4. Gully sucker data is only available for 20 days during January 2002.

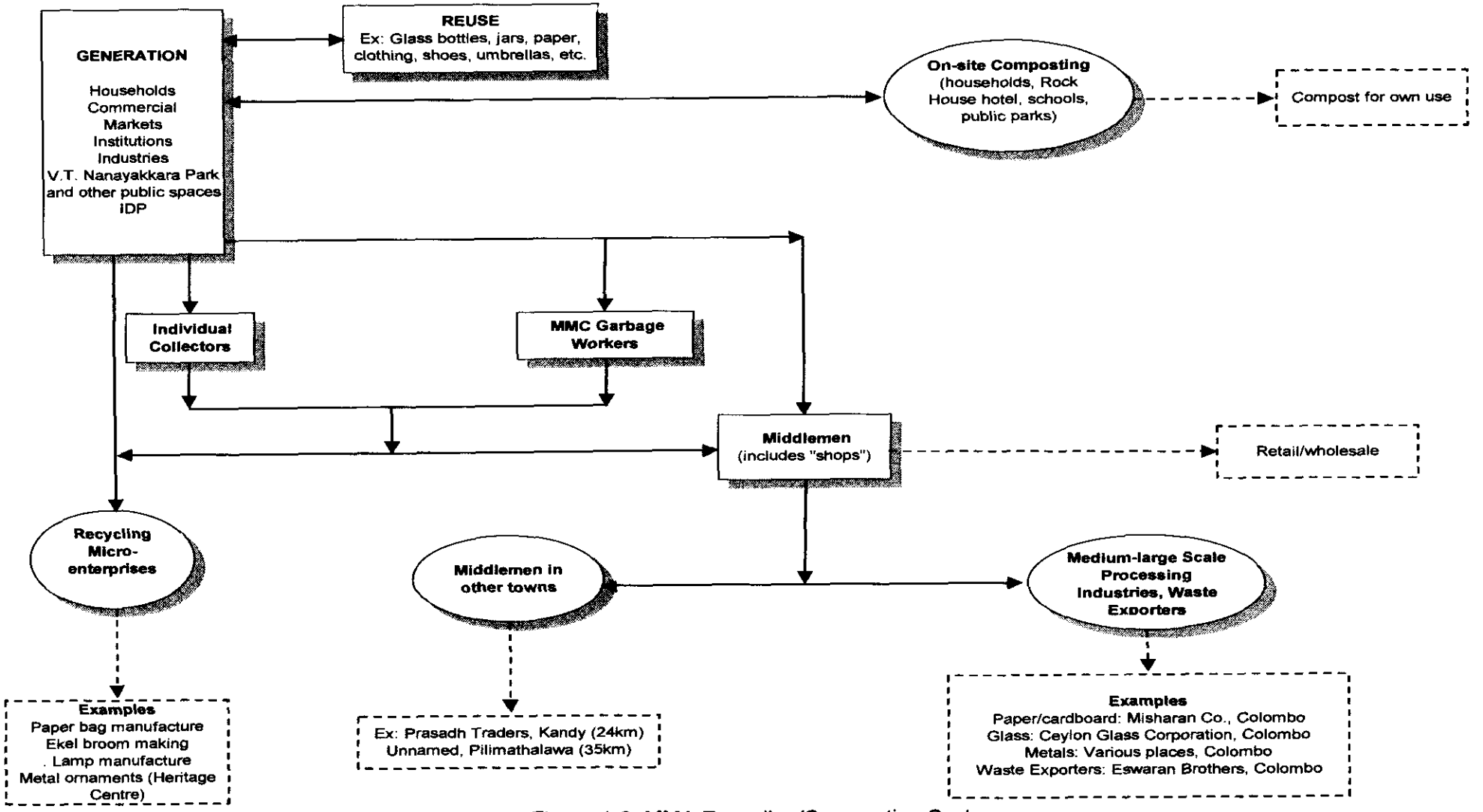


Figure 1-2: MMA Recycling/Composting System

1.9.1 Home Composting Barrels

Home composting barrels were supplied to around 300 households at a cost of 350Rs each in December 1999. These barrels are old tar barrels (metal construction) and are provided with a hinged cover, which can be half opened to load the bin.

A survey was conducted in July 2002 of 76 households to whom compost barrels had been distributed. The key survey results are summarized below.

- 67 (88%) of surveyed households (respondents) received some education/information on how to use the barrels.
- 34 (45%) of respondents are still using the compost barrels, while 28 (37%) have stopped using them and 14 (18%) never used them (see adjacent figure).

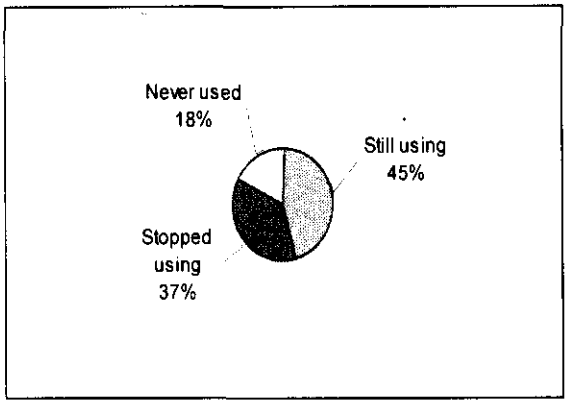


Figure 1-3: Compost Barrel Usage

- 57 (75%) respondents indicated that the main reason they decided to get a compost barrel was due to recommendations made by MMC Officers/workers. Of these people, 56% have stopped using the barrels, which is a higher proportion than the overall average. This suggests that some householders may have been pressurized into getting a compost barrel when they didn't really want one. Informal comments made during the survey confirm this.
- The main other reasons householders decided to get a compost barrel are:
  - Composting is good for the environment - it reuses/recycles waste (26).
  - Interested in producing compost for use in own garden (24).
  - The compost barrel appeared easy to use (17).
  - The compost barrel would not take up much space (12)
  - Hoping to increase income, through making compost for own use/sale (12).
- Of the households who have stopped using the barrel, 15 (20%) stopped within the first three months (i.e. before first compost produced), eight (11%) within the next nine months, and five (7%) within the next year (see figure below). This suggests that public education/assistance should be provided over the first 12 months of a home composting programme in order to reduce the dropout rate, with most efforts being focused within the first three months period. It seems that once people start to obtain compost from their barrels, the dropout rate decreases.

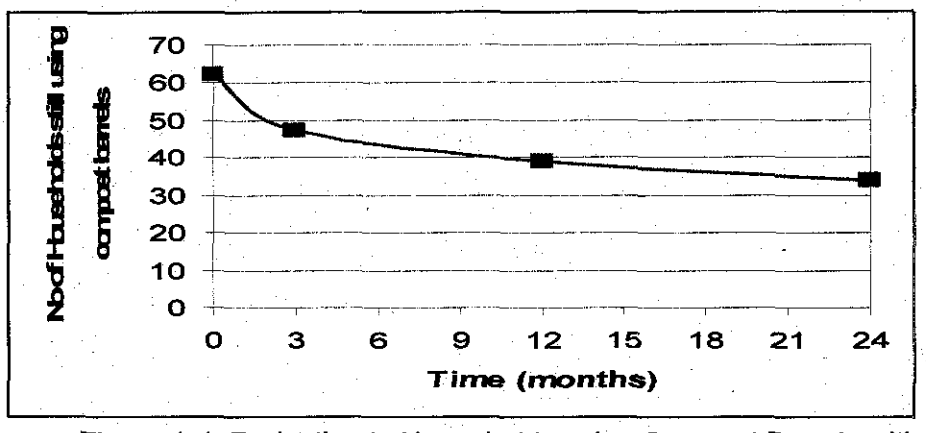


Figure 1-4: Reduction in Households using Compost Barrels with Time

- The 42 households who have never used or stopped using the barrel indicated that the main reasons for this were pest problems (26), odour problems (18), not enough space on site (15) and lost interest (7). Rusting of the bin was not identified as a major problem, presumably because all but five of these households stopped using the bin within the first 12 months, during which time rusting was not likely to be problematic.
- Average household compost production per month amounted to 6.9kg/mth for those still using the barrels, while those who have stopped were producing only around 3kg/mth (overall compost production rate = 5.2kg/mth).
- Assuming a 66% weight reduction on composting[12], 6.9kg/mth of compost would have been produced from around 20kg/mth of food/kitchen wastes. Household monthly waste generation is estimated to be 74kg/month (0.451kg/person.d x 5.5 people/household x 30d), meaning that the households still using their compost barrels are achieving an average reduction in waste to disposal of 27% (see adjacent figure).

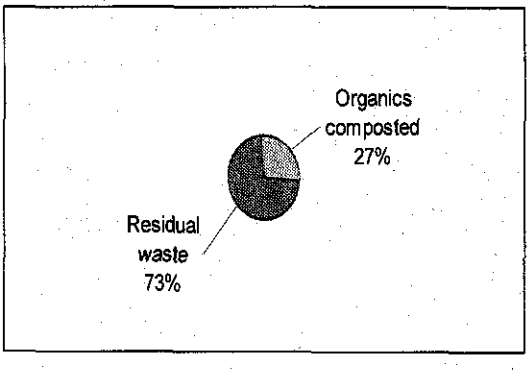


Figure 1-5: Waste Reduction through home composting

The main improvements suggested by household members to MMC's home composting programme are shown below.

[12] Dr Basanyake, Peradeniya University, informal communication

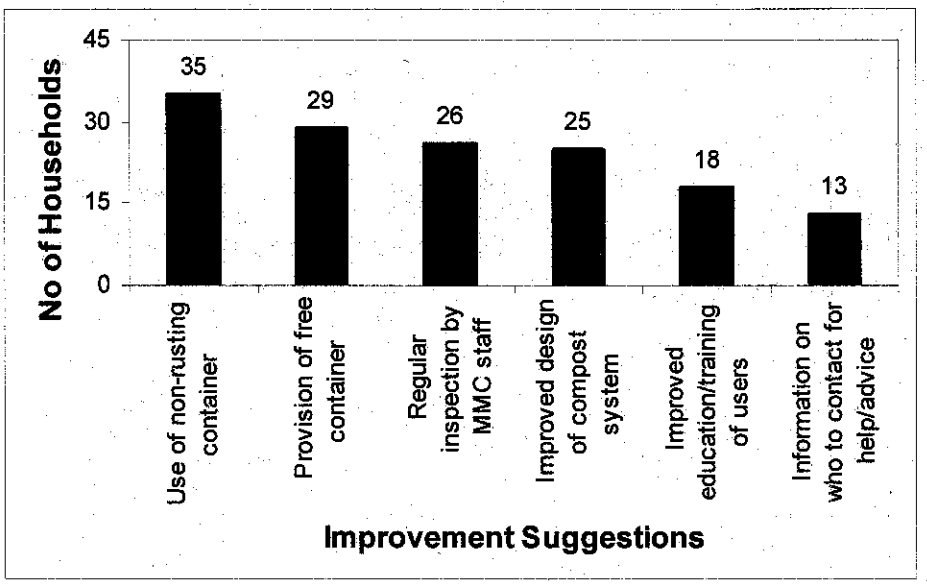


Figure 1-6: Suggested Improvements to MMC's Home Composting Programme

JICA field inspections indicated that rusting of the barrel, 2-3 years after distribution of the barrels, was now a major problem. In addition, the barrels are not well designed, with the lid being slightly concave and with an air gap between the two halves, allowing water to pool on the lid and then seep into the barrel, which can cause anaerobic conditions to develop within the bin.

Compost quality was also inspected for eight random samples, with the following observations being made:

- Four-six of the samples were of reasonable quality, although all of these contained some uncomposted materials/inorganics.
- Four samples were wet.
- Five had some small stones while another had a gritty feel; four had some small twigs, with two additional samples containing some fibrous materials; three contained some plastic bag fragments.
- Five samples had visible biota, comprising small bugs (3), beetles (1) and worms (1).

Overall, these results indicate that the home composting programme has been moderately successful and that some important lessons can be learned for any future expansion of this programme, as discussed in the main report. It should be noted that the Rotary Club is willing to give MMC more barrels for distribution and that MMC is interested in expanding this programme.

1.9.2 CIDA Compost Facility

Funding was provided by CIDA (Canadian International Development Authority) for construction and operation of a pilot scale compost facility (Stage 1) over a one year period, located at the Kaludewala landfill site. This facility was constructed in 1998 and comprised a shredder and roofed shed of estimated area 150m^2 and small storeroom. The facility did not require an electricity supply as the

shredder was powered by a two wheel tractor. No screen was provided. Technical assistance was provided by a Sri Lankan NGO, the National Forum of Peoples Organisations (NFPO).

Mainly market waste was composted, with sawdust, cow dung, leaves and EM (effective micro-organisms) being added to assist the composting process. Sawdust was purchased from some sawmills in Matale at a cost of 800Rs/4WT load, while cow dung was bought for 200Rs/4WT load. Leaves and EM were obtained for free.

About 2,000kg of compost was produced during the one year trial. This was sold in 2 and 10kg bags at 9Rs/kg to individuals and at plant sales exhibitions in Piliyandila, near Colombo, where NFPO is based. At the end of the trial, CIDA advised that they had no available funds for continuation of the project, resulting in the project being abandoned, the shredder returned to CIDA and the shed disassembled.

1.9.3 Middlemen

Six middlemen and one micro-enterprise operating within the MMA were interviewed as part of this study. General information on these businesses is tabulated below and summarised here.

Table 1-13: Middlemen General Information

Business Name	Manager/Owner, Address	Years of work	Total Employees		Recyclables[3] (Rs/mth)	
			Total	FTE	Purch.	Sales
MM1: United Traders	A.L. Amsardeen, 43 Mosque Rd	4	1	0.5	2,925	3,415
MM2: Rushan Traders	K Balandraum, 115A Raththota Rd, Kaludewala	3	2	0.9	3,030	3,895
MM3: Kandy Hardware	A.M. Khalid, 6 Godapola Rd	15	3	0.6	66,500	84,750
MM4: Sooriya Metals	T Nundakumara, 485 Main St	30	3	1.5	>110,575	>135,000
MM5: Indra Stores	R Kulathasamy, 11 Godapola Rd	16	2	2.1	>39,800	>46,175
MM6: Thushantha Traders	R Shadashoban, 522 Main St	24	5	4.3	>92,400	>107,500
MM7: Heritage Centre	C Aluvihare, Heritage Centre	18	8	1.7	1,365	2,500
Total			24	11.7	316,595	383,235

Notes:
1. The Heritage Centre is located just outside MMA, but collects all the metals it uses from within Matale.
2. The number of full-time equivalent (FTE) staff is based on a normal working month in the private sector of 8h/d x 26d/mth = 208h/mth.
3. Recyclable materials purchases and sales costs were calculated based on the average quantity of each item collected and sold per month and the average purchase and sales prices. In some cases, purchases and sales data was incomplete as indicated by ">" above. This means that actual purchases and sales will be higher than indicated above for these middlmen.

Five of them are primarily involved in the collection and selling of recyclable materials, while one business is a hardware shop and one is primarily a metal fabricating workshop. Five of these businesses have been in operation for 15-30 years, with the other two all having started within the last 3-4 years. A total of 24 people (managers/owners, full and part-time workers) are employed by these businesses, representing 11.7 full-time equivalent jobs. About 36% of the materials they collect come

from within the MMA, 54% within the Matale district, 3% within the Central Province, and 7% from other areas[13].

Their estimated monthly expenditure on purchasing recyclable materials is over 316,595Rs/mth, which shows that the scale of these operations is significant. Corresponding estimated monthly income from the sale of recyclable materials is over 383,235Rs/mth, representing a markup of 21%. Respondents were generally reluctant to give total expenditure and income information, with two businesses not supplying income details, while the other data obtained is not considered very reliable, particularly in one case where stated income and expenditure were less than the corresponding recyclable purchases and sales figures. The overall net income quoted by businesses ranged from 3,000-12,000Rs/mth. This is considered a minimum value, for the reasons explained here.

Most of the recyclable materials are brought to them by individuals (6), other middlemen (4) or collected by their own workers (1). Their demand for recyclable materials is generally stable, while the supply is greater than the demand for most materials.

The main sources of most materials is tabulated below and summarised here:

- Households are virtually the sole source of paper/cardboard and glass and the main source of batteries.
- Commercial enterprises are the sole source of bags/sacks.
- Industries, government offices and garages ("other" response) are a significant source of metals, while garages are a major source of batteries.

[13] Percentages are weighted averages, taking into account the relative quantities of materials collected by different middlemen.

Table 1-14: Main Sources of Recyclable Materials

Item	Plastic	Bags/ sacks	Paper/ card-board	Glass	Metals	Batt-eries	Overall (within MMA)
No collecting these items	1	2	4	5	7	5	
No of responses	1	2	4	5	7	5	
Proportion of Materials Collected from each Source (%)							
Households	30	0	99	100	33.4	67.8	87
Hotels	70	0	0	0	0	0	0
Hospitals	0	0	0	0	0	0	0
Commercial enterprises	0	100	0	0	0.1	16.3	5
Markets	0	0	0	0	0	0	0
Government offices	0	0	0	0	19.4	0	3
Schools	0	0	1	0	0	0	0
Industries	0	0	0	0	19.4	0	0
Other (mainly garages)	0	0	0	0	27.7	15.9	5
Total	100	100	100	100	100	100	100

Notes:

1. Above values are average percentages calculated from the survey data, taking into account the relative quantities of materials purchased by different middlemen.
2. The final column estimates the proportion of recyclable materials collected from different sources within MMA only, assuming 0%, 10%, 70% and 70% of materials from industry, government offices, other commercial/institutional sources and garages are obtained from inside MMA respectively, with the proportion of materials being obtained from households being calculated by difference so as to get an overall rate of 36% for materials collected within MMA.

Around 36% of these materials are collected from within the MMA, 54% within the Matale district, 3% within the Central Province, and 7% from other areas[14].

The total quantities of materials recycled by these middlemen[15], together with purchases and sales prices are summarised in the following two tables, amounting to 1.3T/d. Adjusting this total to allow for 36% of these materials being collected from within the MMA gives a recycling amount of 0.45T/d. The household survey indicated that 5.0% of household waste is recycled, which amounts to 0.82T/d, of which a significant quantity is delivered to these middlemen. The assumption made here is to assume that the household recycling amount already includes materials delivered to the middlemen and hence there is no need to allow for any additional materials recovered by them.

Six enterprises act simply as retail/wholesale outlets, onselling the recycled materials directly from their shops, with one of these transporting glass, metals and batteries to other middlemen in Kandy, 24km away and in Pilimathalawa, 35km away. The seventh enterprise, Matale Heritage Centre, fabricates small metal items (ornaments, statues, lockets, etc.) for sale to tourists and at exhibitions in Colombo.

[14] Percentages are weighted averages, accounting for the relative quantities collected by each middleman.
[15] Based on survey interviews. No independent check was made on the accuracy of these quantities.

Table 1-15: Quantities of Recyclable Materials collected by Middlemen and Corresponding Purchase and Sales Prices

Material	Units	MM1: United Trades	MM2: Rushan Traders	MM3: Kandy Hardware	MM4: Sooriya Metals	MM5: Indra Stores	MM6: Thu-shantha Traders	MM7: Heritage Centre	Total			
									Quan-tity	Purch-ase price	Sales price	Units
Plastics												
Containers/ barrels	No/mth				10				10	45	50	Rs ea
Bags: Poly, flour, poultry feed, sugar	No/mth				500		4,000		4,500	5-5.5	6-6.5	Rs ea
Paper												
Old newspapers	Kg/mth		15			300	50		365	8-20	12-20.5	Rs/kg
Old exercise books	Kg/mth				250	NA	NA		>250	6	7	Rs/kg
Bottles												
Beer/arrack/ other	No/mth	NA	60		8,000	200	5,000		>13,260	4-6	5-6.5	Rs ea
Broken glass	Kg/mth	50	50		2,000	50			2,150	1-2.5	1.5-3.5	Rs/kg
Metals												
Aluminium	Kg/mth	3	10	50	NA	300	300	7	>670	40-60	45-70	Rs/kg
Copper/brass	Kg/mth	15	7	200	400	60	200	8	890	60-80	70-87.5	Rs/kg
Ferrous	Kg/mth	200	300	15,000	3,000	1,000	2,500		22,000	3.5-7.0	4.5-9.5	Rs/kg
Lead	Kg/mth				75				75	25	30	Rs/kg
Old battery cases	Kg/mth	40	50		1,500	300	1,000		2,890	4-9	7-10.5	Rs/kg

Note: NA = no answer

Table 1-16: Total Quantities of Different Materials Recycled

Materials	Minimum Monthly Quantity	Daily Quantity (kg/d)	Comments
Plastics	10 containers + 4,500 bags (mainly polysacks) + = 450 kg	15	• Relatively small number of barrels/large containers which are generally sold for reuse – hence, not included in daily recycling amount. • Bags are either sold for reuse or transported to factories for re-processing – hence, they are included in recycling amount ; measured weight of 1 polysack = 0.1kg => 450kg.
Paper/ cardboard	615kg	21	365kg old newspaper, >1250kg old exercise books, no cardboard.
Glass	2.2T broken glass + 13,260 bottles	363	Whole bottles are usually beer or arrack bottles; average measured weight = 0.66kg; 13,260 bottles = 8,752kg.
Metals	23.6T	788	22 T ferrous + 0.89T copper/brass + >0.67T aluminium +0.08T lead
Old battery cases	2.9T	96	Battery cases are drained and then weighed, being recycled primarily for their lead content.
Total	38.5T	1,283	
Total collected from MMA	13.7	450	36% of recyclable materials collected from within the MMA, according to survey results.

Note: Refer previous table for further details. Above quantities are minimum quantities, due to the survey purchases data being incomplete.

The main costs incurred by these businesses in their recycling activities and the associated main problems are summarised in the following two tables respectively.

Table 1-17: Main Costs

Main Costs	Rank				
	1	2	3	4	Weighted average
Buying recyclable materials	6	0	0	0	15
Utilities	0	4	1	1	10.5
Labour	1	1	2	1	9
Transportation	0	2	0	2	6.5
Land/building rental	0	0	2	0	3.5

Table 1-18: Main Problems

Main Problems	Rank				
	1	2	3	4	Weighted average
Difficulties in obtaining credit	2	1	1	0	8.5
Shortage of Recyclable Materials	3	0	0	0	7.5
High land/building rental costs	0	3	0	1	7.0
High transportation costs	1	1	1	0	6.0

The middlemens' main problems are also illustrated below. Their biggest problem is gaining access to credit. Commercial banks and government agencies are not keen to lend them money as recycling is considered an "unreliable" business. Instead, they tend to have an informal credit line through their buyers, supplying them with materials when they need money. This tends to create a buyers' market. Whilst it is true that prices for recycled materials can change very rapidly, the fact that five of these enterprises have been in business for 15 or more years and the scale of their operations suggests that they are reasonable lending propositions. Gaining access to credit could assist in giving these businesses more control over the prices paid to them for recycled materials.

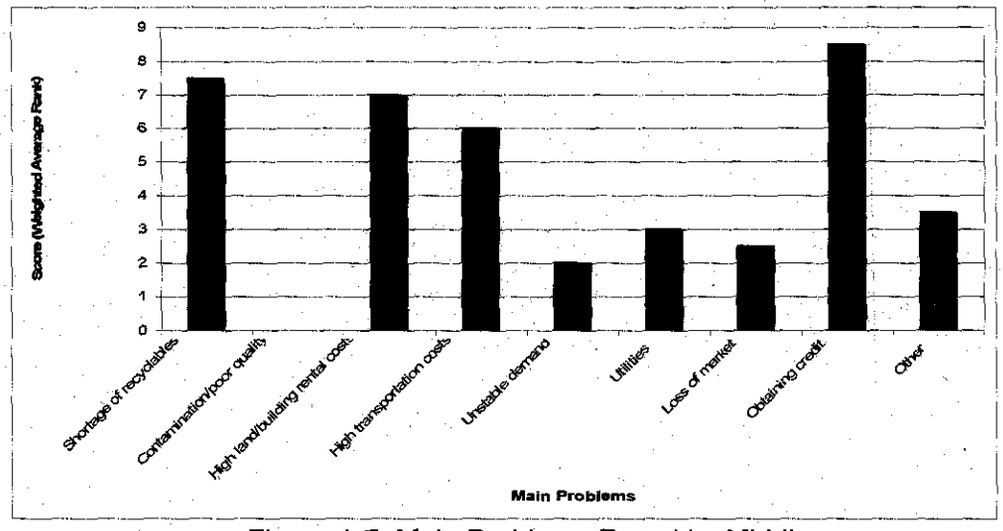


Figure 1-7: Main Problems Faced by Middlemen