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# Cost effective refuse handling vehicles

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COST EFFECTIVE REFUSE HANDLING VEHICLES.

In our work as consultants in waste handling in developing countries my colleagues and I have visited countries all over the world to study at first hand problems and conditions which are very different from those which we encounter in the more industrialised countries. (I always claim that I must hold a world record in that I have been on the rubbish dump in more than 70 countries)

Time and time again I have found situations where costly and complicated refuse compactor trucks have been used in countries where the conditions are so far removed from what the trucks were originally designed for that the life of the trucks has been no more than three or four years and the overall refuse collection costs have been between two and four times what they could be with more suitable vehicles.

In many cases, these sophisticated refuse collection vehicles had been supplied under bi-lateral aid programmes with "soft loans" from the donor countries who manufacture such equipment and at first I thought that this supply of totally inappropriate vehicles must be due to a lack of experience by the consultants employed. However a small article in one of the Kenyan newspapers three years ago highlights the problem more accurately.

This article said that a group of fifteen "consultants" had arrived from one European country under a financial and technical aid programme to study the problems in five Kenyan cities and to make recommendations for the number and type of vehicles to be used. At the end of the article it said that the first vehicles had arrived and would be demonstrated in each of the cities.

In other words the vehicles arrived before the consultants who were supposed to carry out the study to determine what kind of vehicles were required. Were these people consultants or sales men?.

To understand why Western or Japanese refuse compactor trucks are not appropriate in developing countries it is first necessary to appreciate both the differences and the reasons for the differences in the types of wastes to be found in different countries and even within varying communities within each country.

The properties of the solid wastes, refuse or garbage in each country will depend on a large number of factors including the diet of the inhabitants, the way in which their food and other purchases are packaged, the methods of cooking, street conditions and climatic conditions.

Do they for example eat corn flakes like we do in Europe, where maize comes in large bulky flakes within a polythene bag inside a cardboard box, or do they buy the same maize as hulled or ground corn in a plastic or paper bag? (The volume of refuse produced by the cornflake packaging is just 50 times greater than that of the hulled or ground corn).

Do they have a high proportion of fresh vegetables in their diet? vegetable and other organic wastes decompose in hot climates to form acids which are corrosive so that sheet steel vehicle bodies have a very short life unless they are made from special steels. These vegetable wastes have a very high density compared to the cornflake packet.

Do they cook on paraffin, gas or electricity or do they use wood or charcoal adding dense and abrasive ash to the wastes?

Do they live in areas with concrete or tarred roads? In areas where there are unsurfaced roads, sand or mud is carried into the houses on peoples feet and ends up in the refuse combining with ash and vegetable wastes to increase the refuse density and make a grinding paste which will destroy mechanisms designed for the light inert wastes from more affluent countries.

It is obviously crazy to expect a vehicle designed to handle the light, inert and non-abrasive wastes from Europe, the United States or Japan to stand up to the dense

abrasive and acidic wastes found in the less developed countries, but despite this, the salesmen from the more developed countries are persuading the people concerned in developing countries that they should buy the latest most complex and in very many situtions the least cost effective refuse trucks available.

In one situation I have seen in Colombia American front loading compactor vehicles were being used on dense and abrasive wastes. These vehicles use a ram ejection system operated by a six stage hydraulic cylinder. This hydraulic cylinder alone cost nearly 4,000 to replace and had a life of only 10 months. (Just 100 per week maintenance cost on only one relatively small component of the truck). The same trucks will operate for many years without trouble in the United States.

I have been in one African country where a small city was looking for refuse compactor trucks. When I visited the city council yard I found five generations of broken down refuse trucks which had been supplied in turn by Britain, Germany, Italy, Japan and the United States. These had all been supplied under "soft loans", typically 20 year loans with five year moratoriums on capital repayments, and none of these trucks had lasted for more than three years. Thus this city was faced with meeting the capital repayments on five generations of vehicles simultaneously and none of the vehicles were working.

The Sicillian bandit Guilliano is reputed to have said "I can look after my enemies, but God protect me from my friends".

Typical refuse from the industrialised countries will have an uncompacted density of between 90 and 130 kg/m3 and these wastes will be compacted in a compactor truck to perhaps 400 kg/m3. For these light wastes compaction is necessary to enable the truck to carry a sufficient load within the limits of the size of body which can be fitted on the truck. However, in the low and middle income countries the uncompacted density of the refuse will typically vary between 250 kg/m3 and 600 kg/m3 and it is possible to load a non-compaction truck body to the limits of its load capacity without any form of compaction. There is thus no reason whatever to use a compactor truck.

In fact, apart from the costs of buying and running such trucks, the compactor truck is counter productive in that the compaction mechanism alone may weigh as much as 3,000kg and the load carrying capacity of the truck is reduced accordingly.

## SEMI COMPACTION TRUCK

There is a problem with conventional open truck bodies in that they are slow and difficult to load due to the height of the truck body which is necessary to carry a sufficient volume of refuse and problems with refuse blowing off the truck while it is travelling. Thus, what is required is a truck body with a low and convenient loading height combined with a fully enclosed body but without the weight and complexity of a compactor truck.

Such a truck body was common enough in Europe about 40 years ago at a time when refuse densities were much higher than at present and the refuse was much more abrasive. (In those days most houses were heated by coal fires in the winter and many people cooked on coal fired stoves resulting in a high ash content in the refuse).

This truck body, known as the "fore and Aft tipper" was made by a number of European manufacturers and was ideally suited to the wastes commonly found at that time. However, in Europe the increase in the use of electricity and gas for cooking, pre-packaged vegetables and processed foods resulted in a dramatic reduction in the density of the wastes and the fore and aft tipper was replaced by the modern compactor truck.

Some years ago I spoke to a representative of a large British company who had originally manufactured these fore and aft tipping trucks. I said to him that this type of body was ideally suited to many of the developing countries and asked him why they no longer offered it for sale. His reply was that he fully agreed that it was the ideal truck for many countries in Africa, Asia and South America but that it was too easy to make and people in these countries would simply copy it instead of buying his much more costly and profitable compactor trucks. He told me that they had destroyed their drawings to prevent them from getting into the hands of small engineering companies in the less industrialised countries who would then make their own refuse trucks instead of buying the sophisticated British vehicle.

We are now re-designing the fore and aft tipping truck to include improved features and incorporating an additional press plate which will enable it to squeeze the few bulky items such as occasional cardboard boxes or plastic bags of wastes which have been tied at the neck and are full of air.

We are calling this new design of body a "semi-compactor" and will be offering the

designs to manufacturers in low and middle income countries so as to encourage local manufacture of cost effective refuse bodies which can be mounted on locally available trucks. They will carry a higher load and will last much longer than the more sophisticated compactor trucks thus not only reducing the costs of refuse collection but also reducing the need for scarce foreign currency. We have already reached agreement with one manufacturer in India to manufacture these truck bodies to our designs.

No doubt we will not be popular with the manufacturers of costly compactor vehicles.

## COMMUNAL CONTAINER SYSTEMS.

Although I have referred up to now to refuse collection vehicles which are intended for "door to door" or "multiple stop" collection in almost every situation communal containers are the lowest cost refuse system.

There are many different truck and tractor trailed container systems available using containers from 6M3 up to 30M3 or more. These systems pick up the containers and transport them one at a time to the discharge or dumping area. There are also complex systems which use front or rear loading compactor vehicles to pick up containers of 1M3 to 4M3 capacity and empty them into the compaction mechanism. However each of these systems has its drawbacks.

The front or rear loading compactor vehicles are much too costly to purchase and to operate and have a very short life. In any case they can only reach into areas with very wide streets and unrestricted access. (A typical front loading truck will require a clear space of more than 15 metres to enable it to pick up the container and a single car parked in the wrong place can prevent it operating).

With truck mounted or tractor trailed container systems there are problems with access and the size of the contain which are required. Typically these systems will be mounted on a truck with a gross weight of 14,000 to 16,000 kg to give a pay-load of around 8,000 kg. This is an economic payload from a haulage point of view and with a typical uncompacted waste density of 500 kg M3 will require a container with a capacity of 16 cubic metres.

In a low income country, if the container is to be collected on a daily basis, each container would typically serve a population of around 25,000 people or quite a large township.

This means that the distances the people will have to bring their wastes will be considerable and in many cases they will not bother but will just continue to dump their wastes indiscriminately. In any case, the 16M3 container will be too high for children to empty into so they will just throw the wastes on the ground beside the container.

Smaller container trucks are available but in general these are not very robust and will have to make much more frequent trips to the dumping area so they are not the solution either.

## CONTAINER HANDLING VEHICLE

What is ideally required is a system using large numbers of small containers which can be located within easy reach of each house combined with a system for transporting these containers economically to the dump site. The containers must be low enough for children to load and unless the areas are well planned it must be possible to deliver and collect these containers in areas with narrow and perhaps unsurfaced tracks.

We looked for such a system all over the world, but as we could not find one we have now developed one ourselves based on the chassis we developed for our latrine emptying vehicle.

With a payload of 1,000 kg and a container capacity of 2 M3, in a low income country with a typical waste generation rate of 0.3kg per capita per day, each container will serve about 3,000 people on a daily collection basis or 1,500 people if it is collected every second day. However, if we assume a six day working week we must allow extra capacity for the weekend period and would allow one container for each 1,000 inhabitants. (The containers can be made locally at a cost of around US$ 200 each or 20 cents for every person serviced).

The container pick up vehicle has a width of only 155 cms and a length of 335 cms. It can manoeuvre through narrow alleyways, climb steep slopes and travel over soft ground with a fuel consumption of no more than 8 litres of diesel per day.

Where the haul distances are short it can bring each container to the dump site for discharge but if the haul distances are greater than perhaps 5 Km it can leave the full containers at a main road access point for picking up by a separate transport vehicle.

For these longer hauls the transporting vehicle consists of a conventional flat bed truck fitted with a simple hydraulic hoist which can pick up the containers and transport them eight at a time. Thus the transporter will carry up to 8,000 kg on each trip and a special attachment for the hoist enables it to empty each container at the dump site.

In a typical situation. the container vehicle would pick up 64 containers per day and deliver them to the access road. The flat bed transport truck would also pick up 64 containers per day with a turn around time of 1 hour and 8 containers on each load. Thus with a three times weekly collection, one container pick up vehicle an one flat bed truck together with 128 containers could service a population of around 128,000 people, and handle 268,800 kg of wastes per week.

The capital costs of such a system could work out as follows:

| | |
|---|---|
| 128 containers at US$200 | $26,000 |
| 1. Container pick up vehicle | $20,000 |
| 1. Flat bed truck. | $30,000 |
| 1. Hydraulic hoist attachment | $14,000 |
| | $90,000 |

A capital investment of only $0.70 per person serviced.

A conventional compactor truck would typically carry 6,000 kg per load and manage two to three loads per day or perhaps 15 loads per week. It would require three compactor trucks to handle the same amount of wastes as the container system with a capital cost of perhaps US$80,000 per truck or US$ 240,000. A capital investment of $1.87 per person serviced. (2.7 times the capital cost of the small container system).

In most low inome countries, there will be no local manufacturer equipped to make the compactor truck whereas the containers and the flat bed truck body will normally be made locally. Thus the foreign currency required for the compactor truck system would be four times that required for the container system.

I do not have space in this paper to go into the total running costs of the different systems, but taking normal criteria for depreciation, maintenance, fuel and labour costs into account it could be shown that the overall operating costs for the compactor trucks would be in the region of 4 times those for the small container system and about twice those for the "semi compaction" system I have described at the beginning of this paper.

## CONCLUSION.

There are many different systems for collecting solid wastes in low income countries. I have shown two cost effective systems for door to door collection and for communal container systems which have not previously been put forward by consultants from the industrialised countries. Both of these systems can have a high local manufactured content.

It has been our experience in the past that wherever there is a local involvement in the manufacture of effective and appropriate waste handling vehicles long term solutions are found but when inappropriate systems are introduced from the industrialised countries into low and middle income countries any results have been very costly and have only lasted for a very short period.

I was recently quoted figures from one African country to show that just two years after the introduction of a fleet of new sanitation vehicles, less than one third of the veicles are still operating. How long will it take that country to pay for these vehicles? Ten years from now will they still be paying for these costly mistakes and how will they then find the finance to solve their future problems if they are still trying to meet the repayments on vehicles which have long since expired?

Whose responsibility is it? the consultants?, the salesmen's? or the local official's?. I would tend to blame the salesman, or the company behind the salesman for promoting equipment into low income countries which was designed for a completly different environment without bothering to try and understand the differences between the wastes in the different countries.

Our approach has been to offer vehicles which are designed for the environment in which they will have to work and then work with local manufacturers to minimise the imported parts, to maximise any local manufacture and adapt the designs to suit locally available trucks and other items.