Supplementary Material (SM)

Utilizing Wasteaware Benchmark Indicators to Improve Municipal Solid Waste Management in Northern Thailand

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Interview Questions

SM 1 Benchmark Indicators 1 & 1C – Public Health (Waste Collection)

No	Short name	Description	Interview questions/Guidance notes
1.1	Waste Collection Coverage	Percentage of households in the city that receive a reliable waste collection service	- Could you provide the number of households that utilize colored flags to assist in waste management? - How many households in the sub-district?
1.2	Waste Captured by the solid waste management and recycling system	Percentage of waste generated that is actually handled completely by the waste management and recycling system, thus the waste that is not lost through illegal burning, burying or dumping in unofficial areas.	What percentage of waste is captured by the system? Please show evidence how all types of waste are managed.
1C	Quality of waste collection and street cleaning service	Qualitative indicator to assess the quality of the waste collection/street cleaning service	Focus is on observation, especially street cleaning services and waste collection locations.
1C.1	Appearance of waste collection points	Presence of accumulated waste around collection points/containers	Focus is on observation, especially waste collection points. This observation should be conducted before and after the process of collection, and relevant stakeholders should also be interviewed.
1C.2	Effectiveness of street cleaning	Presence of litter and of overflowing litter bins	Focus is on the center of the city, along the main roads and in places where people gather. Also, relevant stakeholders are interviewed.
1C.3	Effectiveness of collection in low income districts	Presence of accumulated waste/illegal dumps/open burning	Focus is on site visits to locate any evidence of illegal dumping and open burning in the area of lower income households. Locate evidence of dumping into river or drains. Also, conduct interviews of relevant stakeholders.
1C.4	Efficiency and effectiveness of waste transport	Appropriate public health and environmental controls of waste transport	Interviews and site-visits - How many waste transportation trucks are used? What type of vehicle? Are they in good working order? Do you have a waste transportation vehicle maintenance plan?

No	Short name	Description	Interview questions/Guidance notes
			- Have you ever faced a problem with vehicles in poor and unusable condition? How was the problem solved? - How do you prevent wind-blown waste? - How do you prevent waste water spillage on the road during waste collecting and transportation?
1C.5	Appropriateness of service planning and monitoring	Appropriate service implementation, management and supervision in place	Please provide data regarding the following: - A memorandum of understanding of to purchase recycled waste between the district and the 'informal' and community sector - Incinerator contract or lease agreement - RDF sales agreement with SCG company - Evidence showing on-going solid waste management appraisal and improvement
1C.6	Health and safety of collection workers	Use of appropriate personal protection equipment & supporting procedures	- Do you have and / or provide regular health-checks / inoculations / boots / gloves / overalls / high visibility vests? - Is there a work manual for every waste management station or site?

SM 2 Benchmark Indicators 2 & 2E – Environment (Waste Treatment and Disposal)

No	Short name	Description	Designed questions/Guidance notes
2	Controlled treatment or disposal	Percentage of the total municipal solid waste destined for treatment or disposal in either a state-of-the-art, engineered facility or a 'controlled' treatment or disposal site	Interviews and site-visits - Can you explain how you manage the waste that is divided into categories?
2E	Degree of environmental protection in waste treatment and disposal	Indicator to assess the 'quality' of waste treatment and disposal	
2E.1	Degree of control over waste reception and general site management	Degree of control over waste reception and handling at each site. This criterion should be applied to all treatment and disposal sites, whatever the specific process being used.	Interview and site-visit at waste plants to assess whether 1) the area is adequate for handing waste 2) the plant is properly built and designed for standardized waste management - Is the site fenced? When the site is closed, is there a gate that is locked? Is there a procedure to handle unauthorized entry onto the site? - Are all entering vehicles logged in and their loads checked? How are vehicle loads weighed? - Is there a method to control windblown litter, flies, vermin, birds and the tracking 'mud' off-site by the vehicle tires? - Do you have an active fire prevention and emergency response system in place in case of accidental fire? Please show supporting documentation.

No	Short name	Description	Designed questions/Guidance notes
2E.2	Degree of control over waste treatment and disposal	Degree of control over both the waste treatment or disposal process in use at each site and over any potential emissions. This criterion covers both the presence of the necessary technologies, and the operating procedures for their proper use.	- Do you have an incinerator maintenance plan that employs environmental controls? Please explain. - How do you manage aspects of anaerobic digestion such as odors, bio-aerosols and leachate collection and treatment?
2E.3	Degree of monitoring and verification of environmental controls	Includes the existence and regular implementation of: robust environmental permitting/ licensing procedures; regular record keeping, monitoring and verification carried out by the facility itself; AND monitoring, inspection and verification by an independent regulatory body	Interviews and site-visits - Is the waste plant built based on standards for environmental control? Please provide the incinerator specification details. - How do you manage waste water from the waste plant? - How do you manage ash from burning waste? - How often are the incinerators maintained? How do you control gas produced by the burning process? - How do you control odor, site fires, and emissions of potential greenhouse gases (particularly methane, nitrous oxides, and carbon dioxide)
2E.4	Efficiency of energy generation and use (Optional criterion used for energy recovery facilities only	Assesses the energy efficiency of those facilities for which a major purpose is (or could be) energy recovery	- Does incinerating waste save energy? Please explain. - Is a mix of technologies used for waste treatment and disposal? Please explain. - Is the waste collection route designed with a focus on saving energy? Please explain.
2E.5	Degree of technical competence in the planning, management and operation of treatment and disposal	An assessment of the level of technical competence at three points in the system: (i) the authority responsible for service provision; (ii) the management of the treatment and disposal facilities; and (iii) the frontline operational staff	- Are there procedures in place to ensure that treatment and disposal sites are provided and operated in-line with authorized objectives? - Is senior management regularly provided training on technical competencies?
2E.6	Occupational health and safety	Use of appropriate personal protection equipment & supporting procedures	- Are there 1) safe operating procedures in place and enforced, 2) regular health-checks provided, 3) boots/gloves and high visibility vests provided? Please show supporting documentation.

SM 3 Benchmark Indicators 3 & 3R – Resource Value – 3Rs – Reduce, reuse, recycle

No	Short name	Description	Designed questions/Guidance notes
3	Recycling rate	Percentage of total municipal solid waste generated that is recycled	- Including organic composting, what is the percentage of recycled waste? - What percentage of waste is recycled in the private recycling sector? - What percentage of waste is recycled by separation at a disposal site?

No	Short name	Description	Designed questions/Guidance notes
3R	Quality of 3Rs – Reduce, reuse, recycle - provision	Indicator to assess the 'quality' of 3Rs provision	Interview village leaders
3R1	Source separation of 'dry recyclables'	Percentage of the total quantity of materials collected for recycling that are collected as clean, source separated materials	Interviews and site-visits - What percentage of recycled waste is separated at the households? - What percentage of recycled waste is collected at waste plants before being incinerated
3R.2	Quality of recycled organic materials	A qualitative assessment of the likely quality of the recycled organic product (i.e. animal feed, compost, and the organic product [digestate] from anaerobic digestion)	Interviews and site-visits - What percentage of food waste is separated at these sources: 1) households 2) restaurants 3) hotels? - Is the food waste generated by these sources separated from other forms of organic waste, e.g. leaves or bamboo shoot bark?
3R.3	Focus on the top levels of the waste hierarchy	An assessment of the degree of both policy and practical focus on promoting reduction and reuse in 'higher waste generating cities'; and on the '3Rs' – reduction, reuse, recycling – in 'lower waste generating cities'.	- Do you have policies or projects to promote waste minimization? Please explain. - Do you have policies or projects to encourage people to use second-hand products? Please explain. - Do you have policies or projects to promote redesigned, reused or recycled products? Please explain. - What are your minimum and ultimate recycling rate percentage goals?
3R.4	Integration of the community and/or informal recycling sector (IRS) with the formal solid waste management system	An assessment of how far and how successfully efforts have been made to include the IRS (in low and middle-income countries) and the community reuse and recycling sector (in higher income countries) into the formal solid waste management system.	- Do you have policies or projects to promote the community's or other group's informal recycling into a formal solid waste management system? Please explain. - How do you connect the informal recycling sector with the community? - Does the municipality purchase composting products from the community? Please show supporting documentation. - Are there projects to encourage the community to use compost products and buy compost products from the composter? Please show supporting documentation.
3R.5	Environmental protection in recycling	Environmental impacts of the recycling chain.	- How is electronic waste managed? - Do you have a monitoring plan of electronic waste that is purchased by the informal recycling sector? Please show supporting documentation.
3R.6	Occupational health and safety	Use of appropriate personal protection equipment & supporting procedures	- Do the employees and the informal recycling sector have appropriate clothing and equipment (e.g. boots / gloves / overalls / high visibility vests) and do they receive regular health-checks and inoculations? Please show supporting documentation.

SM 4 Benchmark Indicators for Inclusivity: (i) 4U – User inclusivity

No	Short name	Description	Designed questions/Guidance notes
4U	User inclusivity	Represents the degree to which all users, or potential users, of the solid waste services (i.e. households, business and other waste generators) have access to services, and are involved in and influence how those services are planned and implemented.	
4U.1	Equity of service provision	Extent to which all citizens (users and potential users). Irrespective of income level, receive a good solid waste management (SWM) service i.e. a service which they can afford, which meets their expressed needs, and which protects public health and environmental quality.	- How many households attend the municipality's waste management project? What percentage of total households? - Do you have a high-density informal settlement? How do you manage waste in the applicable area? Please explain.
4U.2	The right to be heard	Do authorities have a legal obligation to consult with and involve citizens in decisions that directly affect them?	Do you provide opportunities for stakeholders to attend meetings or are public hearings conducted before issuing laws, regulations, or guidelines? Please explain.
4U.3	Level of public involvement	Evidence of actual public involvement at appropriate stages of the solid waste management decision-making, planning and implementation process.	- Do the relevant stakeholders have a chance to participate in the municipality's decision making by providing their opinion or sharing data? Please explain. - Does each village have a waste management committee? How often are meetings held? - How do you boost participation in community solid waste management?
4U.4	Public feedback mechanisms	Existence and use of public feedback mechanisms on solid waste management services.	- Are there accessible and well-known feedback mechanisms? Is feedback considered in decision making? Please explain. - What mechanisms are used to communicate waste management issues to the community?
4U.5	Public education & Awareness	Implementation of comprehensive, culturally appropriate public education, and/or awareness raising programmes	- What mechanisms are used to transfer knowledge and cultivate awareness regarding waste problems and guidelines to manage waste properly? - How much is budgeted per year? - Do you have staff in charge of public education and/or awareness raising programs? How many staff members?
4U.6	Effectiveness in achieving behavior change	Change in the habits and behavior of both the public and businesses regarding their waste management/handling practices	- Is waste dumped in the streets? - Do you have a 'no litter in public areas or streets' campaign? Is it effective? - Does the close loop waste management project result in an increase in source separation? Please Explain.

SM 5 Benchmark Indicators for Inclusivity: (ii) 4P – Provider inclusivity

No	Short name	Description	Designed questions/Guidance notes
4P	Provider inclusivity	Degree of provider inclusivity. Represents the degree to which service providers from both municipal and non-municipal (including the formal private, community or 'informal' sectors) are included in the planning and implementation of solid waste and recycling services and activities	
4P.1	Legal framework	Degree to which laws and/or other legal instruments are in place and implemented at national or local level which enables both the public and private sectors to deliver solid waste management services on a stable basis.	- What waste management activities or projects are available for private sectors or the public to be involved in?
4P.2	Representation of the private sector	Organisations or structures in place to ensure the representation of the private waste sector and facilitate their active participation within solid waste management planning forums, task forces, committees and/or steering-groups	- Please provide either 1) Order for Appointment of Solid Waste Management Driving Committee, or 2) Memorandum of Understanding (MOU) among municipality, community, and private sector.
4P.3	Role of the 'informal' and community sector	Evidence of acknowledgement and recognition of the role of the organized 'informal' and community sectors within or alongside the formal solid waste management system	- Please provide data evidencing the cooperation among the municipality, community and private sector on recycling and reuse.
4P.4	The balance of public vs. private sector interests in delivering services	Degree to which appropriate checks and balances are in place locally, so that waste services are being delivered by either the public or private sector, in a manner that is mutually beneficial and does not substantially disadvantage either party.	- Please provide data evidencing that contracts provide balanced benefits to the parties, e.g. MOU with SCG company on RDF
4P.5	Bid processes	Degree of openness, transparency and accountability of bid processes.	- Please provide evidence of the solid waste management bid process.

SM 6 Benchmark Indicators 5 – Financial Sustainability

No	Short name	Description	Designed questions/Guidance notes
5F	Financial Sustainability	Degree of Financial Sustainability. Represents the degree to which a city's solid waste management service is financially sustainable.	
5F.1	Cost accounting	Extent to which the solid waste management accounts reflect accurately the full costs of providing the service, the relative costs of the different activities within solid waste management, and whether the accounts are open to public scrutiny.	Please show evidence of what was declared to the public and to what the public could access regarding the solid waste management account.

No	Short name	Description	Designed questions/Guidance notes
5F.2	Coverage of the available budget	Is the annual budget adequate to cover the full costs of providing the service?	Please provide evidence of waste collection and disposal fees and cost of waste management categorized by activity i.e. burning, collection, waste separation training, and good practice cultivation activities in the village.
5F.3	Local cost recovery – from households	Percentage of the total number of households both using and paying for 'primary waste collection services'. The focus here is on the number of households, NOT on the percentage of the total costs which they pay.	- How many households pay a fee? - How do you ask a household that doesn't pay a required fee to do so?
5F.4	Affordability of user charges	Are practices or procedures in place to support charges for those who can least afford to pay?	This indicator can by fulfilled by the practice that no waste management fee is charged for people who use a blue flag to indicate their waste management choice.
5F.5	Pricing of disposal	Degree to which all the wastes coming to the final (treatment or) disposal sites (s) are charged at a rate that covers (at least) the operating costs of (treatment or) disposal	- Are all operation costs covered by the collected waste management fees? If not, how is this problem addressed? - Do the collected fees cover maintenance costs? If not, how is this problem addressed
5F.6	Access to capital for investment	Has adequate provision been made for necessary capital investments, both to extend collection coverage to any un-served areas; to upgrade standards of waste disposal; and to replace existing vehicles, equipment and sites at the end of their life?	- How many sources exist form which to obtain waste management capital? - Is it easy to gain financial support? - Which activities does not have a cost associated with them

SM 7 Benchmark Indicators for Sound institutions, proactive policies: (i) 6N – Adequacy of national framework for solid waste management (SWM)

No	Short name	Description	Designed questions/Guidance notes
6N	National SWM Framework	Assesses the adequacy of the national solid waste management framework – including the degree of implementation	Key information was gathered through interviews, secondary sources such as local government reports, research papers and government publications relevant to National SWM Framework
6N.1	Legislation and regulations	Is there a comprehensive national law or laws in place to address solid waste management requirements? Does the legislation require regulation in order to bring it to force and have these regulations been put in place?	Key information was gathered through interviews, secondary sources such as local government reports, research papers and government publications relevant to National SWM Framework - Requests were made for suggestions related to laws and regulations.

No	Short name	Description	Designed questions/Guidance notes
6N.2	Strategy/Policy	Is there an approved and recent national strategy for solid waste management, and clear policies in place and implemented?	- Is there an approved and recent national strategy for solid waste management, and clear policies in place and implemented? - Requests were made for any suggestions related to solid waste management strategy/policy.
6N.3	Guidelines and implementation procedures	Are there clear guidelines for local authorities on how to implement the laws and strategy? Are there effective mechanisms in place for facility siting?	- Are there clear guidelines for local authorities on how to implement the laws and strategy? - Are there effective mechanisms in place for facility siting?
6N.4	National institution responsible for implementing solid waste management policy	Is there a single institution at the national level which is charged with the responsibility of implementing, or coordinating the implementation of, solid waste management strategy/policy	- Is there a single institution at the national level which is charged with the responsibility of implementing, or coordinating the implementation of, solid waste management strategy/policy - Are there any problems implementing regulations from many national institutions?
6N.5	Regulatory control / enforcement	Is there a well organized and adequately resourced environmental regulatory agency? Does it enforce the legislation so as to ensure a 'level playing field' for all?	- Is there a well-organized and adequately resourced environmental regulatory agency? - Does it enforce the legislation so as to ensure a 'level playing field' for all?
6N.6	Extended producer responsibility (EPR) or Product Stewardship (PS)	Has engagement been made with national and international companies who produce the packaging, electronic goods and other products that end up as MSW? Do they share at least some of the costs of the solid waste management service and/or recycling?	- Do you support the concept of Extended Producer Responsibility (EPR) or Product Stewardship (PS)? Please explain. - Are there any practices in your area related to Extended Producer Responsibility (EPR) or Product Stewardship (PS)?

SM 8 Benchmark Indicators for Sound institutions, proactive policies: (ii) 6L – Local institutions

No	Short name	Description	Designed questions/Guidance notes
6L	Local institutional coherence	A measure of the institutional strength and coherence of the city's solid waste management functions	Key information was gathered through interviews, secondary sources such as local government reports, research papers and government publications relevant to local institutional coherence
6L.1	Organisational structure/coherence	The degree to which all solid waste management responsibilities are concentrated into a single organization or department, that can be held accountable for performance, or if multiple organisations, the presence of a significant concentration of responsibilities in one named agency.	- How many people in your department's work is related to waste management? Do you have adequate staff working in relation to waste management? If not, how many more would you like to have? - Is there any other skilled staff that you need to complete the job successfully and improve overall performance?

No	Short name	Description	Designed questions/Guidance notes
6L.2	Institutional capacity	An assessment of the organizational strength and capacity of the department (s) responsible for solid waste management	- Is there a detailed solid waste management departmental organizational chart (or of each department with responsibility?) - Are all key positions filled and are staff suitably qualified? - Is there structured career progression and are staff provided with appropriate training - both in the classroom and in the field?
6L.3	City-wide solid waste management strategy & plan	Is there a recent strategy or plan in place & being implemented at the city (or regional) level for solid waste management?	- Is the strategy/plan recent/still valid? - Are the resources and funding for implementation in place?
6L.4	Availability and quality of solid waste management data	Is there a management information system (MIS) in place? Are data regularly measured, collected and monitored?	- Is there a management information system (MIS) in place? - Are data regularly measured, collected and monitored?
6L.5	Management, control and supervision of service delivery	A measure of the strength of control by the city, as the 'client' for solid waste management, over the on-the-ground delivery of solid waste management services.	- Are the municipal waste collection and/ or disposal services adequately supervised by the municipality? - How do you monitor waste volume and the volume of waste correctly separated at the source? - Is there documentary evidence of this monitoring procedure in place?
6L.6	Inter-municipal (or regional) co-operation	Waste collection is often delivered at a local level, while treatment and disposal may require co-operation city-wide or at a regional level. Regulatory control may be organized at regional or national level. How well does such co-operation work?	- What is your opinion of cluster concept solid waste management - What is your opinion that a single local government can manage their own waste? - Do you think co-operative work is useful for waste management? How?

Source: University of Leeds. User Manual for Wasteaware ISWM benchmark indicators: supporting information to Wilson et al., 2014. A repository copy of 'Wasteaware' Benchmark Indicators for Integrated Sustainable Waste Management in Cities. [Online] Available from: https:// eprints.whiterose.ac.uk/85319/9/Wilson_et_al_Supplementary_information_Wasteaware_ISWM _Benchmark_Indicators_User_Manual_FINAL.pdf [Accessed 15 September 2022]