Sustainable Sanitation for Low-Income Densely Populated Urban Areas in Indonesia

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Presentation Outline

- Background Information
- Objective and Methodology
- Scenario Comparison
- Ecosan Implementation in Indonesia
- Sustainability Assessment
- Conclusions and Future Outlook

Indonesia Country Profile

Background Information

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- The world's largest archipelago (1.91 million km^2 land and 81000 km of coastline, scattered over 17,508 islands)
- Population :±85 Million Urban; 135 Million Rural) → 69% of urban population and 46% or rural population have access to improved sanitation (WHO & UNICEF, 2001).
- The lowest levels of sewerage (only 16 % of total population) and sanitation coverage in Asia (World Bank, 2003)

Indonesia Country Profile

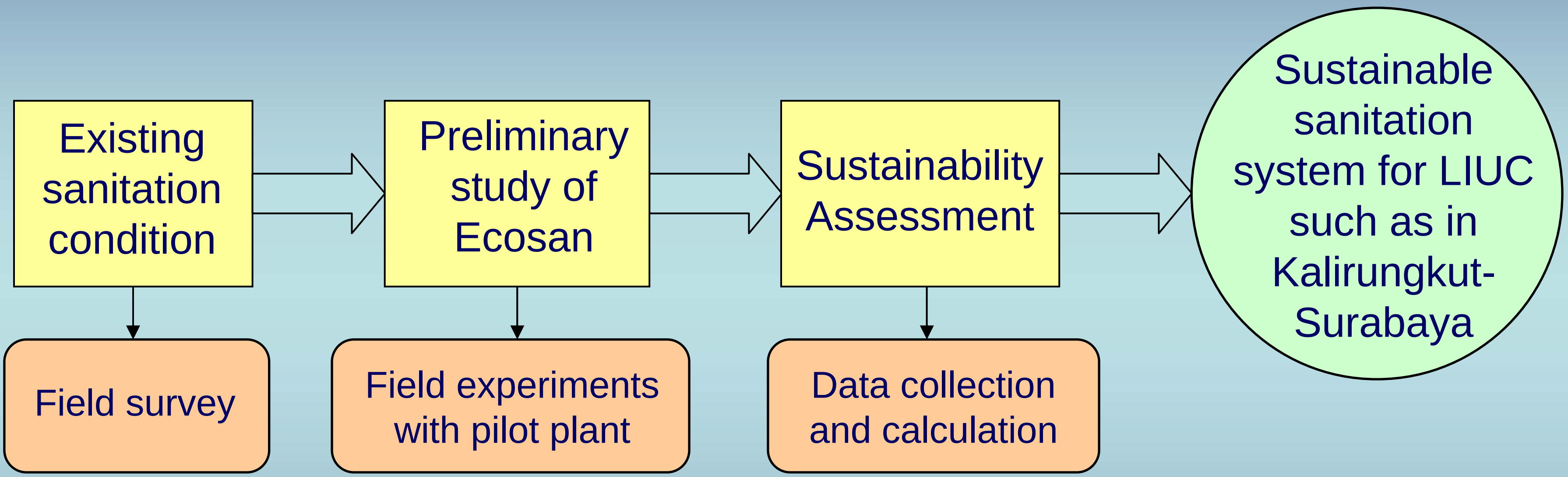
Observations at the Surabaya case study area:

- Had septic tanks installed less than 5 m from the wells
- Most shallow wells in areas of high pop. density (> 100 p/ha) were reported to be contaminated with fecal coliform bacteria

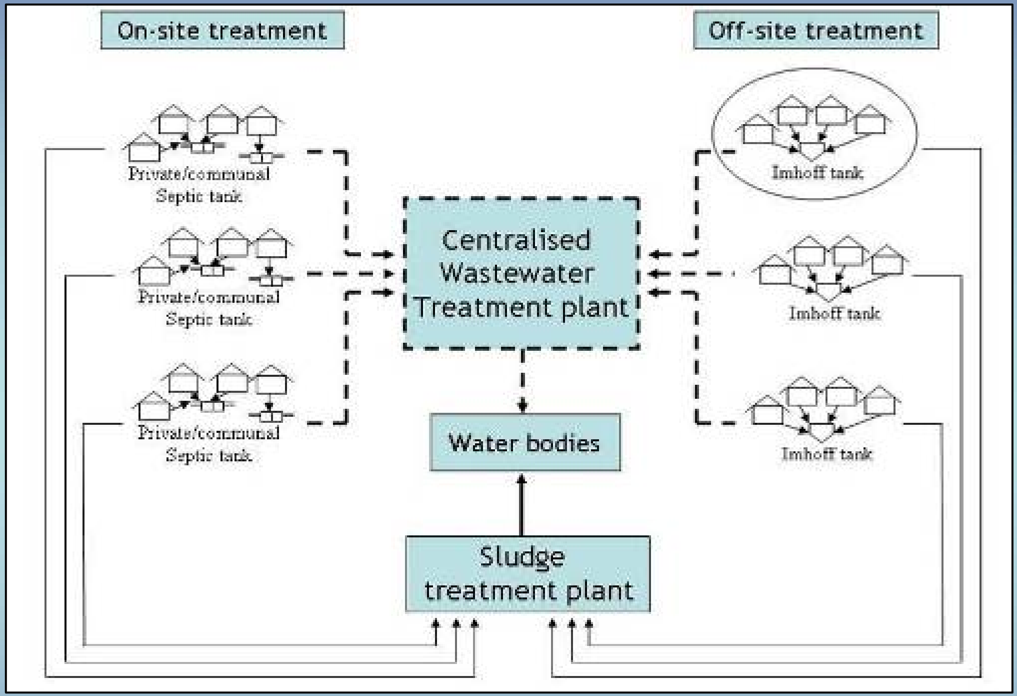
Research Objectives

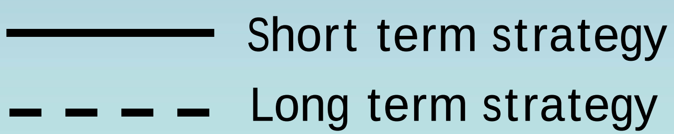
- Preliminary study of an Ecological Sanitation Concept implementation in a low income case study urban area in Indonesia
- To assess the sustainability (economical, environmental, and social aspects) of the Ecosan system together with 2 other existing sanitation systems.

Methodology



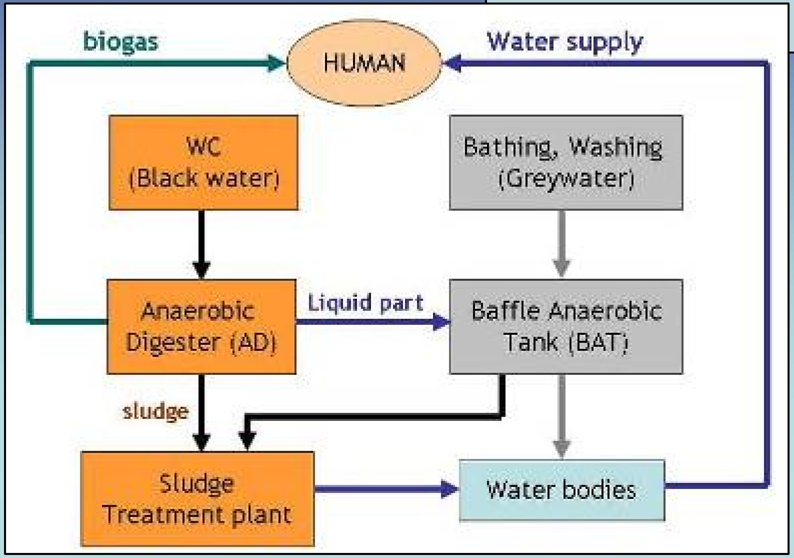
SSDP Scenario

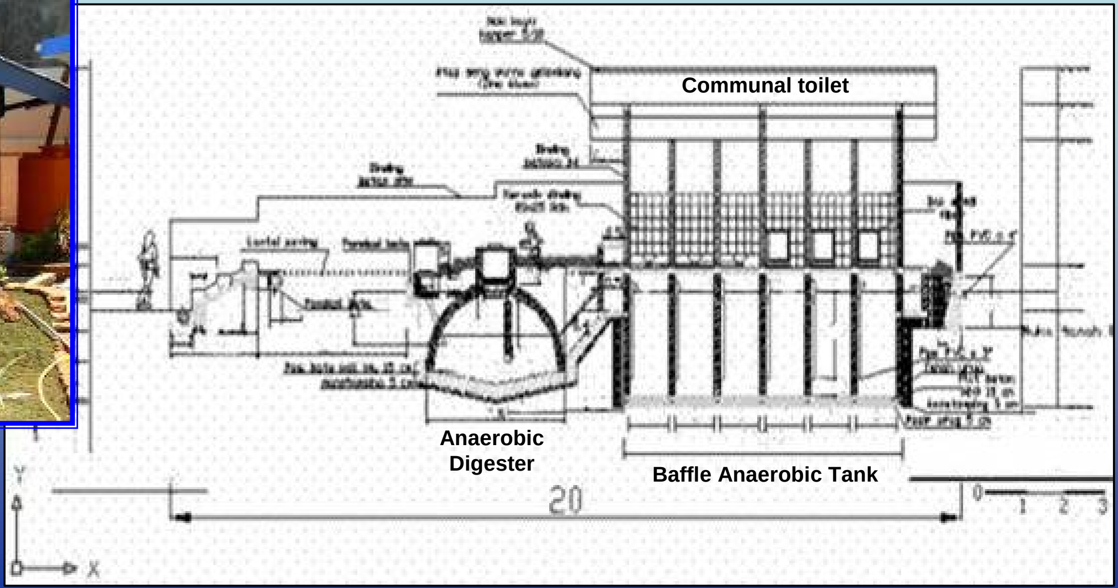




Surabaya Sewerage Development Project (SSDP) was proposed by the local government on Surabaya Master Plan for the year 2020.

DEWATS Scenario



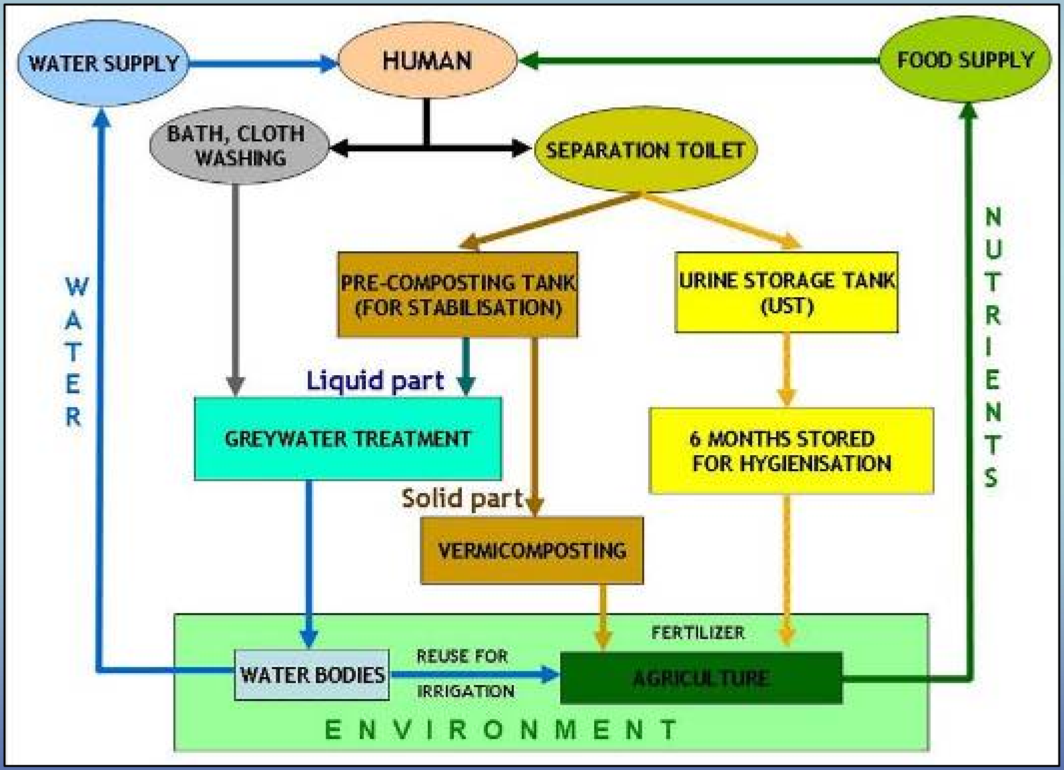


Source: www.best.or.id

BORDA: www.borda-sea.org

Ecosan Scenario

Location: A 20 m^2 area next to Pusdakota Office in Rungkut Area, Surabaya, East Java, Indonesia

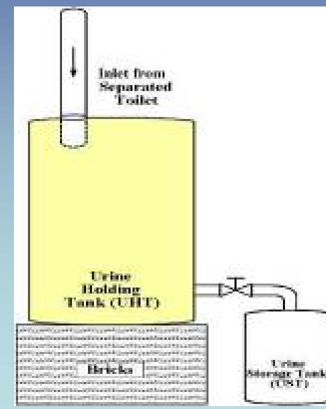


Brown water treatment - Vermicomposting

Faecal matter (without toilet paper)
a) vermicomposted with *Eisenia fetida* after 30 days
b) Vermicomposted with *Lumbricus rubellus* after 30 days

Parameter	Indonesian Compost National Standard	*Eisenia fetida*	*Lumbricus rubellus*
C (% C)	Min. 9.8	17.11	14.6
N (%Kjedahl)	Min. 0.40	1.48	1.22
P (%P_2O_5)	Min. 0.10	3.36	3.08
K (%K_2O)	Min. 0.20	3.51	2.98
E.coli (MPN/gr)	Max. 1000 MPN/gr	120	230
C/N	Min. 10	11.56	11.97

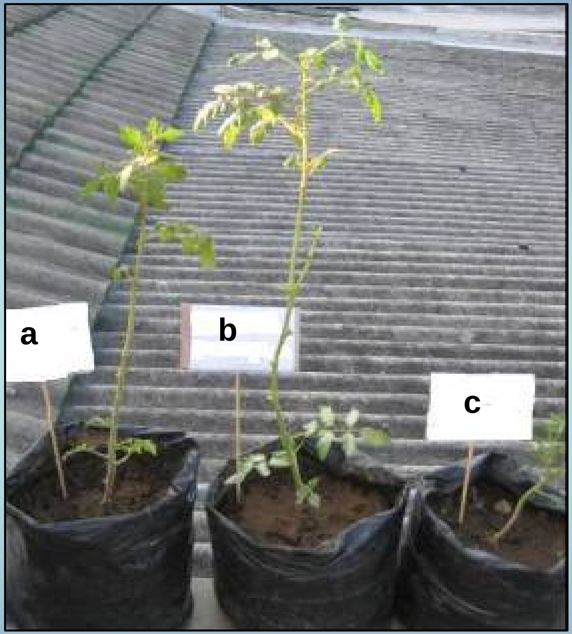
Yellow water treatment - Storage



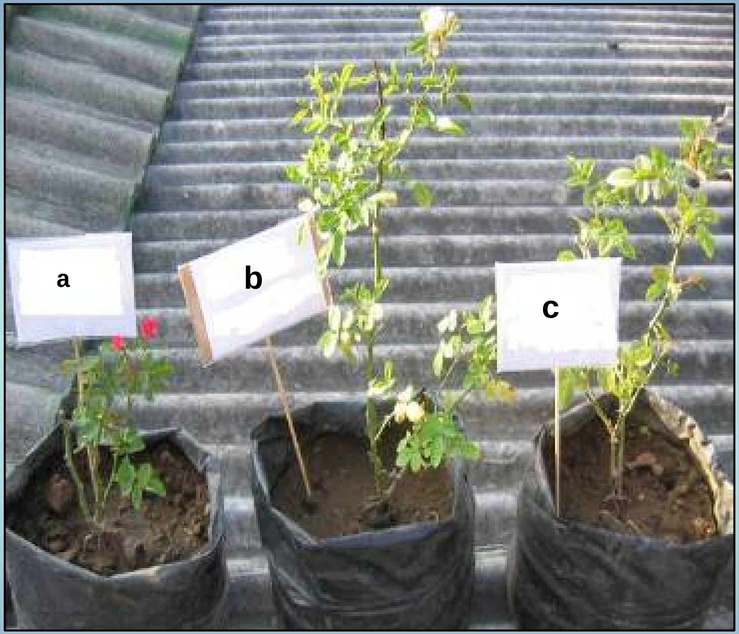
Parameter	Fresh urine	Urine in Storage Tank after 6 months
Total C (%)	1.46	0.04
Total N (%)	1.38	0.11
Phosphorous (% P_2O_5)	0.12	0.003
Potassium (% K_2O)	0.23	0.0275
E.coli (colony/gram)	0	0

Yellow water treatment - Storage

Tomato plants



Baby rose plants



Different growth rate of plants under influence of urine and vermicast fertilizers

a. Urine as fertilizer (200 ml/week) and vermicast as soil conditioner (0.014 kg/m^2) added

b. Only urine (200 ml/week) added

c. Only vermicast (0.014 kg/m^2) added

Grey water treatment – Sub Surface Flow Constructed Wetlands (SSFCW)

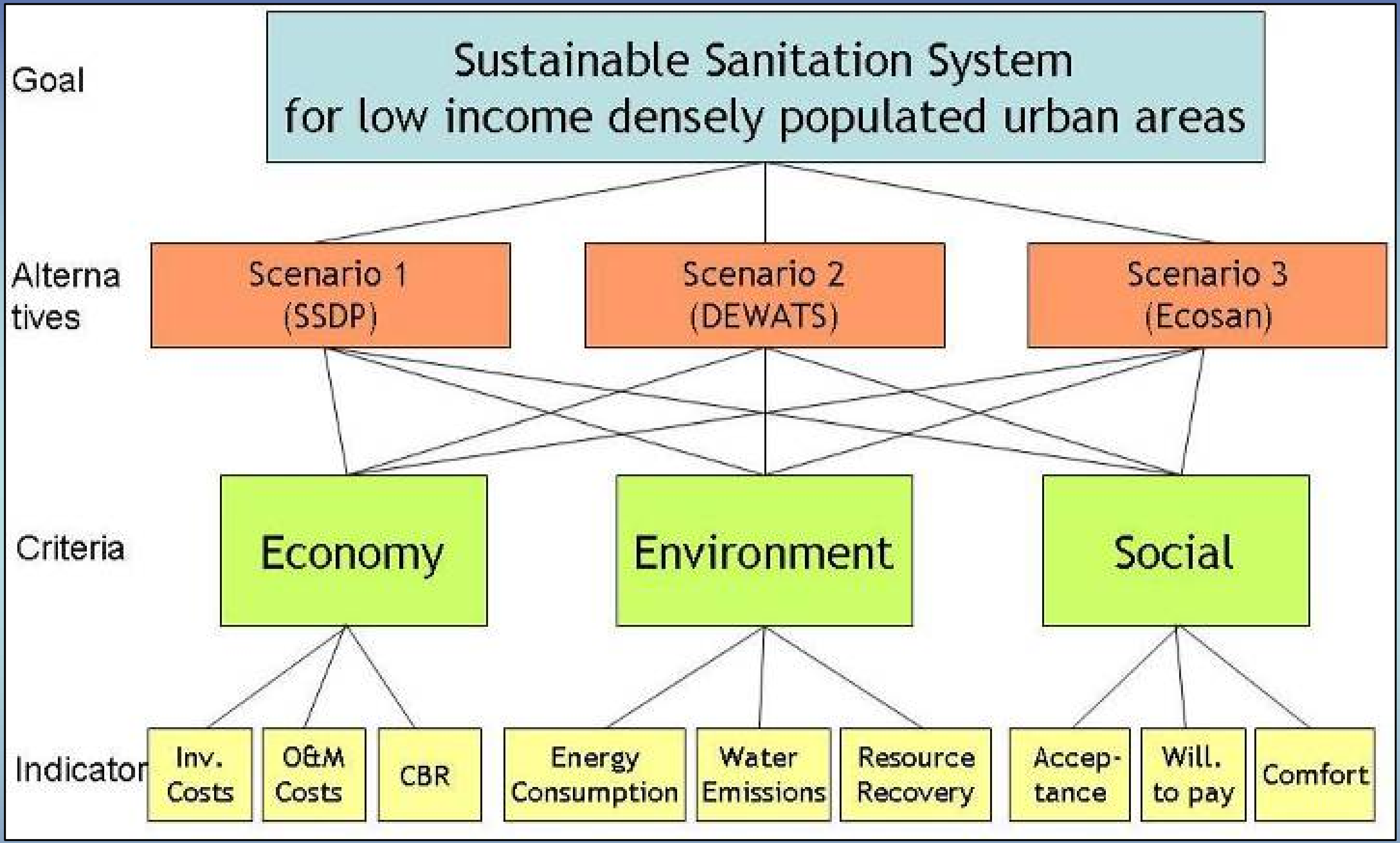
Small scale constructed wetland

Gravel

Coconut Charcoal

Parameter	Inlet	Outlet				Indonesian regulation for water discharge
		Media variation		Plant variation		
		Charcoal	Gravel	Cattails	Reeds	
BOD (mg/l)	200-490	23-75	23-170	23-100	55-170	12
COD (mg/l)	530-1220	137-313	200-340	185-230	137-340	100
E.Coli (MPN/100ml)	$(1.6\text{-}2.9)\times10^{13}$	370 – 850,000	65-4,500,000	1,700-4,500,000	65-35,000	10,000

Sustainability Criteria



The list of criteria was based on the work of several different authors who worked in the area of sustainable sanitation (Balkema, 2003; Hellström et al., 2000; Urban Water, 2004; Larsen and Gujer, 1997; Larsen and Lienert, 2003; Lennartsson, 2004).

Environmental Criteria – Energy Consumption

<table>
<tr><th rowspan="2">Energy consumption (MJ/p/d)</th><th rowspan="2">Scenario 1</th><th colspan="2">Scenario 2</th><th colspan="4">Scenario 3</th></tr>
<tr><th>Comm.</th><th>Decent.</th><th colspan="2">Communal</th><th colspan="2">Decentralised</th></tr>
<tr><td>a. Toilet usage</td><td>0.162</td><td>0.19</td><td>0.162</td><td colspan="2">0.19018</td><td colspan="2">0.16216</td></tr>
<tr><td rowspan="2">b. Recycled product transportation</td><td rowspan="2">-</td><td rowspan="2">-</td><td rowspan="2">-</td><td>BW</td><td>YW</td><td>BW</td><td>YW</td></tr>
<tr><td>0.016</td><td>0.29</td><td>0.019</td><td>0.266</td></tr>
<tr><td>c. Sludge transportation</td><td>0.00053</td><td>0.00053</td><td>0.00083</td><td colspan="2">0.0008</td><td colspan="2">0.0022</td></tr>
<tr><td>c. Septage treatment</td><td>0.0086</td><td>0.0074</td><td>0.016</td><td colspan="2">0.0194</td><td colspan="2">0.053</td></tr>
<tr><td rowspan="2">TOTAL SPECIFIC ENERGY CONSUMPTION (MJ/p/d)</td><td rowspan="2">0.171</td><td>0.198</td><td>0.178</td><td colspan="2">0.71</td><td colspan="2">0.68</td></tr>
<tr><td colspan="2">0.184</td><td colspan="4">0.66</td></tr>
</table>

BW= Brownwater, YW=Yellowwater

Environmental Criteria – Water Emission

Parameter	Scenario 1	Scenario 2	Scenario 3	Septage treatment effluent
BOD (mg/l)	156[a]	21.6	13.1[a]	80[b]
COD (mg/l)	443[a]	35.3	54.2[a]	200[b]

[a] = **Calculation based on computer sheet of Sasse, 2000**

[b] = **Laboratory of Settlement Environment Department**

Environmental Criteria – Resource Recovery

Sustainability Assessment 5

Scenario 1

Based on the Surabaya city Master Plan 2020, there are no plans to recover resources for the SSDP system

Scenario 2

Biogas from anaerobic digester

From communal system	1.2-1.4 m^3 of biogas per day
From decentralized system	4.07 m^3 of biogas per day

Scenario 3

Nutrients	Greywater Production		Yellowwater Production		Brownwater Production	
	kg/p/y	%	kg/p/y	%	kg/p/y	%
Nitrogen (N)	0.4	2	12.5	68	5.5	30
Phosphorous (P)	0.4	13	0.9	30	1.6	57
Potassium (K)	0.3	10	1.9	67	0.6	23

Economical Criteria – Investment, O&M Costs

Scenario	Investment Cost (€)	Annual O&M Cost (€)	Annual Benefit (€)
1 – SSDP	6,173,838	308,692	558,125
2 – DEWATS	2,896,973	141,888	559,603
3 - ECOSAN	2,993,827	233,094	1,508,125

Social Criteria

Sustainability indicators	SSDP Scenario	Scenario 2	Scenario 3
Acceptance	N/A	95 % well accepted	27% accept to use UDT, 57% accept to reuse faecal as compost, 26% accept to reuse urine, 15% accept to treat their own waste
Comfortability	N/A	98 % fell comfort	40% users feel comfort using UDT
Willingness to pay	52 % willing to pay for house connection	100% willing to pay the communal toilet fee (Rp 300,-)*	61% willing to pay new sanitation concept, 27% willing to pay Rp 300,- for one usage ecosan communal toilet

N/A = No quantitative data from SSDP report.
* Rp 12,000,- per Euro is used as the basic exchange rate for the calculation in this work.

Conclusions

- SSDP scenario:
  - ✓ The highest cost and the lowest benefit.
  - ✓ The lowest energy consumption but lowest water discharge quality.
  - ✓ No social barrier
- DEWATS scenario:
  - ✓ The lowest investment and O&M costs.
  - ✓ Good outlet quality and can reuse biogas
  - ✓ Community is well-accustomed to the system
- ECOSAN scenario:

  Positive findings that support implementing Ecosan in Indonesia:
  - ✓ Ecosan can be feasibly implemented in Indonesia without advanced technology.
  - ✓ Ecosan recovers nutrients.
  - ✓ Ecosan has the highest financial benefit.

  Challenges:
  - ✓ Social aspect due to local population’s apprehension in reusing human waste.
  - ✓ High fertilizer transport cost
  - ✓ Special user education needed

Thank you