Solid Waste Collection and Transport

1. On-site Handling, On-site Storage: Curb Collection, Direct haul, transfer station
2. Collection services: types and methods
3. Vehicle and labor requirements
4. Types of Collection systems (hauled container system, stationary container system)
ON-SITE HANDLING:

- Activities associated with the handling of SW until they are placed in the containers used for storage before collection

ON-SITE STORAGE:

Factors considered:

1. Types of containers used
2. Container Locations
3. Public health
4. Aesthetics
5. Methods of Collection
Factors considered:

i) Types of Containers:

- Depend on:
  - characteristics of SW collected
    - E.g. Large storage containers (Domestic SW: flats/apartment)
    - Containers at curbs
    - Large containers on a roller (Commercial/Industrial)
  - Collection frequency
  - Space available for the placement of containers (Refer to Table 11-4)

- Residential; refuse bags (7 -10 litres)
- Rubbish bins - 20 -30 litres
- Large mechanical containers - more commonly used to cut costs (reduce labor, time, & collection costs)
- must be standardized to suit collection equipment.
ii) Container Locations:

- side/rear of house
- alleys
- special enclosures (apartment/condos)
- Basement (apts. in foreign countries)/ newer complexes

iii) Public Health:

- relates to on-time collection to avoid the spread of diseases by vectors, etc.

iv) Aesthetics:

- must be pleasing to the eye (containers must be clean, shielded from public’s view).
v) Collection of SW
- 60-80 percent of total SWM costs.
- Malaysia (other developing nations) - labor and capital intensive.
- Major problems:
  – Poor building layouts - e.g. squatters
  – Road congestion - time cost, leachate, transport costs.
  – Physical infrastructure
  – Old containers used (leaky/ damaged)
  – Absence of systematic methods (especially at apartments, markets with large wst. volume).
Collection of SW (cont.)

• Collections were made by:
  1. Municipal/District Council
  2. Private firm under contract to municipal
  3. Private firm contract with private residents

• After Privatization (1998) - A Consortium of mngr. companies were given the responsibility.
  – (e.g. SWM (The Southern Waste Management - handles southern region) took over the mngr. from MBJB/MPJBT; Alam Flora (Central Region).
TYPES OF COLLECTION:

1. Municipal Collection Services:
   a. Residential:
      i. Curb (Kerb-side), alley, and backyard collection (100-120 litres)
         - Quickest/ economical
         - Crew: 1 driver + 1 or 2 collectors
         - No need to enter property
         - Most common in Malaysia.
TYPES OF COLLECTION (Cont.)

ii. Set-out, set back:
   - Collectors have to enter property
   - Set out crew carries full containers from resident storage location to curb/ alley before collection vehicle arrives.
   - Collection crew load their refuse into vehicle
   - Set-back crew return the container to storage area.

iii. House-to-house collection where refuse bags used in 20-30 liter bins.
iii. High-rise apartment or flats, specially designed chutes or a communal storage or roll-on-roll-offs (RORO’s).


b) Commercial-Industrial Collection Services

( > 12 m³ )

i. Large movable and stationary containers

ii. Large stationary compactors (to form bales)
Collection Frequency:

- residential areas: everyday/ once in 2 days
- communal/ commercial: daily
- food waste: max. period should not exceed:
  - the normal time for the accumulation of waste to fill a container
  - the time for fresh garbage to putrefy and emit foul odor
  - the length of fly-breeding cycle (< 7 days).
TYPES OF COLLECTION SYSTEMS:

1. Hauled Container System (HCS)
2. Stationary Container System (SCS)

1. HCS:
- Container is hauled to disposal sites, emptied, and returned to original location or some other location
- Suitable for areas w/ higher wst. generation
- Types:
  » Hoist truck: 2 - 10 m³
  » Tilt frame container: 10 - 40 m³
  » Trash trailer - for heavy, bulky rubbish (construction, commercial, usually open top container);
  » 2 crew per vehicle.
2. SCS:

- the container used to store waste remain at the point of generation; except when moved to curb or other location to be emptied.
- Types include:
  - Mechanically-loaded system
  - Manually-loaded collection vehicle (more common).
- Used for residential/commercial sites.
- Vehicle w/ internal compaction mechanism or uncompacted (open top lorry - side loaded.
- Refer to Figure: 11-10 (handout).
PRIVATIZATION OF SWM:

• Specific tasks of the company included the following:
  • To take over the collection and disposal of solid waste and cleaning activities of MPJBT
  • To employ the staff of MPJBT involved in both activities
  • To take over property involved with both activities
  • To take over contracts currently held by the Council.
SWM - strategies to improve:

• increasing number of vehicles and staff
• rearranging work areas to increase productivity
• opening up new tenders for newer development areas
• repairing vehicles
• upgrading drainage-cleaning performance, collection of illegal dumping sites, and opening up new cells at Ulu Tiram landfill site (Southern Waste Management, 1998).
COST ACCOUNTING FOR SW COLLECTION SYSTEM:

- Part of management control
- Accounting concepts must be utilized to the maximum.
- Referred to as an “Enterprise Fund Accounting”.
Costs in SW Collection Systems:

i. Capital Costs (i.e. depreciation (susut nilai) costs for vehicles, garages, administrative services).

ii. Interest costs of debt (to acquire /construct facilities/equip.)

iii. Costs (i.e., labor, parts, oil, tires) of repairing and maintaining facil./equip.).

iv. Employee benefits (pension, etc.).

v. Cost of temporary employees (short-term needs).
vi. Overhead costs (executives, supporting staff).

vii. Costs associated with budgeting, accounting, and report activities.

viii. Costs associated with billing and collecting user charges.

ix. Liability and damage claims.

x. Insurance premiums (personnel, facilities, and equipments).
TRANSPORT COSTS:

- estimates of the costs per km and per hour to move the waste after collection from the end of collection route to the various facility locations in the study.

- Unit transport cost (RM/km) for various types of vehicles:
  
  i. Collection vehicle
  ii. Transfer vehicles
  iii. Residue and/or ash vehicles

- Labor costs (driver + crew in RM/hr unit cost) only for (i) and (iii).

- For (ii) - labor costs should be included as part of the annual labor cost of the transfer station.
Factors Affecting SW Collection Productivity:

a. Service Level Related:
   • Collection point, frequency, waste material

b. Route related:
   • Containers, Distance, constraints, topography, delays, road conditions

c. Collection Methodology Related/Climate Related:
   • Crew size, collection procedures, wind, rain.
ANALYSIS OF COLLECTION SYSTEMS

- Must be optimized to save collection time and costs.

- Important to determine vehicle and labor requirements

- Activities involved 4 units: pick-up, haul, at-site and off-route.
Waste Collection Models

Determination of Vehicle and Labor Requirements.
LAY-OUT OF ROUTES:
4-Step Process

1. **Prepare location maps:**
   - with pick-up point locations
   - number of containers
   - collection frequency
   - estimated quantities (in the case of SCS with self-loading compactors).
2. Data summaries:
   - Estimate of wst. each day (from pick-up locations)
   - (for SCS - number of locations for each pick-up cycle).

3. Lay preliminary collection routes (from different stations).
   - Route should connect all pick-up locations + last location be nearest to disposal site).

4. Develop balanced route - determine haul distance for each route
   - Determine labor requirements per day, check against available work times per day - draw master map.
Selecting Collection Equipment:

- Changing needs and advances in technology
- Trends - increase use of computer-aided equipment and electronic control (e.g. on-board computers for monitoring truck performance and collection performance).
- Most prevalent: compactor trucks (equipped with hydraulically powered rams that can compact wastes to increase payload).
- Open and close non-compacting trucks:
  - Inexpensive to purchase or maintain
  - Inefficient for most collection application (small amt. of waste, have to lift high to dump into the truck)
  - Suitable for yard, bulky wastes, and recyclable materials, for small communities and rural areas.
Factors to consider in selection of vehicle:

1. Waste quantities

2. Truck body or container capacity
   a. Regulations regarding truck size and weight,
   b. To maximize the amount of wastes that can be collected while remaining within legal weights for the overall vehicle.

3. Consult with collection crew and drivers.

4. Loading location/Location of container - determine the type of vehicles to be used: Front-loading; Side-loading or rear-loading compactor truck.

5. Physical characteristics of the collection routes/road width - e.g. wide street - use side-loading automatic collection system; for narrow urban streets - use rear loaders.
Factors to consider in selection of vehicle (Cont.):

6. Residential, commercial or industrial: HCS for large buildings (e.g. apt., industries, etc.)

7. Safety and comfort - to minimize danger to crews.
   - Truck turning radius - be as short as possible.
   - Water tightness - to prevent leakages.
   - Speed - wide range of speed.
TRANSFER OF MUNICIPAL WASTE:

- More common as the distance of landfill sites becomes greater
- Most common in larger metropolitan areas.
- Variance in types, size, and degree of sophistication
  - E.g. open-air stations or enclosed in a building (newer stations).
Advantages of Transfer stations:

- better haul roads for collection vehicles (usually paved - reducing damages to trucks and delay).
- greater traffic control (avoid traffic jams/congestion or litter + safety to children).
- fewer truck on the sanitary landfill haul routes (reduction ratio of from 3 (trucks) :1 (transfer haul) or 5:1).
- improved landfill operating efficiency (fewer trucks mean better traffic control).
- Lower overall haul cost (reduction in no. of drivers/crew).
Criteria for Transfer Location:

- Near the collection area served (to minimize collection crew time for haul to the transfer station).
- Accessible to major haul routes (public acceptance and economics - lower transfer haul cost).
- Adequate land area to provide isolation (to handle traffic flow).
- Suitable Zoning (commercial or industrial)
- Served by utilities (water, sanitary sewer, storm drainage, electricity)
  (Size vs. station capacity)
Station Concepts

1. Pit
   a) Direct Dump
   b) Compaction

1. Pit:
   - Collection vehicles unloaded wastes into a large pit.
   - Wastes are then pushed to an open-top transfer trailer by a tractor.
   - The pit - as storage during peak periods.
   - Compaction of bulk items made by the tractor in the pit.
2. Direct Dump:

- Collection vehicles dump directly into open-top transfer trailer.
- Large hoppers direct the waste into the transfer trailers.
- Very large transfer trailers are used (due to minimal compaction).
- Efficient - no intermediate handling required (direct from vehicle to transfer trailer).
3. Compaction:

i) **Hopper type compaction station**: waste drop by gravity into a compactor - packs the waste into the trailers.

ii) **Push pit compactor station**: a large hydraulically operated blade moves the waste to the stationary packer - then packs the waste into the trailers.
### Advantages & Disadvantages of Design Alternatives:

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<tr>
<th>Option</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Tipping floor, open-top trailer</td>
<td>• Large tipping floor where collection vehicles unload • Dozers organize and push waste into open-top trailers</td>
<td>Not as eff. as other syst. For large vol. of waste</td>
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<td>Little site work inv. Low bldg. Cost Can separate recyclables</td>
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<tr>
<td>2. Pit, Open-top Trailer</td>
<td>Reduced transfer time (coll.veh. unload while loading &amp; transfer operations still going on) • Pit serves as a storage • Efficient system for high volumes of wst. Can sep. recyclables</td>
<td>Requires 3-level facility (considerable amount of site work &amp; capital investment</td>
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<tr>
<td>Option</td>
<td>Advantages</td>
<td>Disadvantages</td>
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<tr>
<td>3. Direct dump, open-top trailer</td>
<td>1. Can be used to distribute the wst. in trailer ·</td>
<td>1. May req. separate trailer-packing machines (in case of large uncompacted wst)</td>
</tr>
<tr>
<td></td>
<td>2. No intermediate handling of the wst. inv.</td>
<td>2. Req. additional tipping flr/storage space.</td>
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<td>4. Fac. shutdown rare</td>
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<td>5. No complicated equip. inv.</td>
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<td>• Coll. veh. dump loads directly into open-top trailers via large hoppers</td>
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<td>• Stationary or mobile clamshell equip.</td>
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<td>Option</td>
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<td>4. Hopper-type Compaction</td>
<td>1. Efficient for small capacity demand</td>
<td>Trucks may line up waiting to unload because of limited hopper size.</td>
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<td></td>
<td>2. If compactor fails, no alternative method of loading</td>
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<td>• Wst. is gravity-fed via hopper into stationary compactors that compacts the wst before or while entering the trailer</td>
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<tr>
<td>Option</td>
<td>Advantages</td>
<td>Disadvantages</td>
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| 5. Push-pit Compaction | • Coll. veh. dump loads into large steel or concrete pits.  
  • Large hydraulic blade moves the wst. to compactor charging box.  
  • Compactor packs the wst. into trailer. | 1. Large capital investment.  
  2. Facil. operations dep. on operation of the compactor. |
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<th>Disadvantages</th>
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<tr>
<td>6. <strong>Stationary Compactor, roll-off container</strong>&lt;br&gt;• Low-vol. operations (e.g. rural drop-off centers).&lt;br&gt;• Refuse unloaded directly into container.</td>
<td>Container may be equipped with compactor to handle lighter materials.</td>
<td>1. Bulky and large materials - create problem w. small compactor.&lt;br&gt;2. Operation dep. on functioning compactor</td>
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<tr>
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<td>Advantages</td>
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| 7. **Track and top-load.**  
  • Tracked compactor followed by loading in open-top trailers. | Efficient for larger facilities (≥ 300 t/d) |              |
PROCESS OPTIONS AT TRANSFER STATIONS:

- To prepare waste for transfer haul and subsequent disposal

1. Baling:
   - practiced in the US since 1960’s
   - reduces haul cost
   - a more controlled operation at the landfill
   - require lower cover material
   - density 2000-1500 lb/yd3
   - may have wire ties or may not be tied.
   - Requires little or no separation of wastes.
2. Shredding:

- Shredders are used.
- Handles bulky wastes (furniture, tree limbs, etc.)
- Transport - use enclosed transfer trailers.
- Wastes have good compaction characteristics - requires small trailers.