

Data collection for improvement of waste management

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General challenges on waste management in developing countries

Collection

- ✓ Areas with no waste collection services
- ✓ Poor accessibility for local people to collection points
- ✓ Unsanitary and unsafe condition in collecting and loading process

Transportation

- ✓ Long distance to dumping sites
- ✓ Vibration and noise along access roads
- ✓ Leakage of wastewater on the roads

Landfill

- ✓ Lack of land for dumping sites
- ✓ Landfill slide
- ✓ Leachate flows into river and ground water
- ✓ Odor
- ✓ Fire and smoke
- ✓ Greenhouse gas (CH₄) emission



Important to collect **reliable data for improving waste management**

Target 11.6

By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management

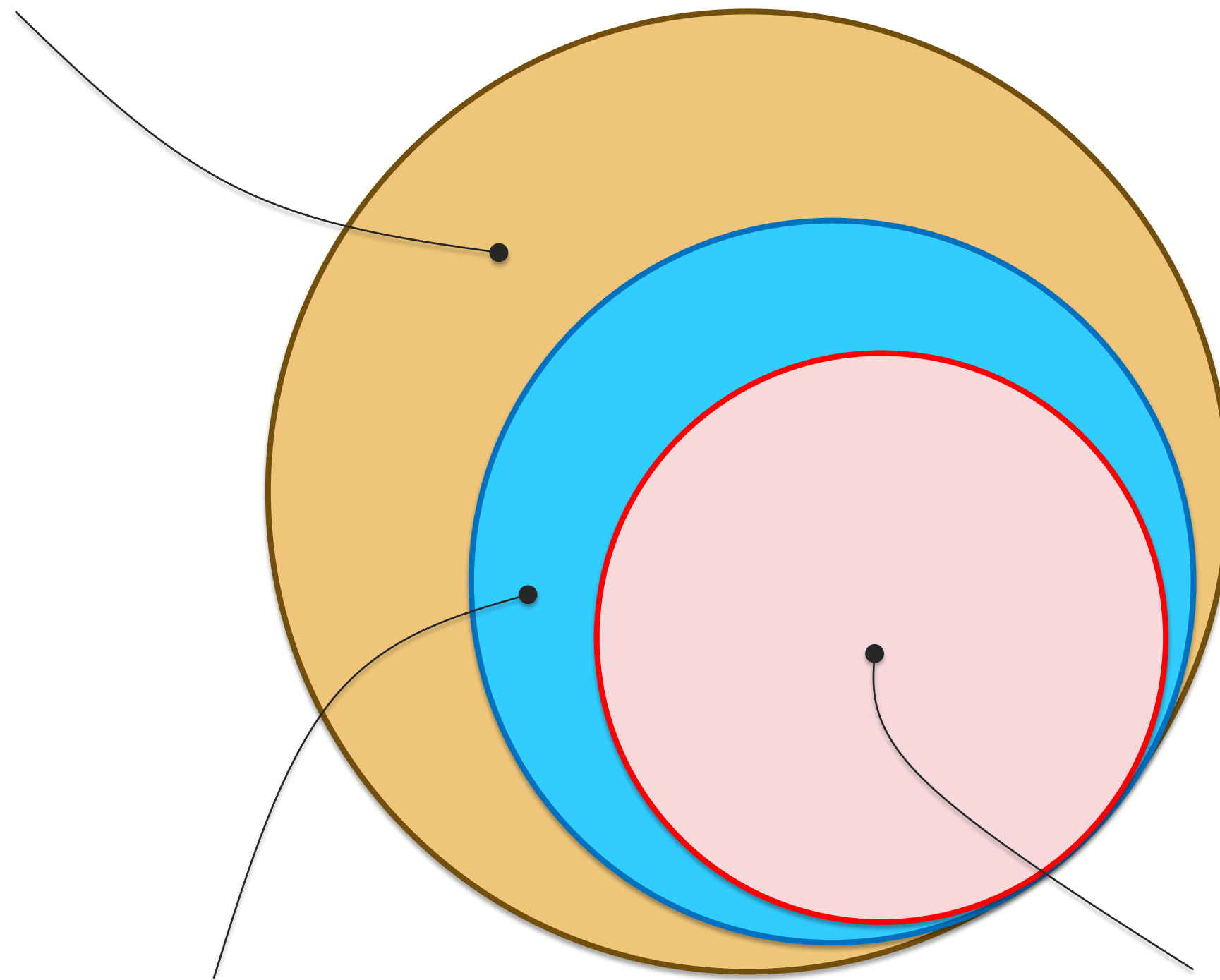
Indicator 11.6.1

Proportion of municipal solid waste regularly collected and managed in controlled facilities out of total urban solid waste generated, by cities

Definition of MSW

Waste managed by or for governments as a public service

*Waste other than MSW
(such as industrial waste)*



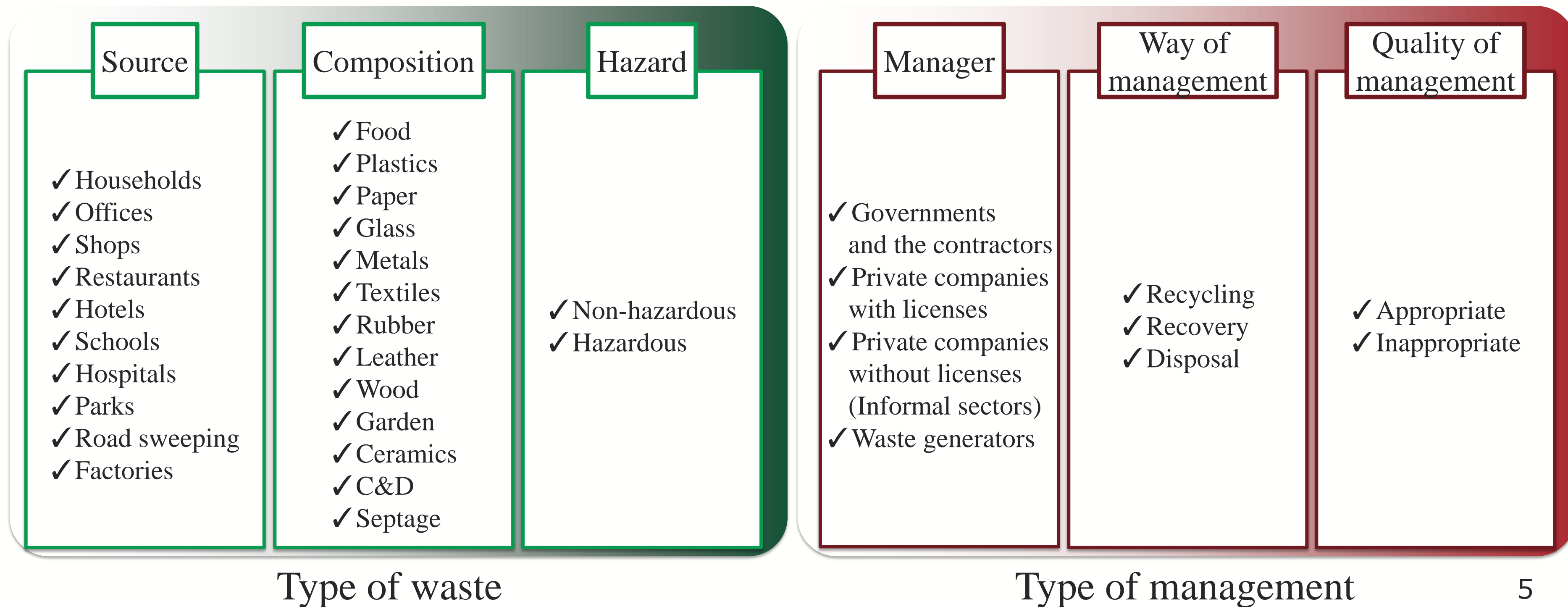
*MSW that is not currently managed
but generated*

MSW that is currently managed

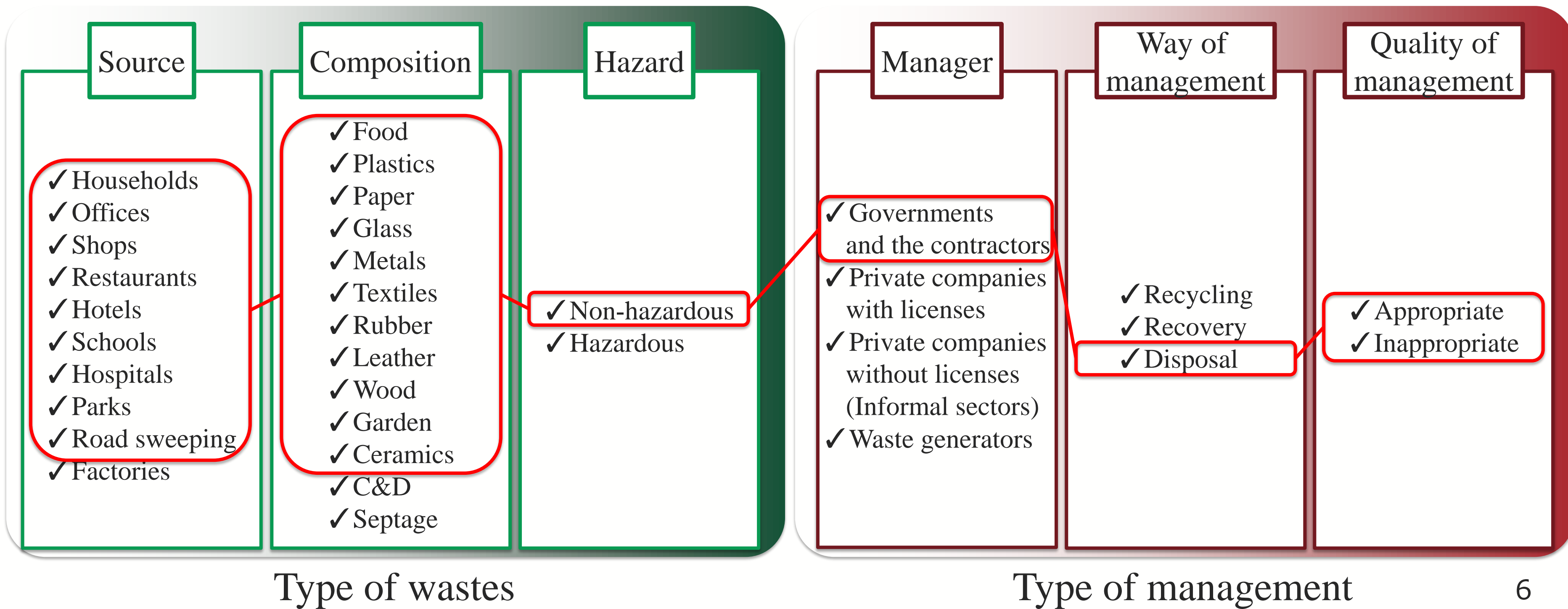
Definition of MSW varies among countries.

It depends on;

- ◆ type of waste (source, composition and hazard), and
- ◆ type of management (manager, way of management and quality of management)



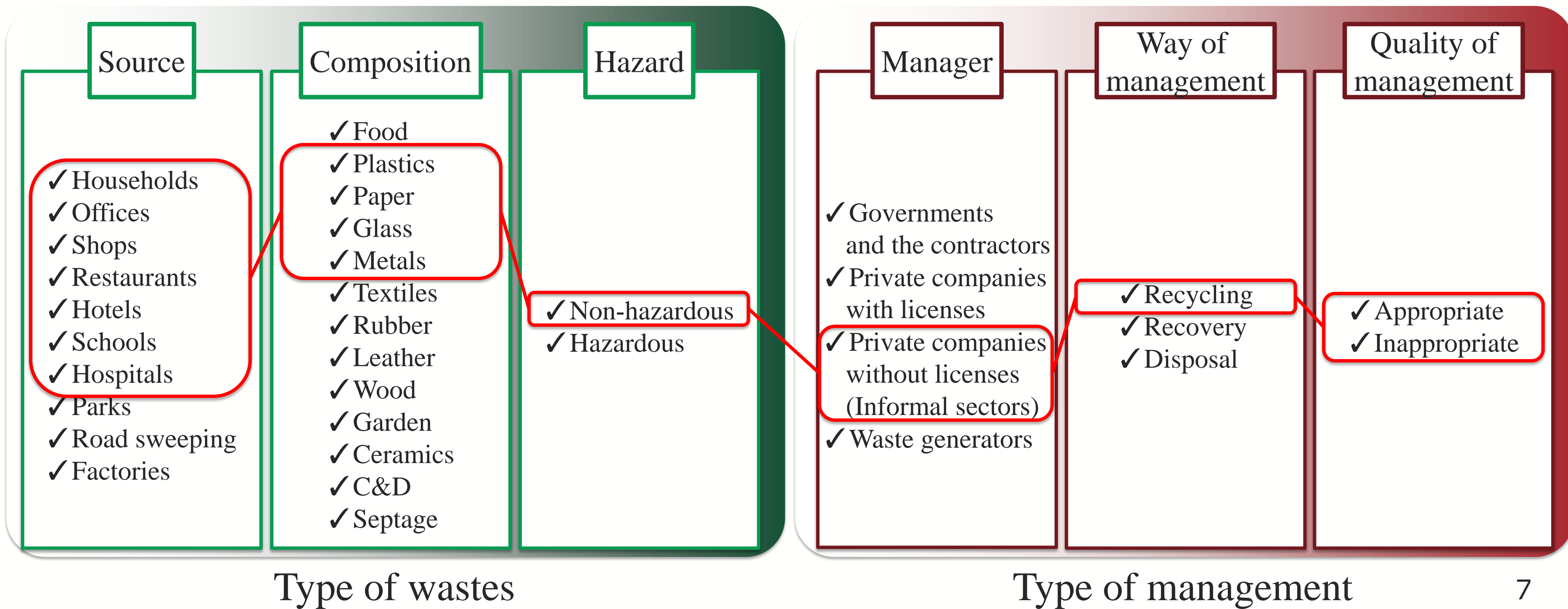
Examples of type of waste and management in Medan, Indonesia



Type of wastes

Type of management

Examples of type of waste and management in Hanoi, Vietnam



Amount of MSW to be identified

$$M_a = M_m + M_n$$

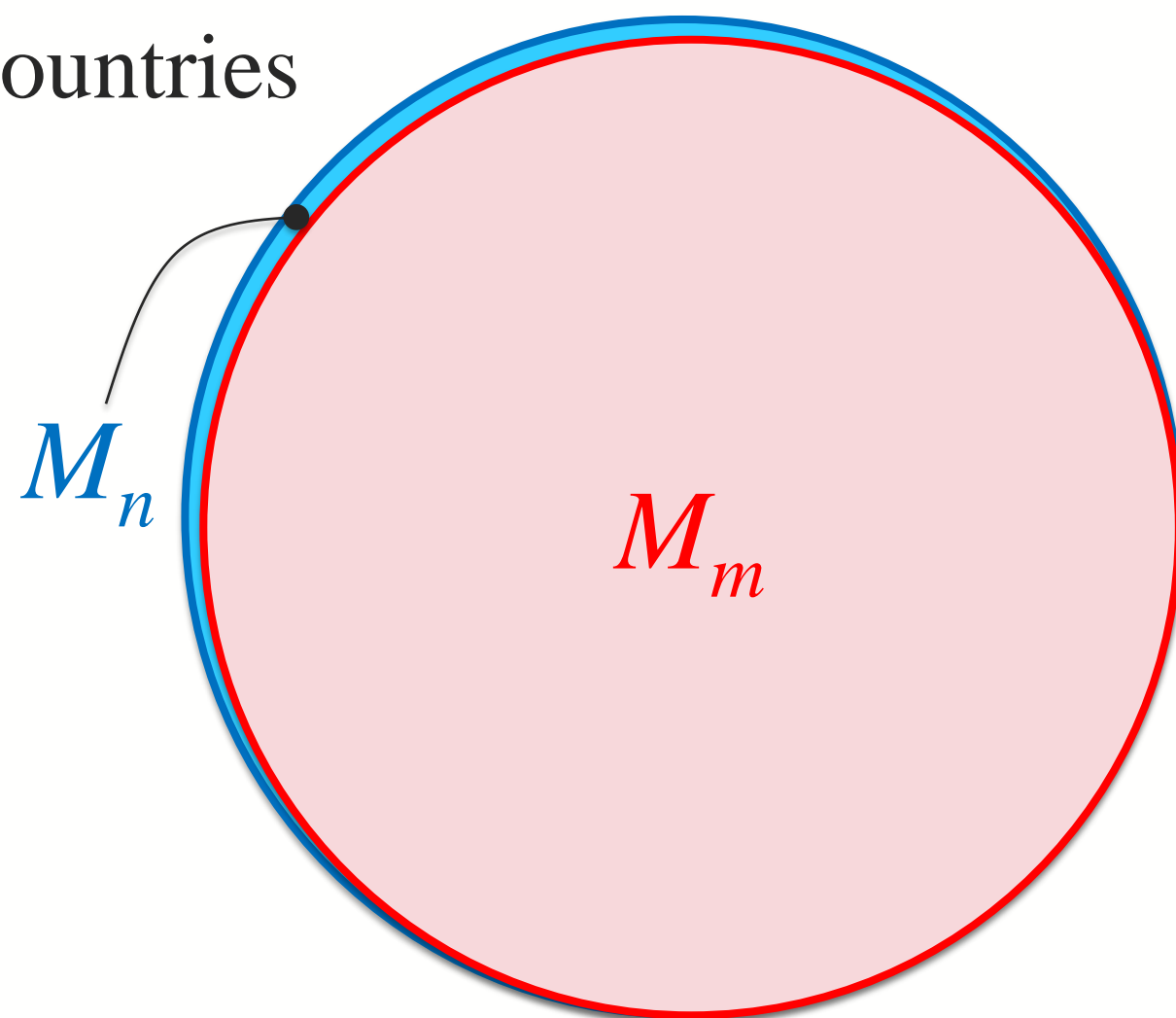
M_a : Total amount of MSW generated (tons/year)

M_m : Amount of MSW that is currently managed (tons/year)

M_n : Amount of MSW that is **not** currently managed but generated (tons/year)

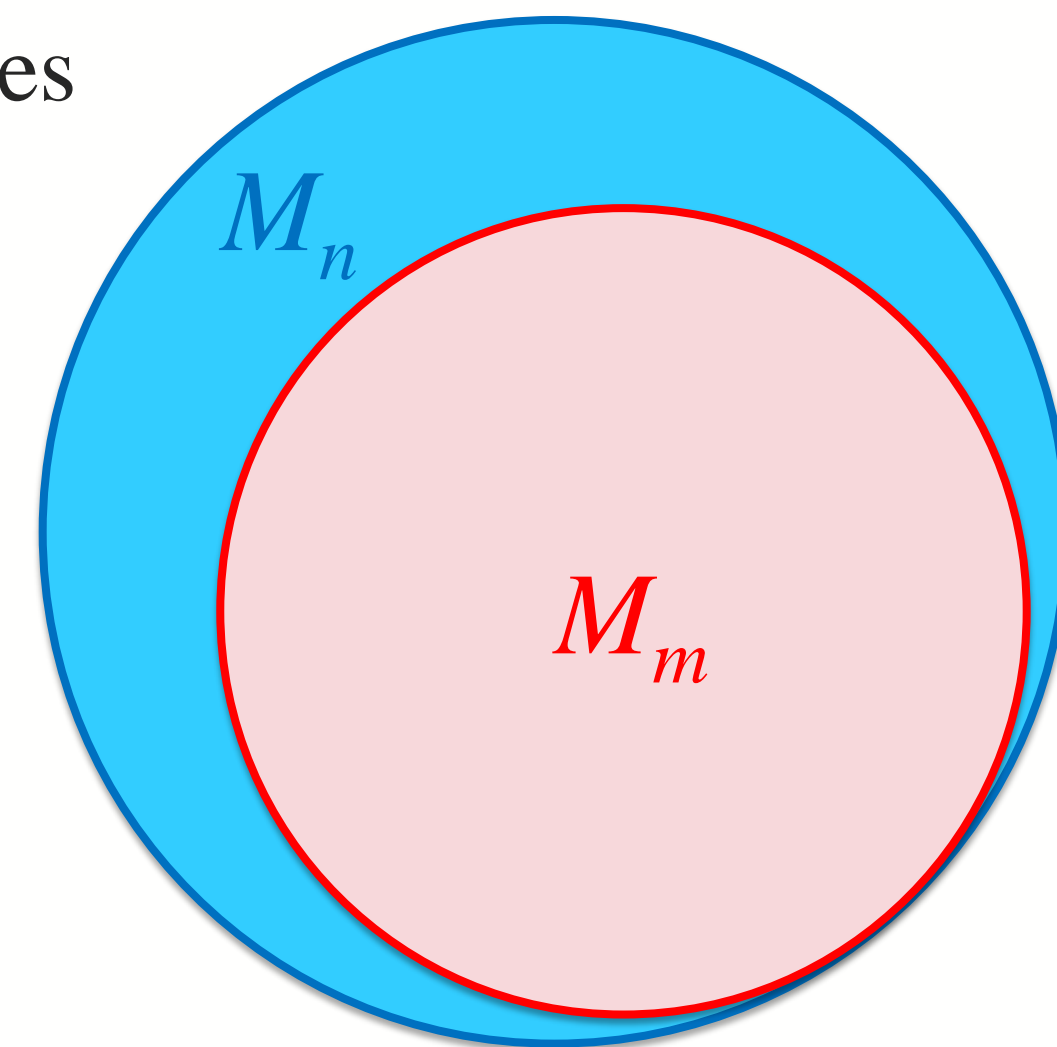
In developed countries

$$M_n \approx 0,$$
$$M_a \approx M_m$$



In developing countries

$$M_a > M_m$$



$$\frac{M_m}{M_a}$$

Both of M_a and M_m should be identified to calculate **Indicator 11.6.1**.

With weighbridges, M_m can be identified accurately.

Without weighbridges, M_m has to be estimated.



Weighbridge in Bekasi, Indonesia

How to estimate the amount of MSW that is currently managed (M_m)

Per-capita data

$$M_m = m_m \times p_m \times 10^3$$

m_m : per-capita amount of MSW that is currently managed (kg/person)

p_m : population served by MSW collection (persons)

Average truck data

$$M_m = c \times v \times d \times t \times l$$

c : average capacity of a truck (m^3/truck)

v : average loading volume ratio of a truck

d : average density of MSW loaded on truck (tons/m^3)

t : average number of trips per truck (frequency of trips)

l : average number of operating trucks (number of trucks)

Individual truck data

$$M_m = \sum (c_i \times v_i \times d_i \times t_i)$$

c_i : capacity of truck i (m^3/truck)

v_i : loading volume ratio of truck i

d_i : density of MSW loaded on truck i (tons/m^3)

t_i : number of trips by truck i (frequency of trips)

Per-capita data

$$M_a = \frac{m_a \times p_a}{10^3}$$

m_a : per-capita amount of MSW generated (kg/person)

p_a : total population (persons)

Per-generator data

$$M_a = \sum m_i$$

m_i : amount of MSW generated from source i (tons)

household, office, shop,
restaurant, hotel, etc.

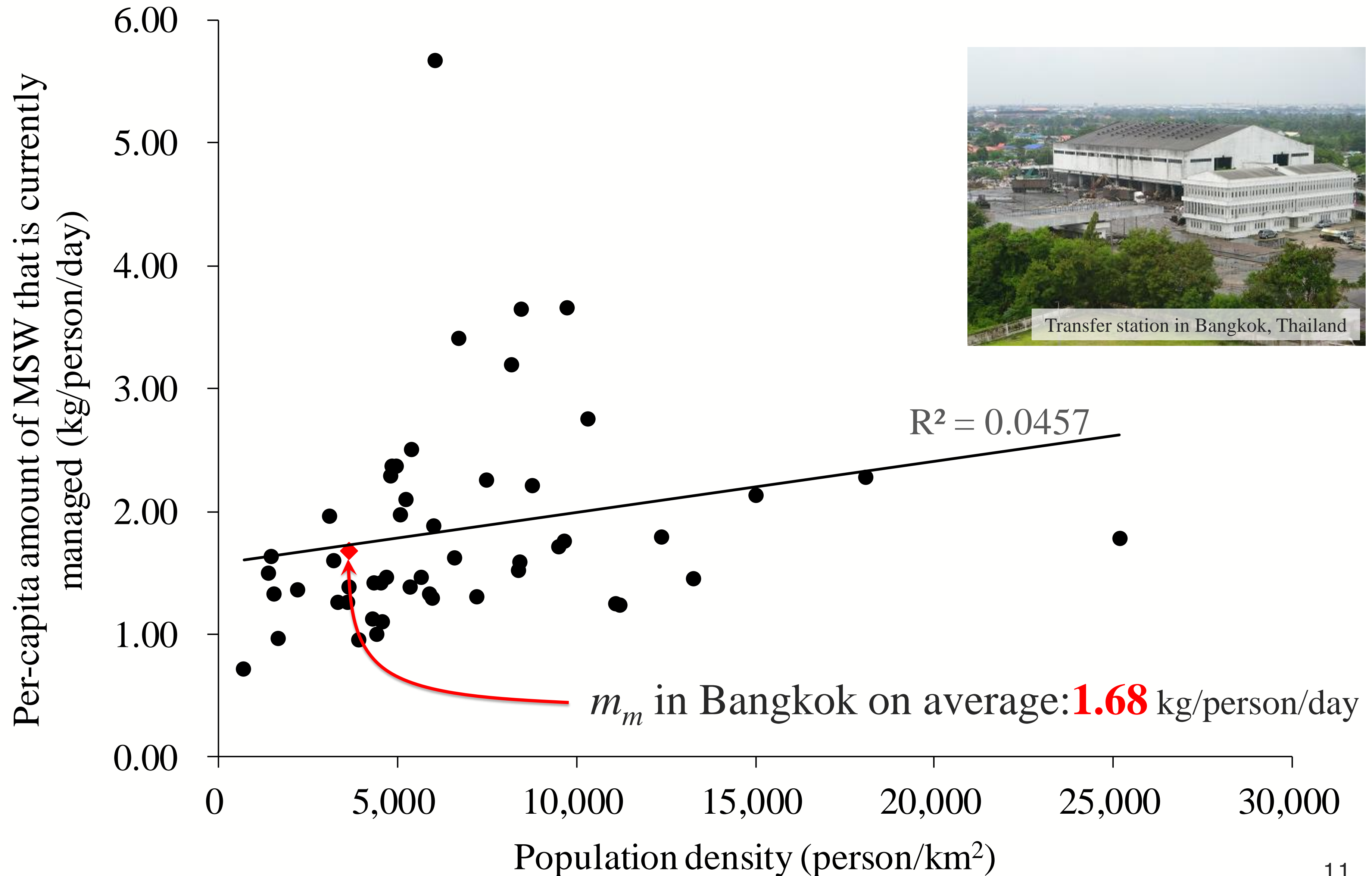
Hybrid data

$$\begin{aligned} M_a &= M_m + M_n \\ &= M_m + \sum n_j \end{aligned}$$

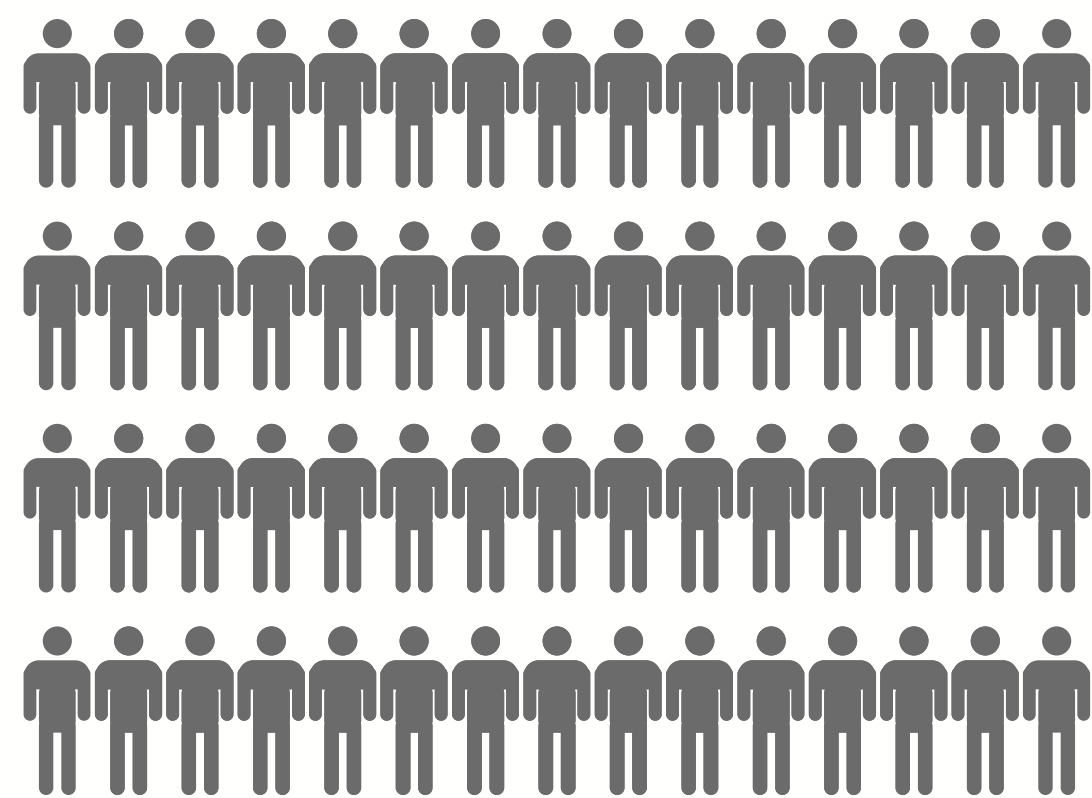
n_j : amount of MSW that is not currently managed but generated from source j (tons)

household, office, shop,
restaurant, hotel, etc.

Per-capita amounts of MSW that is currently managed (m_m) in 50 districts of Bangkok, Thailand



Effect of non-registered population on per-capita amount of MSW that is currently managed (m_m) in Bangkok



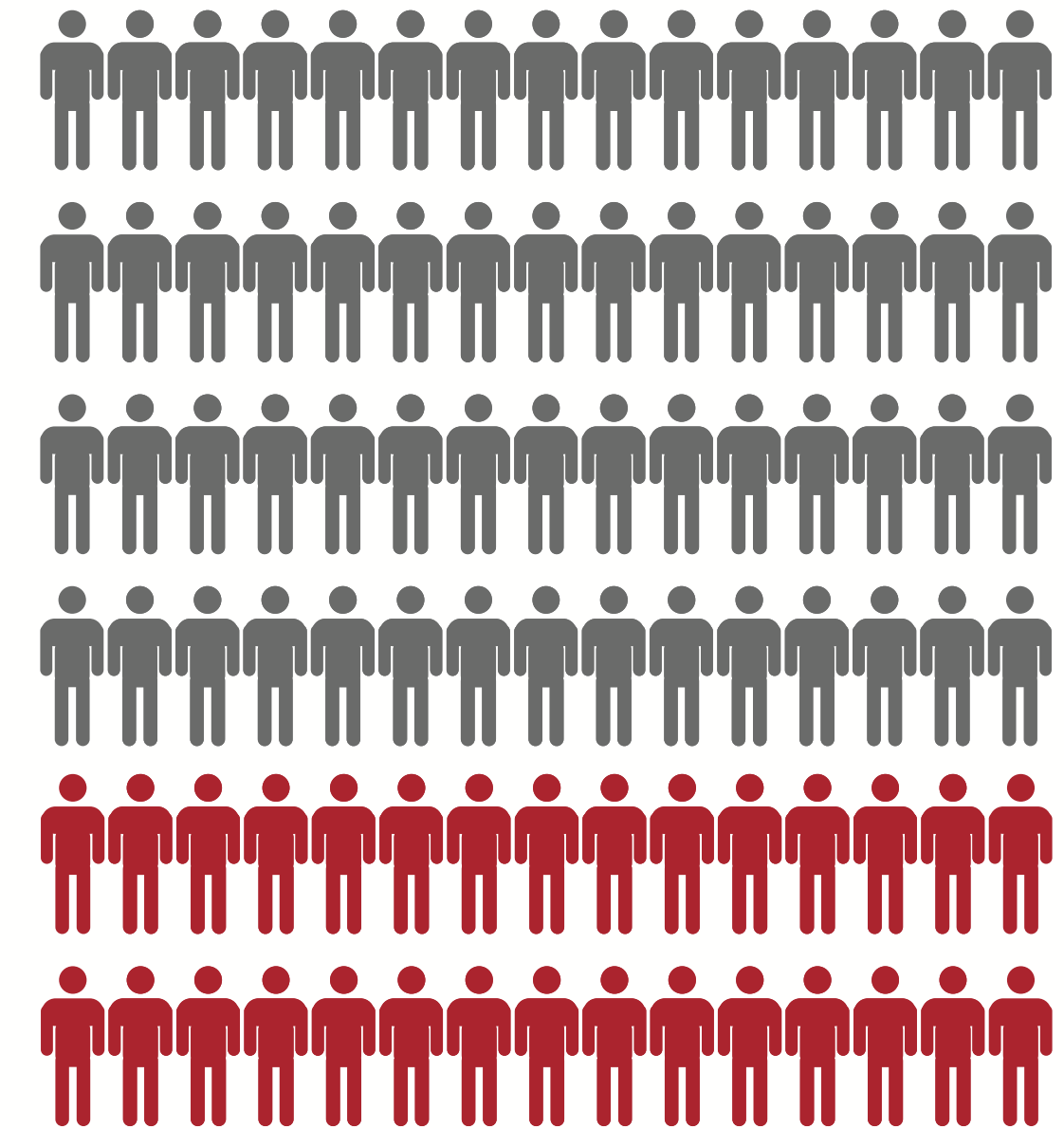
Registered population
 p_r

+



Non-registered population
 $0.5 p_r$

=



Total population
 $1.5 p_r$

$$m_m = \frac{M_m \times 10^3}{p_r \times 365} = 1.68 \text{ (kg/person/day)}$$

$$m_m' = \frac{M_m \times 10^3}{1.5 p_r \times 365} = 1.12 \text{ (kg/person/day)}$$