Chapter C-1

Selection of solid waste collection vehicles

by Adrian Coad

C- 1.1 THE SELECTION PROCESS

In India, and in many other countries, the costs of collection of municipal solid waste are far higher than the expenditure on disposal. Of the collection costs, the largest component in the Indian context seems to be the labour costs, but the decision with the biggest financial implications is likely to be the selection of the vehicles, since managers generally inherit their workforces from their predecessors, and any decisions about employment are usually concerned with small modifications to the size or composition of the workforce, rather than major changes to the salaries budget.

Since the selection of the storage and transportation system is such an important decision, it should not be made hastily, but include the input of

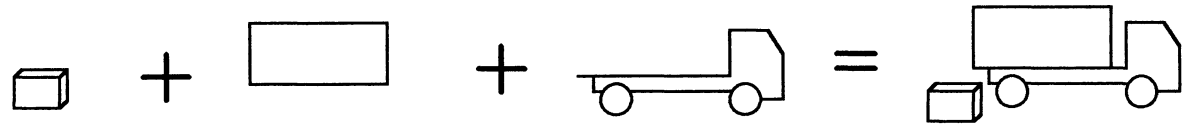
- ◊ experts with detailed knowledge of all relevant systems
- ◊ information based on operational experience of the systems under consideration. (If this is not available, and it is not possible to investigate operational experiences elsewhere, the wise plan of action is to operate the system or vehicle that is being considered on a trial or pilot basis for a period of perhaps six months, in order to gain operational experience that can be fed into the decision-making process.)
- ◊ a thorough analysis of the financial implications of the choice, concentrating on operational costs (maintenance, economic life and replacement costs, manpower requirements, and other operational costs).

It is very unfortunate that decisions about large purchases of vehicles and equipment are often not based on these factors, but are too frequently made by officials and politicians who have little technical knowledge, and are concerned only about the lowest tender price, or other non-technical factors. A study of total costs in Part B shows that capital costs of vehicles are usually less or equivalent to the costs of operation and maintenance over the lifetime of the vehicle. Furthermore the differences in capital costs between different alternatives may be relatively small. For both these reasons it is very short-sighted to base selection of equipment on capital cost alone - short-sighted, but far too common. It is hoped that a study of Part B of this report will help to acquaint future decision-makers concerning the *methods* and *considerations* of cost comparisons. The *actual* costs calculated in Part B cannot be used for other places or situations (i.e. situations different from the one in which the data in Part B were collected.) These cost figures are for particular situations and therefore should not be generalised. The system that is the most economical in Part B is not necessarily the most economical in other situations.

Another common error is to consider too few options. At the preliminary stage of the selection process all possible methods and systems that meet the required objectives should be considered, and the range of options should be reduced in a rational and scientific way.

C-1.2 FACTORS TO CONSIDER IN SELECTION

As far as equipment is concerned, a collection system can be considered in three parts: container, body and chassis.



Container + *body* + *chassis* = *system*

Whilst they are separate parts, the interrelationships between these parts must also be carefully considered.

The wide variety of systems available is well documented in the book published by UNCHS (Habitat) in Nairobi entitled *Refuse Collection Vehicles for Developing Countries,* and the reader is urged to refer to this book.

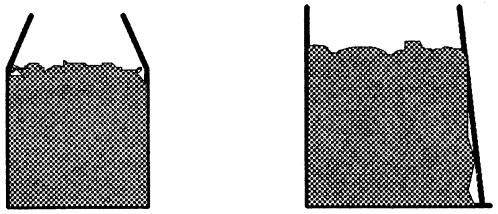
This section is not concerned with determining the numbers of vehicles or containers, but simply with selecting the type. The numbers of items required needs data on waste generation and properties, and much of the performance measurement data mentioned in Part B.

The following list suggests some of the factors that should be considered in selecting the most appropriate type of refuse collection system, considering the choice of container, body and chassis separately, and then considering the three components together. The list of factors is a long one, but it is not purely academic - many of these points have been impressed upon the author by actual problems and failures, and this section is written in the hope that it will help to prevent similar problems occurring in the future.

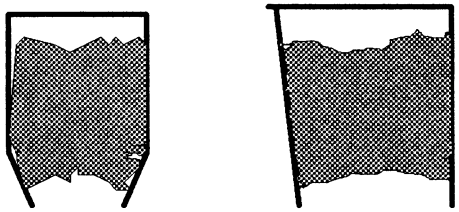
Containers (The choice of container need only to be considered if waste is not to be loaded manually from the residents' containers directly into the collection vehicle, because if refuse is loaded in that way a range of container types is possible.)

Factors to consider in selecting the best type of container are:

- ◊ waste density - if containers are lifted manually to load, because the maximum weight that a labourer can lift and the refuse density will determine the required size of container. Waste density is also important in assessing whether a container has sufficient structural strength (for example, a container designed for the USA would need to be able to carry five or six times the weight in India than it would in the USA).
- ◊ method of loading - Can the waste be transferred to the vehicle in an acceptable, efficient, reliable and hygienic way? If loading involves tipping the waste onto the ground and later lifting it into the collection vehicle, this is inefficient and unhygienic, violating the *Handle Once Only* principle of David Jackson.
- ◊ shape - Sharp corners accumulate waste which stays in the container when it is emptied, thereby encouraging corrosion. Containers that are tipped to empty should be wider at the top than at the base, otherwise some types of waste may wedge themselves into the container so that they can only be removed by hard banging (which damages containers and makes unacceptable noise) or by digging them out. This problem is illustrated in the sketches below.



Containers that are narrower at the opening than elsewhere



With certain types of waste, the contents are wedged inside when the containers are tipped.

- ◊ size of items in the waste - The container should be larger than the largest items so that it does not quickly become blocked
- ◊ corrosivity of the waste - If the waste is corrosive (usually because of high moisture and putrescible contents), unprotected steel containers will quickly corrode, especially if they are not cleaned regularly)
- ◊ presence of hot ashes in the waste - If they are present they will damage plastic containers
- ◊ maximum height - If waste is brought to containers by children it must be possible for them to put the waste inside the container
- ◊ risk of theft, damage and abuse - Do people set fire to waste, or move containers to other locations?
- ◊ location of the containers - How much space is available? What slope and type of ground surface will it be resting on? (Slope and surface are especially important if the container has wheels and is to be moved for emptying.)
- ◊ whether a cover is necessary -Covers on community bins are nearly always a failure, because people are unwilling to open them (because the lids are heavy, dirty or inconvenient) so either

they are left open or waste is dumped outside the container. A great amount of money has been wasted on community bin covers that are never used.

Body - this includes lifting, compacting and unloading mechanisms. Factors to consider include:

◊ whether compaction is necessary - Compaction of the waste has economic advantages when the waste is of a low density (as in USA and northern Europe), but there is a price to pay for compaction - the mechanisms are heavy (reducing the load of refuse that the truck can carry), and compacting bodies are expensive.

◊ reliability - Some bodies are very complex or require frequent repair because of poor quality or overloaded components. Reliability is a very important criterion, and should be a major factor in selection. Information on reliability comes from operational experience. A measurement of reliability is *availability* (the fraction of time when the equipment is available for use) and this is also affected by the time taken to obtain spare parts. Part D has extensive examples of this type of information.

◊ ease of unloading - Unloading should be accomplished quickly and hygienically. Unloading should be completed in a short time so that the vehicle can quickly return to collect more waste, and to avoid occupying space at the disposal site. (In Mumbai many of the trucks are unloaded manually, by men standing in the waste and pulling it with rakes. The process usually takes between 20 and 30 minutes.) Apart from the risks of infection and injury associated with this practice, a very large space is taken up on the disposal site by up to 40 trucks unloading in this way, with the result that management and control of the placing of the wastes is much more difficult. If the trucks spent one-tenth of the time unloading, there would be one-tenth of the trucks present at the unloading point at any time.) Bodies that tip to unload should be able to tip their bodies at a sufficient angle so that the waste falls out cleanly and quickly, and there should be no obstructions to the movement of the waste down the sloping floor. Rotating drum compactors usually cannot unload at one place, but must move forwards several times to discharge a full load. Hoppers of conventional compactors should have a facility for cleaning them quickly.

◊ the corrosivity of the waste - Solid waste that has a high putrescible content, or that has been in a container for several days, is very corrosive because of the acids formed in the decomposition processes; for corrosive wastes special materials or thicker steel plate should be used.

◊ the abrasive properties of the waste - If the waste contains significant quantities of sand, it is advisable not to use certain types of bodies that cause the waste to slide against metal surfaces, because the metal will be worn away by this grinding action.

◊ method of covering the load - If the vehicle is capable of moving faster than 20 km/h (so this does not apply to handcarts or carts pulled by animals) the load should be covered in transit. Some people also require that the load be enclosed all the time, in order to keep the waste out of sight and control smells. This is a matter for personal taste, but it should be mentioned that waste in enclosed compactor trucks also emits a detectable odour, and open trucks with a reasonably high loading height keep the waste out of the view of pedestrians. As far as the prevention of the scattering of waste is concerned, the best test is experience. Compactor trucks in India can be observed to shed items of waste as they load and as they move, partly through the crack between the rear hopper and the main part of the body. The compaction of wet waste often produces an unpleasant liquid which runs onto the street unless special tanks are provided to contain it. Since the refuse in India is usually dense and low in plastic content, the amount of waste being blown out of open trucks during the loading phase has been observed to be very little. The covering of open trucks with tarpaulins may involve walking over the waste which is an unhygienic and hazardous action.

◊ design to prevent accidents - Hydraulically-operated machinery is complex and potentially dangerous. It is important that the controls are designed so as to minimise the chance of operators or bystanders being injured by moving parts (particularly descending bodies or rear hoppers) or by glass or other materials that shatter during loading. Vulnerable parts - such as hydraulic hoses - should be protected against damage - for example when the vehicle passes under a low tree branch.

Chassis - (Factors such as chassis size also affect the body.)

◊ reliability - The working conditions for a refuse collection vehicle are often arduous. These trucks must operate in congested conditions, frequently stopping and starting. They may be required to

negotiate rough and soft ground at disposal sites. The chassis should be able to cope with such duty, and spare parts and maintenance expertise should be readily available. Currently in India there are two manufacturers of heavy vehicles, but a wider number of medium-sized chassis, and in the future there may be foreign-made heavy goods vehicles on India's roads. The choice of chassis should be carefully made according to experience of their operation in anticipated working conditions, the availability of spare parts and the advice of the mechanics. (The advice of mechanics is very useful in relation to maintenance considerations; they know that, for example, it is much quicker to change the clutch on one type of vehicle than on another, or that the failure of a particular component in a particular type of chassis is a frequent cause of breakdown.)

◊ local conditions - A number of factors relating to the road conditions affect the type and size of chassis that is appropriate. In big cities it may be necessary to operate several different truck models because of differences in road conditions in different parts of the city. Amongst the major local factors are:

- ⇒ distance that the vehicle is required to travel each day - the distance to the disposal site and the number of trips required. The operating speed of the vehicle is an important consideration when comparatively long distances must be travelled.
- ⇒ traffic speed - In congested areas a slow-moving vehicle may be adequate.
- ⇒ road width and corner radius - Where the streets are narrow or seriously blocked by parked vehicles, a narrow chassis is appropriate. Where corner radii are small, a short, narrow chassis, or an articulated vehicle may be required.
- ⇒ road slope - Steeply-sloping roads may need chassis with special gearing and braking systems.
- ⇒ road surface - Where roads in the collection area or on the way to the disposal site are particularly poorly surfaced, vehicles with special wheels or extra ground clearance may be needed. On unpaved roads, four-wheel drive may be an advantage. Heavy-duty springs and reinforced structural members may also be appropriate.
- ⇒ road construction - Heavy vehicles, especially those with double axles, can cause rapid damage to roads that have been designed for light traffic (as might be the case for roads in residential areas). The gross vehicle weight of the chassis must be limited in such cases.
- ⇒ space for manoeuvring - In some residential areas collection vehicles are required to operate in confined spaces, do frequent 'U' turns, and drive in reverse. The chassis should be chosen with this in mind.
- ⇒ headroom - The height of vehicle bodies or the height to which lifting equipment (such as cranes) can operate may be restricted by overhead power or telephone lines, by advertising gantries or other obstructions.

◊ crew accommodation - Refuse collection trucks often have "crew cabs" which are big enough to carry a crew of four or five with a reasonable degree of comfort. The need for transporting the loading crew should be assessed, and the ease and speed with which they can enter and leave the cab should also be considered.

◊ engine and transmission - Currently in India diesel engines and manual gearboxes are used for heavy trucks, but other alternatives may appear in the future. In some countries automatic transmissions are used to avoid clutch replacement, and there are now refuse collection vehicles designed to run on natural gas to reduce air pollution. Small, battery powered vehicles are sometimes used for street cleaning and primary collection. The decision to move away from what is well-tried and well-known should be made with caution.

The system as a whole

◊ The cost per ton is a key factor in selecting a system. Such costs have been calculated for some systems in particular conditions in Part B, and include both capital and recurrent costs.

◊ The compatibility of the body and the chassis should also be investigated. A body may be well suited to one chassis, but cause frequent problems on another. Weight distribution is a common problem with some compactor trucks, because of the considerable weight of the rear hopper overhanging behind the back axle, compounded by the weight of the refuse at the rear when the body is half full.

◊ Loading height is another issue. For some uses or applications of heavy vehicles, the height of the body is of little importance, but for solid waste collection, the height to which the solid waste must be lifted during loading is of crucial importance.

◊ The rear lights of the vehicle are important safety features, and so the body should be designed so that the lights are not obstructed or quickly obscured by dust and refuse.

C - 1.3 A FINAL PLEA TO DECISION-MAKERS

It may be that experienced vehicle engineers reading this list will say to themselves:

"Yes, I know all this. The problem is that *they* did not ask for my advice before *they* made the decision."

(The term "*they*" refers to the senior decision-makers who selected the vehicles.)

It is to be hoped that senior municipal officials and leaders are aware that they may have in their organisations talented and dedicated engineers and technicians who have a great deal of experience and knowledge concerning the operation and maintenance of heavy vehicles, and that the information that such people have could help avoid a very expensive mistake in this issue of vehicle selection. One does not need to look far to see such mistakes, made in the past.