Collection and Transfer of Solid Waste

CE 431: Solid Waste Management

What does Collection and Transfer encompass ?

- collection of solid waste (by external stakeholders) from its various sources or from communal storage facilities, and transportation of this waste to the place of final disposal.

- It also considers all activities related to loading of waste into collection vehicles, and unloading of waste from collection vehicles at communal collection points, processing places, transfer stations and final disposal sites.

- is the largest cost element in most municipal solid waste management systems, accounting for 60–70 per cent of costs in industrialized countries, and 70–90 per cent of costs in developing and transition countries (IETC, 1996)

Classification of Collection System

Classified based on

- availability of collection services,
- the mode of operation and
- the types of waste materials collected

Primary Collection

collection of solid waste from the source of generation and transportation of waste to the final disposal site, but more often it involves transportation to communal collection bins or points, processing or transfer station

Secondary Collection

collection of waste from communal bins, storage points or transfer station, and transportation to the final disposal site

Basic Collection Scheme

- Based on the availability of service

1. Communal system
2. Block Collection
3. Kerbside/alley
4. Door to door collection

Communal System

- The principal disadvantage of this system is that containers/collection points are located in a public place (lacking ownership by the public) which, in many situations, leads to indiscriminate disposal of waste outside the container.
- Thus, the actual economy of this system mostly depends on public co-operation
- It is therefore essential to pay more attention to improving the design, and operation and maintenance practices of a communal system to increase public acceptance, and to optimize the productivity of this system
- The use of portable storage containers maximises the productivity of labour and vehicles of such collection system

Block Collection

- Waste generators are responsible for bringing their waste to collection vehicles
- This system has low to medium labour and vehicle productivity, but it minimises the spread of waste on streets

Kerbside/alley

- This is the most common collection method in industrialised countries and in the wealthier communities of some developing countries.
- Waste generators place the waste containers or bags (sacks) on the kerb or in the alley on a specific day (or specific days) for collection by external actors.
- A regular and well organized collection service is essential so that generators know exactly when to leave out their waste.

Kerbside / Alley Collection Method:

Kerbside / Alley Collection Method:

Door to door collection

- This is more common in industrialized countries, but an increasing number of micro-enterprises and/or community-based organizations are forming in wealthier communities in many developing countries to perform this task.
- This system has yet to receive public attention, but as with the use of bags for waste it maximizes the productivity of crew, as retrieval of containers is not required.

Collection method

- Based on mode of operation

1) Hauled Container System
2) Stationary Container System

Hauled Containers

- An empty storage container (known as a drop-off box) is hauled to the storage site to replace the container that is full of waste, which is then hauled to the processing point, transfer station or disposal site
- The time required per trip

$T_{hcs} = (PT_{hcs} + q + m + nx)$ (4.1)

Where,

T = time per trip for hauled-container system, h/trip hcs

PT_{hcs}= pick-up time per trip for hauled-container system, h/trip

q = at-site time per trip, h/trip

m = empirical haul constant, h/km

n = empirical haul constant, h/km

x = round-trip haul distance, km/trip

Hauled Containers

- The pick-up time per trip PT_{hcs} is equal to:

$PT_{hcs} = pc + uc + dbc$ (4.2)

Where,

pc = pick-up time per trip, h/trip

uc = time required to unload empty container, h/trip

dbc = average time spent driving between container locations, h/trip

(determined locally)

Hauled Containers

- The number of trips that can be made per vehicle per day with a hauled-container system, including a factor to account for off-route activities, is determined using equation 4.3:

$Md = \{(1-W)L (t_1 + t_2)\} / Thcs$ (4.3)

Where,

M = number of trips per day, trip/d d

W = off-route factor, expressed as a fraction

L = length of working day, h/d

t_1 = time from garage to first container location, h

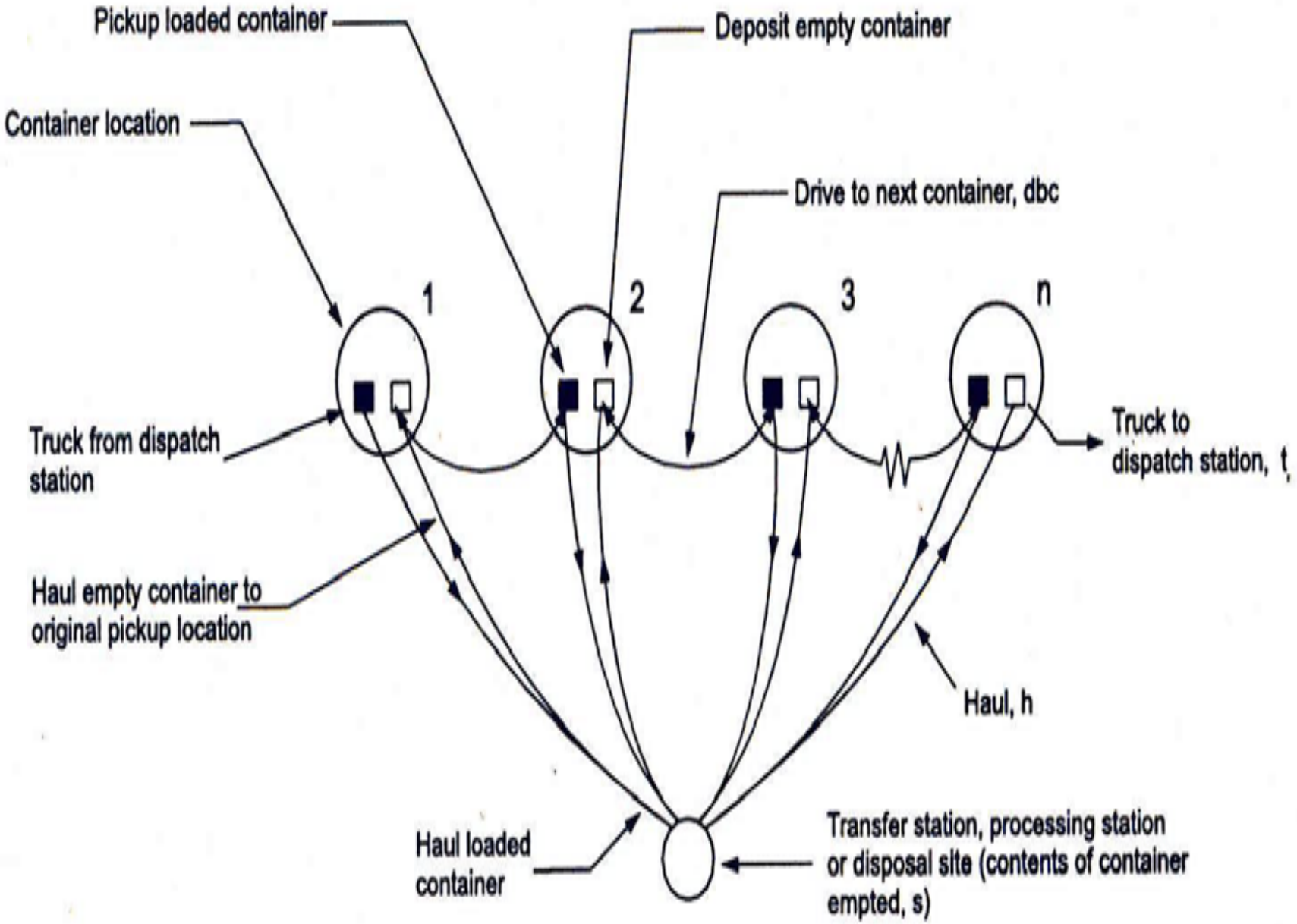
t_2 = time from last container location to garage, h

Hauled Containers

Table 4.1: Typical values for haul constant coefficients m and n

Type of haul	Speed limit km/h	m h/trip	n h/km
Communal	88	0.016	0.011
Block	72	0.022	0.014
Kerbside	56	0.034	0.018
Door-to-door	40	0.050	0.025

Adapted from: Peavy et al., 1985



Haul container system

Hauled Containers

Example 4.1: Analyzing a hauled-container collection system

Solid waste from a industrial park is to be collected in large containers, some of which will be used in conjunction with stationary compactors. Based on traffic studies at similar parks, it is estimated that the average time to drive from the garage to the first container (t_1) and from the last container (t_2) to the garage each day will be 15 and 30 minutes, respectively. If the average time required to drive between containers is 6 minutes and the one-way distance to the disposal site is 30km (speed limit: 88km/h), determine the number of containers that can be emptied per day, based on a 7-hour working day.

Stationary Containers

- In this system, containers used for the storage of waste remain at the point of collection. The collection vehicles generally stop alongside the storage containers, and collection crews load the waste from the storage containers into the collection vehicles and then transport the waste to the processing, transfer or disposal site

Stationary Containers

- For systems using mechanically self-loading compactors, the time per trip is:

$T_{scs} = (PT_{scs} + q + m + nx)$ (4.4)

Where,

T_{scs} = time per trip for stationary-container system, h/trip

PT_{scs} = pick-up time per trip for stationary-container system, h/trip

q = at-site time per trip, h/trip

m = empirical haul constant, h/km

Stationary Containers

- The pick-up time per trip PT_{scs} is equal to:

  $PT_{scs} = C_t uc + (S-1)(dbc)$ (4.5)

  Where,

  C_t = number of containers emptied per trip, container/trip t

  uc = average unloading time per container for stationary-container

  systems, h/container

  S = number of container pick-up locations per trip, locations/trip

  dbc = average time spent driving between container

Stationary Containers

$$C_t = \frac{V_v z}{V_c f}$$

Where,

V_v = volume of collection vehicle, m^3 /trip

V_c = container volume, m^3 /container

z = compaction ratio

f = weighted container utiliz $M_{dc} = \frac{V_d}{V_v z}$ or.

The number of trips require is given by:

Stationary Containers

- Where an integer number of trips are to be made each day, the proper combination of trips per day and the size of the vehicle can be determined by using equation 4.8 in conjunction with an economic analysis:

$$L = \frac{(t_1 + t_2) + M_{dc}(PT_{scs} + q + m + nx)}{1 - W}$$

To determine the required truck volume, two or three different values for M_{dc} are substituted in equation 4.8 and the available pick-up times per trip are determined. Then, by trial and error, the truck volume required for each value of Mdc is determined using equations 4.5 and 4.6. From the available truck sizes, select the ones that most nearly correspond to the computed values, compute the actual times per day that will be required using these sizes. The most cost effective combination can then be selected.

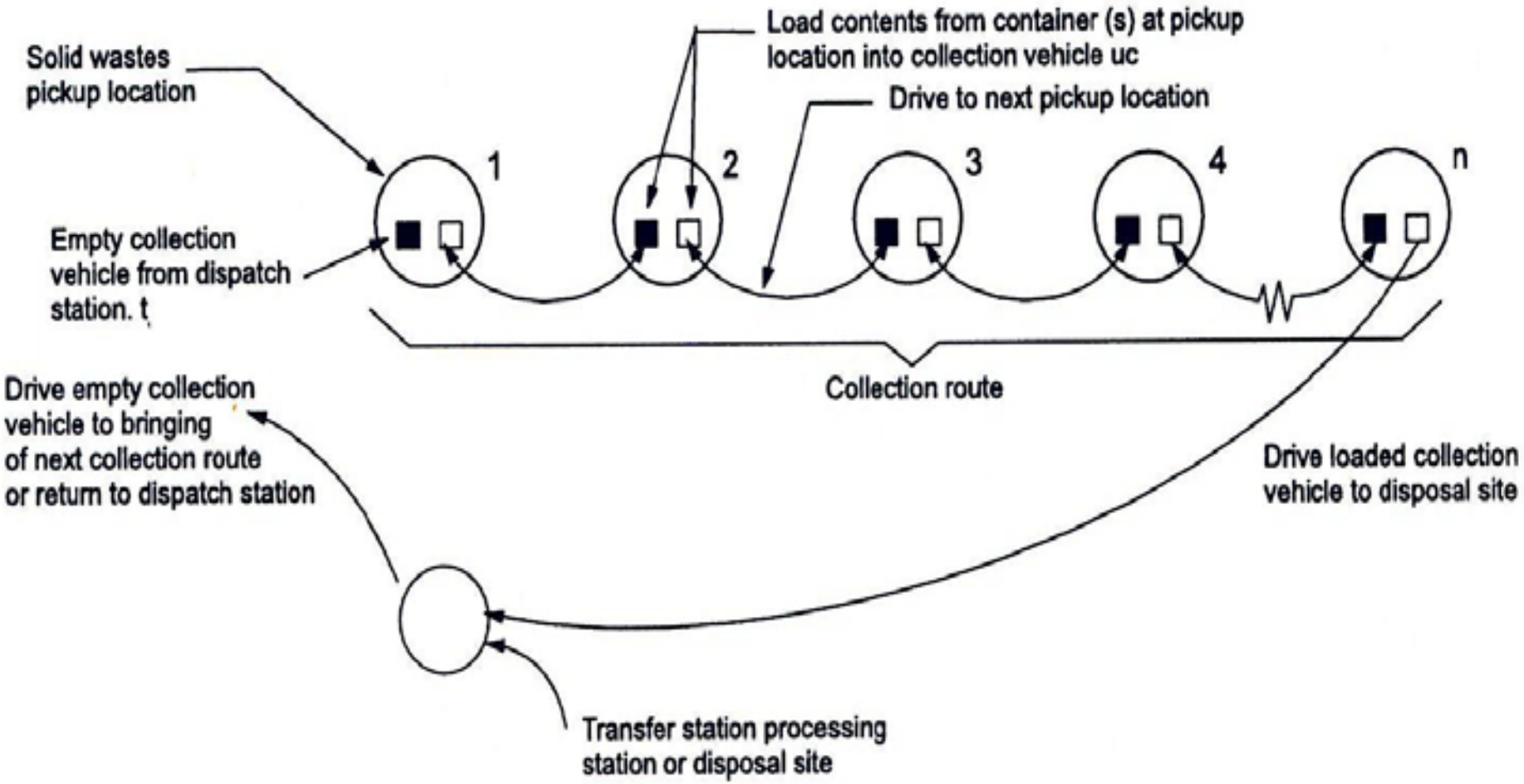


Figure 14.2 Schematic diagrams of hauled and stationary container systems (after Peavy et al. 1986)

Stationary Systems

Example 4.2: Analyzing a stationary-container collection system

Solid wastes from a commercial area are to be collected using a stationary container

collection system having 5 cubic metre containers. Determine the

appropriate truck capacity for the following conditions:

- Container utilization factor = 0.70
- Average number of containers at each location = 2
- Collection-vehicle compaction ratio = 2.5
- Container unloading time = 0.15h/container
- Average drive time between container location =

Point of Collection

- The choice of location of storage and collection points mostly depends on:
- access to the property (e.g. housing)
- physical characteristics of the property
- availability of waste management resources.

Comparison of various methods of collection

Description	Communal	Block	Kerbside	Door-to-door
Co-operation of generators in carrying waste	Yes	Yes	Yes	No
Co-operation of generators in emptying waste	Yes	Optional	No	No
Need for scheduled services	No	Optional	Yes	No
Susceptibility to scavenging	Very high	None	High	None
Average crew size	1-2 (portable) 2-4 (stationary)	1-3	1-3	3-7
Complaints regarding trespassing	No	No	No	Yes
Level of services	Poor	Fair	Good	Very good
Collection cost	Low	Medium	High	Very high

Source: Habitat (undated)

Frequency of Waste collection

- quantity of waste
- rate of generation
- characteristics of waste
- climate
- density and type of housing
- availability of space within the premises
- size and type of storage facilities (small, large, individual or communal)
- attitude of generators