Benchmark Indicators for Integrated & Sustainable Waste Management (ISWM)

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ABSTRACT

This paper reports progress with development of an integrated and sustainable (solid) waste management (ISWM) indicator set to allow benchmarking of a city's performance; comparing cities, both North and South; and monitoring changes over time. The work builds on pioneering work for UN-Habitat's *Solid Waste Management in The World's Cities* in 2010. The analytical framework divides a city's solid waste management system into two overlapping 'triangles'. For the three physical components, a quantitative indicator, i.e. % collection coverage, % controlled disposal and % recycling, is supplemented by a composite indicator showing e.g. the 'quality' of the collection system. For the three governance aspects, composite, qualitative indicators are defined, covering user and provider inclusivity; financial sustainability; and the national policy framework and local institutions. The first generation of the ISWM benchmark indicators was tested in some 25 cities; results from testing the prototype revised indicator set in a further five cities are presented here. Work is continuing to finalise what we believe is a powerful tool: the choice and definition of criteria within each of the composite indicators is being refined and the indicators tested in a wide range of situations and applications. The final indicator set will be available on the web, and it is hoped that it will be widely applied as a standard methodology, helping to address the historical lack of comparative data on solid waste management in the World's cities.

KEYWORDS: benchmark indicators, performance monitoring, comparative analysis, solid waste management, integrated and sustainable waste management (ISWM), governance aspects

INTRODUCTION

How does a city judge its own performance in terms of delivering solid waste management services? What should be the priority focus for the limited funds available for service improvements? What do we really mean by 'good practice' in solid waste management (Wilson & Scheinberg, 2010)? And why is it important in the first place?

Solid waste management is a key utility service, on which the public health, and arguably also the financial 'health', of a city depend. Uncollected solid waste is still a serious public health issue in many developing countries, with both direct effects on child health and indirect effects through blocked drains, causing both the spread of water-borne diseases and widespread flooding (Wilson, et al., 2013). A clean city is also attractive to tourists, business people and investors; the effectiveness of a city's solid waste management system can be used as a proxy indicator of good governance (Whiteman, et al., 2001), and hence of a local government who can be trusted and with whom one can do business. Appropriate benchmark indicators

allow a city to judge its own performance in terms of delivering solid waste management services, and provide information for deciding what should be the priority focus for the limited funds available for service improvements, and also for monitoring changes over time. It is also important to have consistent indicators that allow the performance of cities to be compared – the ambition of the research reported in this paper is to develop a single indicator set that is useful for comparing all cities, irrespective of income level.

Benchmark indicators rely on having good information on the state of the solid waste management system. This immediately throws up a potential problem of the availability and reliability of such information – itself an indicator for the quality of the local institutional and management systems, which can be an issue particularly in low- and middle-income countries. Even in high-income countries, it is only fairly recently that all wastes were routinely weighed following collection. E.g. in the UK this was achieved in the early 1990s, with the publication of regular quarterly waste statistics for local authority collected wastes dating back only to 2004 (www.wastedataflow.org). Existing reporting tends to focus on hard data across a fairly narrow range of easy-to-quantify physical parameters: e.g. the statutory reporting of statistics in the European Union dates back to 2002, and now includes waste generation by households and 18 industries, each categorised into 51 waste types; waste treatment by 6 treatment types for each of the 51 waste categories; numbers and capacities of recovery and disposal facilities by 4 treatment types; and the percentage of population covered by a collection scheme for household and similar waste (Eurostat, 2011). The Global City Indicators Facility includes for solid waste only the percentage of city population with regular collection and the percentages that are recycled and disposed of by five specified disposal routes (GCIF, 2012). The GCIF initiative does promise an improvement in the current level of availability of comparable data as more cities sign up – currently the best that the literature can offer on a worldwide basis is compilations of older data, of dubious comparability and often just at the national level (Hoornweg & Bhada-Tata, 2012; Chalmin & Gaillochet, 2009; Karak, et al., 2012).

A notable recent attempt to address this situation was the report prepared for UN-Habitat on the state of solid waste management in the World's cities (Scheinberg, et al., 2010). A large international team took up the challenge of collecting new data for 20 'representative', reference cities in low-, middle- and high-income countries; some 300 data points were sought for each city, and a set of Integrated Sustainable Waste Management (ISWM) benchmark indicators defined for both physical components and governance aspects. Defining such an indicator set forces one to think about what we really mean by 'good practice' in solid waste management (Wilson & Scheinberg, 2010). A detailed comparison of the results for the 20 reference cities was subsequently undertaken (Wilson, et al., 2012). The same methodology has since been used to profile a number of other cities: on the one hand to focus on geographical 'gaps' in the original sample of 20 cities (Al Sabbagh, et al., 2012; Sim, et al., 2013); on the other, to produce a baseline assessment of a city's waste management system at the start of a planning or upgrading process.

This paper reports progress on development of an indicator set that facilitates benchmarking of a city's performance in developing an integrated and sustainable (solid) waste management (ISWM) system. The aim is to use existing data, not to carry our primary survey work. The set of ISWM benchmark indicators developed in the original work for UN-Habitat has been used as the starting point for the on-going work reported here. Experience in deriving and using the indicator set has shown its strengths and weaknesses, and a revised 'prototype' ISWM indicator set has been developed and tested in five further cities. The revised indicator set is presented here alongside the results of its further testing; and current work to finalise the development is outlined. The final indicator set will be available on the web, and it is hoped that its future use will help to address the historical lack of comparative data on solid waste management in the World's cities.

APPROACH TO DEVELOPING THE BENCHMARK INDICATORS

Analytical Framework and Original 'Habitat' ISWM Indicator Set

The analytical framework is built around the concept of integrated and sustainable (solid) waste management, known as ISWM (Schübeler, 1996; Van de Klundert & Anschütz, 2001; IJgosse, et al., 2004). The ISWM framework distinguishes three dimensions for analysis of solid waste management and recycling systems: the physical system and its technological components, sustainability aspects (social, institutional,

political, financial, economic, environmental and technical) and the various groups of stakeholders involved. This was simplified in the UN-Habitat work to two 'triangles' as shown in Figure 1, the physical components and the governance aspects (Wilson, et al., 2012). The first 'triangle' focuses on three key drivers for development of waste management (Wilson, 2007), corresponding to the three key physical, 'hardware' components: public health which depends on a good waste collection service; environmental protection particularly during waste treatment and disposal; and resource management, the '3Rs' – reduce, reuse, recycle. The second 'triangle' focuses on ISWM 'software', the governance strategies to deliver a well-functioning system. These have been identified as *inclusivity*, allowing stakeholders to contribute and benefit as both service users and as service providers; *financial sustainability*, ensuring that SWM services and activities are cost-effective and affordable; and a base of *sound institutions and pro-active policies*.

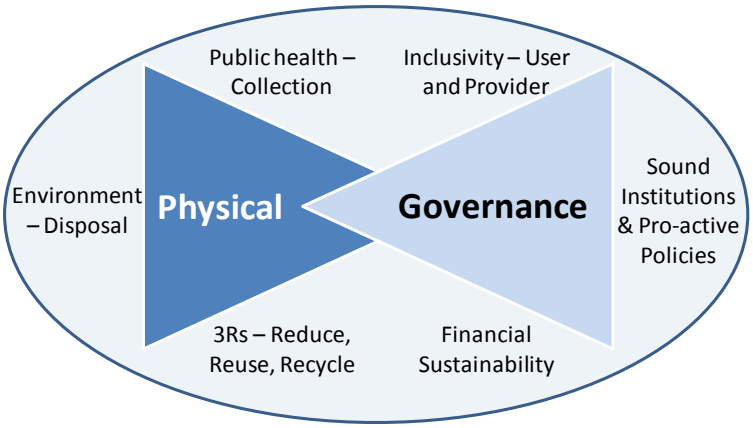

Figure 1: The Integrated Sustainable Waste Management (ISWM) framework
Concept: (Scheinberg, et al., 2010). © David Wilson, Ljiljana Rodic, Costas Velis

The ISWM benchmark indicators were designed around this analytical framework. For each of the three physical components, a single quantitative indicator was defined: two of these – % waste collection service coverage for public health and % recycling for resource management (3Rs) – follow widespread international practice (GCIF, 2012). The remaining indicator, pertaining to disposal for environmental protection, is novel, being the % of collected waste which goes to any sort of *controlled* disposal (Rushbrook & Pugh, 1999) or treatment facility rather than an uncontrolled site. For financial sustainability, a range of quantitative data were collected, focusing on the solid waste budget and the effectiveness and affordability of cost recovery mechanisms; unfortunately, data on actual costs, and particularly on costs per tonne of waste collected or disposed of, were often either unavailable or unreliable. The quantitative indicator eventually selected was the percentage of total households both using and paying for waste collection services. For the remaining governance aspects, qualitative indicators were constructed, depending on yes/no answers to a series of questions covering 5-6 criteria for each – details are shown in Table 1. Separate indicators were developed for user and provider inclusivity.

The original methodology was tested on at least 25 cities, the results for 22 of which have so far been published. The strengths of the ISWM indicator set included its *comprehensiveness* in allowing performance measurement and comparison of both 'hard' physical components and 'soft' governance aspects; its utility in *prioritising 'next steps'*, by focusing attention of the 'weak points' in a city's solid waste management system which could merit priority attention; and its *applicability* to a wide range of cities with very different levels of income. It also allows comparison between cities on a consistent basis, which is in itself a major step forward. The comparative analysis also threw up some perhaps unexpected results, including the significant progress that has been made in middle income countries over the last decade in improving collection coverage and introducing basic environmental control over disposal; the relatively high recycling rates in some of the lowest income countries, due to an active informal recycling sector; and relatively patchy performance against the qualitative governance indicators even among the high income countries (Wilson, et al., 2012).

Table 1: The original UN-Habitat qualitative indicators (Scheinberg, et al., 2010; Wilson, et al., 2012)
In each case, a composite score is assigned using a set of criteria, allowing a 'yes' for present (20%) and a 'no' for absent (0%). Later applications also allowed an intermediate 'partial' (10%) answer (Sim, et al., 2013). Where there are five criteria, the scores are summed to give an overall %; where there are 6 criteria, scores are first summed and then normalised to give an overall %. These scores are then translated into a rating: LOW (33% or below), 'MEDIUM' (35-60%), 'MEDIUM/HIGH' (61%-70%), or 'HIGH' (71% and over).

Indicator	Description	Specific criteria
User inclusivity	Represents the degree to which users of the solid waste services (i.e. households, business and other waste generators) are included in the planning, policy formation, implementation and evaluation of those services	1. laws at national or local level that require consultation and participation with stakeholders outside the bureaucratic structures 2. procedures in place/evidence of citizen participation in the siting of landfills or other treatment facilities 3. customer satisfaction in the waste management services being measured at the municipal level 4. feedback mechanisms between service users and service providers 5. citizens committees in place that address WM issues
Provider inclusivity	Represents the degree to which economic niches in service delivery and recycling are open and accessible by non-municipal service providers from the formal private, community or 'informal' sectors	1. laws at national or local level in place which encourage public-private partnership (PPP), private sector participation (PSP) or community based organisation (CBO) participation 2. organisations or platforms in place which represent the private waste sector (formal, community-based or informal) 3. evidence of formal occupational recognition of the informal sector active in WM practices or recycling 4. evidence of protection of informal sector rights to operate in WM 5. little or no institutional or legal barriers for PSP in WM in place 6. institutional or legal incentives for PSP in WM in place
Sound institutions and pro-active policies	Degree of institutional coherence. The first four criteria assess policy and the degree of municipal control; while the remaining criteria focus on more specific, local aspects of institutional coherence	1. Are there any sustained policy commitments to sustainable solid waste management? 2. Is there a clear and transparent policy framework for the planning and implementation of waste management practices? 3. Are authorities allowed to retain the revenues collected from the municipal fines and charges or to levy direct charges for services? 4. Are the out-sourced municipal waste collection services defined, supervised and controlled by the municipalities? 5. The degree to which the solid waste budget is directly controlled by one responsible department within the city; and 6. The degree of management control over WM which that department has (based on a qualitative assessment of the organisational chart of the city)

Second Generation ISWM Indicators

Experience with using the original ISWM indicator set also pointed up some weaknesses and opportunities for improvement, which have been addressed in the revised, second generation indicator set. The overall results for each city now comprise three individual, quantitative physical indicators based on actual data; and eight composite, qualitative indicators.

The three quantitative indicators for the physical components proved their merit in terms of their being indicative, practical and available, and have been retained. However, the experience with their application in various cities revealed a need to refine them beyond a numerical score so as to discern significant differences in performance levels between cities with apparently similar scores: e.g. even if collection coverage in a lower-middle income city is close to 100%, the *quality* of the collection service may not yet be comparable to the best systems in the region. So each quantitative % indicator is now complemented by a composite 'quality' indicator defined by five or six component criteria.

While most of the governance indicators in the original indicator set were composite, qualitative indicators, that for financial sustainability was quantitative: the % of total households both using and paying for waste collection services. While being novel and informative, this addressed just one specific component of financial sustainability, which is a very complex concept, depending rather on a combination of factors such

as knowing your costs; having an adequate budget and reliable sources of revenue; setting realistic and affordable user charges for both households and businesses; and being able to secure access to capital for investment. So a composite indicator has been devised instead, made up from relative scores against six criteria.

The original qualitative indicator for sound institutions and proactive policies used a mixture of criteria, some of which are assessed at the national and some at the city level, which made it relatively insensitive to differences when comparing the performance of cities within the same country. In the revised version, there are now two separate indicators, one for the National Framework, and the other for Local Institutions. These sit alongside revised indicators for both user and provider inclusivity.

In the revised ISWM indicator set, there are thus now eight composite, qualitative indicators, based on assessment against five or six criteria for each. This assessment was originally yes/no, or latterly yes/maybe/no; this has now been replaced with a standardised, five-fold scoring system with a score of 0, 5, 10, 15 or 20 being assigned against each criterion. The second generation assessment uses a detailed protocol, provided in an accompanying guidance document, which is designed to ensure a degree of consistency between the professional judgments made by different assessors in widely different cities. It should be noted that the assessment – even with the guidance document – is designed for use by solid waste professionals. It is also important that each assessor provides information sources, assumptions, and full details in their reports, showing the information used and the rationale behind the scores assigned against each criterion, so that the consistency between assessors can be verified independently. Such *traceability* is essential also for the transparency of the assessment process – anyone reading the assessment report can immediately know where the information came from and how it was scored.

The scoring system for each of the criteria comprising a qualitative indicator is a device to allow the very different aspects of performance, each ideally being assessed by its own distinct and traceable criterion, to be combined into one indicator; so the resulting overall percentages are converted back into a qualitative assessment. This follows the concept in the original UN Habitat methodology, as is shown in Table 1. This qualitative assessment is also five-fold, to match the scoring system. Each resulting range of scores has also been colour-coded using a 'traffic lights' system, to assist with a rapid visual assessment of the tabulated data and to illustrate, at a glance, areas of performance requiring immediate attention – as denoted by the colour red. The convention used is that an assessment of LOW corresponds to an overall score in the range 0-20% and is coded as red; MEDIUM/LOW to 21-40% and red-amber; MEDIUM - 41-60%, amber; HIGH/ MEDIUM - 61-80%, green-amber; and HIGH - 81-100%, green.

It is important to note that the significance of each quantitative indicator varies according to the values that are currently considered good practice, which means that they do not follow the same gradation pattern in assessing relative performance. For example, collection coverage or controlled treatment and disposal at 60% is relatively low, while a recycling rate of 60% is relatively high. A separate scale has thus been defined for each of the quantitative physical indicators to provide a comparable, colour-coded, five-fold assessment from LOW (red) to HIGH (green) - for details, see Table 2 below.

In presenting the summary indicators for each city, it is also necessary to provide both contextual information such as income level, population, degree of urbanisation, or other socio-geographical factors, alongside basic data on waste generation and composition. A very simple set of summary data has been defined: for example, for the sake of simplicity, just three components have been chosen here to represent waste composition, as opposed to the 51 categories that Member States of the European Union are obliged by law to report (Eurostat, 2011).

REVISED ISWM INDICATORS: PHYSICAL COMPONENTS

Table 2 shows the three quantitative benchmark indicators for the physical components of the system, and the scaling that allows performance against these to be compared directly with the qualitative indicators using the colour coding ('traffic light') system.

Table 2: The three quantitative indicators for the physical components of a solid waste management system

No	Physical component	Indicator name and definition	Traffic light colour coding				
			LOW	LOW/ MEDIUM	MEDIUM	MEDIUM/ HIGH	HIGH
1	Public health - waste collection	**Waste Collection Coverage**: % households who have access to a reliable waste collection service	0-49%	50-69%	70-89%	90-98%	99-100%
2	Environmental control - disposal	**Controlled treatment or disposal**: % of the total municipal solid waste destined for disposal which goes to either a state-of-the-art, engineered or 'controlled' treatment / disposal site	0-49%	50-74%	75-84%	85-94%	95-100%
3	Resource management - '3Rs' - Reduce, reuse, recycle	**Recycling rate**: % of total municipal solid waste generated that is recycled. Includes materials and organics recycling (composting, animal feed, anaerobic digestion).	0-9%	10-24%	25-44%	45-64%	65% and over

The detailed guidance document that accompanies the ISWM indicators provides further elaboration of the definitions. For example for collection coverage, 'access to' includes both formal municipal and informal sector services; where the service is provided only to those who pay for it, then the % should not include those who do not use the service; 'reliable' waste collection means regular, with a frequency which depends on local conditions that have to be explicitly stated both at the data collection stage and in reporting. Recycling rates include both formal and informal recycling (Velis, et al., 2012); and quantities collected for recycling should be adjusted downwards to allow for any materials subsequently rejected and sent to disposal or thermal treatment.

Each of these three quantitative indicators is now supplemented by a 'qualitative' indicator of the quality of service provision, assessed using best professional judgment against a defined set of criteria. It is neither possible nor appropriate here to present full details of the assessment and scoring systems defined in the guidance document for all eight sets of qualitative criteria included in the revised ISWM benchmark indicators – the space available here is limited, and the details at this level are still being finalized and may be subject to change. So instead, one detailed example is provided in Table 3, for indicator 1Q, the quality of the waste collection and street cleaning service; along with a summary of the criteria considered in the other composite qualitative indicators.

A continuing area for debate amongst the project team is where to assess different types of waste treatment facility. Recycling is higher up the waste hierarchy than energy recovery, so organics recycling (including composting, anaerobic digestion and animal feeding) is included here under the 3Rs (benchmark indicator 3) when calculating the % recycled; while thermal treatment with energy recovery is excluded from that indicator. However, composting, anaerobic digestion and thermal treatment with energy recovery are all forms of waste treatment, so for aspects related to environmental protection and health and safety at the treatment plant itself, these are all considered under indicators 2 and 2Q, the indicators for waste treatment and disposal related to environmental protection.

Table 3 sets out the five criteria used to assess the quality of the waste collection service, including street cleaning. The table also shows the guidance provided on how to assign scores against each criterion. The accompanying guidance document provides further detail. For example, for criterion 1Q.4, Effectiveness of supervision and management control, detailed guidance is available on what is considered 'appropriate'; for

Table 3: Criteria used to derive Indicator 1Q: Quality of the waste collection and street cleaning service

No	Criterion	Description	Assessment	Score to be assigned				
				0	5	10	15	20
1Q.1	Appearance of waste collection points	Presence of accumulated waste around collection points/containers	Incidence is:	Very high	High	Medium/ High	Medium	Low
1Q.2	Effectiveness of street cleaning	Presence of litter and of overflowing litter bins in city centre, along main roads and in popular places where people gather	Incidence is:	Very high	High	Medium/ High	Medium	Low
1Q.3	Effectiveness of collection in low income districts	Presence of accumulated waste/ illegal dumps/ open burning in and around lower income districts of the city	Incidence is:	Very high	High	Medium/ High	Medium	Low
1Q.4	Effectiveness of supervision and management control	Appropriate service implementation, management and supervision in place	Compliance is:	None	Low	Medium	Medium/ High	High
1Q.5	Health and safety of collection workers	Use of appropriate personal protection equipment & supporting procedures	Compliance is:	None	Low	Medium	Medium/ High	High

service provision by the public sector, one is looking for documentary evidence of appropriate service planning, delivery, monitoring, liaison and feedback; while for service provision by the private sector, it is documentary evidence of appropriate contracts in place, a transparent bid process and contract award, and detailed specifications of service, monitoring procedure and tool. In addition, both cases also require evidence for regular supervision on the ground, including important practical details such as supervisory staff having access to suitable transportation such as motorcycles or vehicles. For criterion 1Q.5, Health and safety of collection workers, the reference requirements for 'appropriate' personal protection is specified as regular health-checks, inoculations, boots, gloves, overalls and high visibility vests.

Table 4 summarises the criteria used to assess indicators 2Q, the degree of environmental protection in waste treatment and disposal. Again, the accompanying guidance provides detailed advice on scoring; as an example, five categories are defined in detail under criterion 2Q.1 Degree of control of treatment or disposal for each of land disposal and thermal treatment – from state-of-the-art/ fully engineered (scoring 20), through well engineered (15), controlled (10), semi-controlled (5) and uncontrolled (0). A score of 10 or above is required here, in order for a facility to count as part of the 'controlled' % under the quantitative indicator 2. The guidance for the individual criteria within indicator 2Q generally differentiates between land disposal and thermal treatment; with guidance also for biological treatment facilities under 2Q.3. For criterion 2Q.4, differentiation is made between private and public sector service provision.

Table 4: Criteria used to derive Indicator 2Q - Degree of environmental protection in waste treatment & disposal

No	Criterion	Description
2Q.1	Degree of control of treatment or disposal	For land disposal the World Bank classification has been applied which is based upon the degree of organization, management and engineering of the site. The same principles of engineering, control and organization have been adapted and applied to thermal treatment
2Q.2	Environmental and regulatory control	Includes the existence of: robust permitting/ licensing procedures; an environmental monitoring, inspection and verification regime by an independent regulatory body; regular monitoring carried out by the facility itself.
2Q.3	Control of greenhouse emissions and/or energy efficiency	For land disposal: control of site fires & management of landfill gas. For thermal treatment: the degree and efficiency of energy recovery as well as stack emission control, residence time, emissions etc. For biological treatment: the overall energy balance, the degree of methane capture or avoidance.
2Q.4	Management control	An assessment of the level and appropriateness of management control in planning, implementing and monitoring services.
2Q.5	Occupational health and safety	Use of appropriate personal protection equipment & supporting procedures

Table 5 summarises the criteria used to assess indicator 3Q, the Quality of the 3Rs. In this case, guidance for several criteria differs for high-income and medium- and low-income countries. The threshold for a city with a higher waste generating rate under 3Q.3, focus on the top levels of the waste hierarchy, is set at 1kg capita^{-1} day^{-1} (365 kg capita^{-1} yr^{-1}). Criteria 3Q.1 Source separation of 'dry recyclables', and 3Q.4 Integration of community and/or informal recycling sector with the formal SWM system, recognise the role of the 'community sector' in high-income countries and of the informal recycling sector in middle- and low-income countries. Detailed guidance for assessing informal sector integration (part of 3Q.4) follows the recent ISWA framework (Velis, et al., 2012), which categorised integration initiatives into 4 groups: one focuses on organization and capacity building of the informal sector; while the other three focus on its interfaces with formal solid waste management, secondary material markets and society as a whole.

Table 5: Criteria used to derive Indicator 3Q - Quality of 3Rs provision

No	Criterion	Description
3Q.1	Source separation of 'dry recyclables'	Based on the % of the total quantity of materials collected for recycling that are collected as clean, source separated materials The focus here is on the relative % of clean, source- separated materials, as opposed to materials that are separated out from 'mixed' wastes – where there will inevitably be much higher levels of contamination
3Q.2	Quality of recycled organic materials	A qualitative assessment of the likely quality of the recycled product (i.e. animal feed, compost, and the organic product (digestate) from anaerobic digestion)
3Q.3	Focus on the top levels of the waste hierarchy	For cities with higher waste generation rates, assesses degree of policy focus and practical efforts or institutional support to: prevention of wastes; organised reuse of second-hand products and materials; and extension of useful life through improved design and/or organised repair and refurbishment. For cities with lower waste generation rates, assesses primarily the degree of policy and practical focus on diverting waste from treatment and disposal to recycling.
3Q.4	Integration of community and/or informal recycling sector with the formal SWM system	An assessment of how far and how successfully efforts have been made to include the informal recycling sector (in low and middle-income countries) and the community reuse and recycling sector (in higher income countries) into the formal solid waste management system
3Q.5	Occupational health and safety	Use of appropriate personal protection equipment & supporting procedures

REVISED ISWM INDICATORS: GOVERNANCE ASPECTS

A major principle in developing the ISWM benchmark indicators has been that they should reflect also the 'soft', inherently difficult to measure, governance aspects, without adequate attention to which any attempts to introduce sustainable changes and modernise solid waste management systems are likely to fail (Scheinberg, et al., 2010).

Inclusivity addresses the depth of involvement of key groups of stakeholders, with separate indicators for user and provider inclusivity (Table 6). The original indicator for *user inclusivity* focused on assessing the degree to which users, or potential users, of the solid waste services (i.e. households, business and other waste generators) are involved in the planning, policy formation, implementation and evaluation of those services. This has now been supplemented by an explicit criterion (4U.1) on the equity of service provision, to assess the extent to which all citizens, irrespective of their income level and whether they live in planned neighbourhoods or in slums, receive a good service which they can afford, which meets their expressed needs, and which protects public health and environmental quality.

Table 6: Criteria used to derive Indicators 4U and 4P: Degree of user and provider inclusivity

4U - Degree of user inclusivity			**4P - Degree of provider inclusivity**		
No	**Criterion**	**Description**	**No**	**Criterion**	**Description**
4U.1	Equity of service provision	Assessment of the extent to which all citizens, irrespective of income level, receive a good solid waste management (SWM) service which they can afford, which meets their expressed needs, and which protects public health and environmental quality	4P.1	Legal framework	Assesses the degree to which laws and/or other legal instruments are in place and implemented at national or local level which enables the private sector to deliver SWM services on a stable basis The legal framework should cover public-private partnership (PPP), private sector participation (PSP), and participation by community based organisations (CBOs) and/or the organised 'informal' sector
4U.2	The right to be heard	Assessment of the legal right to be heard – do authorities have a legal obligation to consult with and involve citizens in decisions which directly affect them	4P.2	Representation of the private sector	Organisations or structures in place which represent the private waste sector and actively participate within SWM planning forums, task forces, committees and/or steering-groups
4U.3	Level of public involvement	Evidence of public involvement and the encouragement thereof at appropriate stages of the SWM decision making, planning and implementation process.	4P.3	Role of the 'informal' and community sector	Evidence of acknowledgement and protection of the organised 'informal' and community sectors role within the formal SWM system
4U.4	Public feedback mechanisms	The existence and use of public feed-back mechanisms on SWM services	4P.4	Private sector participation	Assessment of the degree to which institutional or legal incentives are in place, nationally and/or locally, which actively encourage private sector participation in SWM
4U.5	Public education & Awareness	Implementation of a comprehensive, culturally appropriate public education, behavioural change and/or awareness raising programme	4P.5	Bid processes	Evidence of the private sector being included within open, transparent and accountable bid processes for the provision of SWM services

The indicator for *provider inclusivity* assesses the degree to which economic niches in service delivery and recycling are open and accessible to non-state actors and non-municipal service providers from the formal

private, community or 'informal' sectors. Informal service providers working in the waste sector are defined primarily in terms of their lack of a formal, recognized status within the municipally-organised solid waste management system – they can be and often are registered with the authorities and pay taxes (Velis, et al., 2012).

Indicator 4P focuses on the openness of the system to different groups of service providers. In cases where such 'private sector' service providers are used by a municipality, the assessment looks for evidence of specific systems to control the quality of the services delivered (e.g. (Awortwi, 2004)) – this is measured elsewhere (currently there is a degree of overlap between criteria 6L.5 under local institutional coherence and 1Q.4 and 2Q.4 under waste collection and treatment and disposal).

For criterion 4P.1, Equity of service provision, in order to assess the degree to which a legal framework is in place to allow private sector partners to deliver solid waste management services on a sustainable basis, the accompanying guidance suggests that it may be appropriate to use a proxy indicator. One example of such a proxy would be the legally allowed duration of solid waste management service contracts, reflecting the fact that shorter term contracts constrain the ability of the private sector to invest in proper equipment and thus affect the long-term sustainability of private sector service delivery: in this case, a contract duration of seven years or above would rank as high compliance and score 20, no minimum contract duration or less than one year would score 0, with intermediate scores assigned on a sliding scale.

The *degree of financial sustainability* is assessed against six criteria as summarised in Table 7. These cover transparent accounting procedures (5F.1); the adequacy of the total budget, irrespective of the source of revenues (5F.2); local cost recovery from households (5F.3) and from businesses (5F.5); affordability of user charges (5F.4); and ability to raise capital for investment (5F.6.). The guidance on scoring against each criterion is particularly detailed for this indicator, partly because there is quantitative data available for some of the criteria which need to be converted into a score out of 20; but also because it is particularly challenging to ensure that the indicator can be applied to both high- and to low-income cities. To take just one example, criterion 5F.3, Local cost recovery from households, focuses on the % of total number of households who pay at least some direct contribution to the cost of primary collection – that is the part of the service which ensures that waste is removed from individual properties, either via some sort of individual service or via the provision of communal collection points. Primary collection has been selected here as experience shows that even in slum areas of low income cities, people are prepared to pay to keep their neighbourhood clean and their children healthy. Payments can be either through a direct charge for waste services, or indirect, e.g. via property tax, communal service charges or a utility bill or a component of a utility bill linked to water/wastewater or electricity bills.

Table 7: Criteria used to derive Indicator 5F: Degree of financial sustainability

No	Criterion	Description
5F.1	Cost accounting	An assessment of the 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 SWM, and whether the accounts are open to public scrutiny
5F.2	Does the available budget cover the full costs?	Is the annual budget adequate to cover the full costs of providing the service?
5F.3	Local cost recovery – from households	Quantitative % 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 % of the total costs which they pay
5F.4	Affordability of user charges	Are practices or procedures in place to cross-subsidise charges for those who can least afford to pay?
5F.5	Local cost recovery – from businesses and institutions	Degree to which local businesses and institutions pay the full financial costs of both waste collection, treatment and disposal
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?

In the revised version two benchmark indicators are defined for sound institutions and proactive policies, one focusing on the national framework and the other on local institutions; Table 8 summarises the six criteria defined for each. Indicator 6N assesses the adequacy of the national solid waste management framework and to what degree it has been implemented. The criteria cover the basic legislation and implementing regulations (6N.1); an approved and recent national strategy and clear policies (6N.2); guidelines for local government on implementation (6N.3); the designation and capacity of a single national responsible authority for solid waste management (6N.4); the environmental regulatory agency (6N.5); and the extent to which companies responsible for the products that become solid waste share the costs of its management thorough extended producer responsibility (6N.6). Indicator 6L is a measure of the institutional strength and coherence of a city's solid waste management functions, with the individual criteria including organizational structure, institutional capacity, availability and quality of data and inter-municipal co-operation.

Table 8: Criteria used to derive Indicators for sound institutions and proactive policies: 6N - National framework and 6L - Local institutions

6N - Adequacy of national framework for solid waste management (SWM)			**6L - Degree of local institutional coherence**		
No	**Criterion**	**Description**	**No**	**Criterion**	**Description**
6N.1	Legislation and regulations	Is there a comprehensive national law(s) in place to address solid waste management (SWM) requirements? Have any necessary regulations required to implement the legislation been put in place?	6L.1	Organisational structure	The degree to which all SWM responsibilities are concentrated into a single organisation 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
6N.2	Strategy/ Policy	Is there an approved and recent national strategy for SWM, and clear policies in place and implemented?	6L.2	Institutional capacity	An assessment of the organisational strength and capacity of the department responsible for SWM
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?	6L.3	City-wide SWM strategy & plan	Is there a recent strategy or plan in place & being implemented at the city (or regional) level for SWM?
6N.4	National institution responsible for implementing SWM policy	Is there a single institution at the national level which is charged with the responsibility of implementing, or coordinating the implementation of, SWM strategy/policy?	6L.4	Availability and quality of SWM data	Is there a management information system in place? Is the waste system performance regularly monitored and measured and data collected?
6N.5	Regulatory control	Is there a well organised and adequately resourced environmental regulatory agency? Does it enforce the legislation to ensure a 'level playing field' for all?	6L.5	Management, control and supervision of service delivery	A measure of the strength of control by the city as 'client' for SWM, over the on-the-ground delivery of SWM services
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 municipal solid waste? Do they share at least some of the costs of the SWM service and/or recycling?	6L.6	Inter-municipal 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 organised at regional or national level. How well does such co-operation work?

Again, detailed guidance is provided on assessing the scores assigned against each criterion. To take just one example from each, for criterion 6N.4, national institution responsible for implementing solid waste management policy, detailed guidance is given on how to assign the scores depending on the degree of integration and autonomy of that institution and its separation from the environmental regulator. For criterion 6L.2, institutional capacity, the assessment considers three questions: Is there a detailed organisation chart of the SWM department? 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 class-room and the field?

PRESENTING THE INDICATORS

Using the revised ISWM benchmark indicators to assess the solid waste management system in a city results in set of detailed tables, documenting the data used to calculate the three quantitative indicators, and how 'best professional judgment' has been applied to assign scores against the criteria used to calculate each of the eight qualitative indicators. This level of detailed reporting is essential, so that it is possible to audit and check the assessment and to ensure that a consistent approach is applied when cities are compared with each other. However, it is also important that a one-page summary of the indicators is available, in an attractive and easy-to-interpret format such as the use of the "traffic light" colour coded system, for presentation to local and national decision makers and also to international agencies with an interest.

For this purpose, the indicators themselves have been supplemented by a summary set of background data, to put each city into context. General background information comprises the gross national income (GNI) per capita for the country and the corresponding World Bank income category (four categories are defined: high, upper-middle-, lower-middle- and low-income (World Bank, 2012)); the population and the total waste generation. Key waste-related data are the municipal solid waste (MSW) generation per capita per year and MSW composition. To maintain the summary nature of the overall table, just three specific components of waste composition have been selected here, focusing on those which differ most between cities (Wilson, et al., 2012) or which most affect the selection of appropriate management methods: these are the organic (food and green waste) fraction; paper (and card); and plastics. Again, the data collection form is accompanied by detailed guidance, to facilitate consistency in the assumptions used in estimating or interpreting the relevant data. One area where such guidance is seen to be essential is on MSW generation - definitions of MSW vary widely, and a degree of consistency is required to focus on household and household-like wastes.

DISCUSSION, ON-GOING WORK AND CONCLUSIONS

Demonstrating the second generation ISWM indicators

The second generation ISWM benchmark indicator set was developed alongside a GIZ project which focused on comparing the 'operator models' used to deliver waste management services in cities around the world (Soos, et al., 2013; Garcia Cortes, et al., 2013; Wilson, et al., 2013). The project developed five new case studies for cities in low and middle-income countries, and the indicator set was used to provide a uniform methodology for their characterisation. Table 9 presents a summary of the results, in effect collapsing the summary page for each case study into one comparative table.

The primary use of the indicators is to focus attention on the priority areas for improvement in each individual city. For example, Maputo in Mozambique and Qena City in Egypt have relatively good collection systems, but have much to do to improve both environmental control- disposal and recycling. Castries in St Lucia and CIGRES, a consortium of 30 municipalities in the State of Rio Grande do Sul in southern Brazil, have good collection and disposal systems, but relatively low recycling rates. Surat in India has made progress on all three physical components, but has still considerable room for improvement in terms of environmental control-disposal, and also the quality of recycling provision. Performance against the governance indicators is fairly mixed: Qena is generally the weakest; while each of the other cities performs better on some indicators than on others - e.g. in Maputo, a priority would be to improve the national framework, while in Castries, priorities would appear to be financial sustainability and the national framework.

Table 9: Summary results for five case study cities

No	Category	Indicator	Results									
City			Maputo		Surat		Qena City		Castries		CIGRES	
Country			Mozambique		India		Egypt		St Lucia		Brazil	
Background information on the city												
G1	Country income level	World Bank income category	Low		Lower-middle		Lower-middle		Upper-Middle		Upper-Middle	
		GNI per capita	$470		$1,420		$2,600		$9,080		S10,720	
G2	Population of city	Total population of the city	1,131,149		4,600,000		210,000		62,000		88,050	
G3	Waste generation	MSW generation (tonnes/year)	508,000		456,250		38,000		78,021		16,400	
Key Waste-related data												
W1	Waste per capita	MSW per capita (kg per year)	*449 (or 316)*	-	*119*	-	*180*	-	*219*	-	*190*	-
W2	Waste composition:	3 key fractions – as % wt. of total waste generated										
W2.1	Organic	Organics (food and green wastes)	*65%*	-	*54%*	-	*50-60%*	-	*40%*	-	*60%*	-
W2.2	Paper	Paper	*8.5%*	-	*8%*	-	*8-12%*	-	*10%*	-	*6.4%*	-
W2.3	Plastics	Plastics	*8.0%*	-	*10%*	-	*10-15%*	-	*26%*	-	*7.3%*	-
Physical Components												
1	Public health – Waste collection	Waste collection coverage	*82%*		*80-100%*		*100%*		*100%*		*95%*	
1Q		Quality of waste collection service	*M/H*		*M/H*		*M/H*		*H*		*M/H*	
2	Environmental control – waste treatment and disposal	Controlled treatment and disposal	*0%*		*55%*		*0%*		*100%*		*100%*	
		Environmental quality of waste treatment and disposal	*L/M*		*L/M*		*L*		*M/H*		*M/H*	
3	3Rs – reduce, reuse and recycling	Recycling rate	*< 5%*		*30%*		*<5%*		*20%*		*14.6%*	
3Q		Quality of 3Rs provision	*L/M*		*L/M*		*L/M*		*M*		*M*	
Governance Factors												
4U	User inclusivity	Degree of user inclusivity	*M*		*M/H*		*L/M*		*H*		*M/H*	
4P	Provider inclusivity	Degree of provider inclusivity	*M/H*		*M/H*		*L/M*		*M/H*		*M/H*	
5F	Financial sustainability	Degree of financial sustainability	*M/H*		*H*		*M*		*L/M*		*M/H*	
6N	Sound institutions, proactive policies	Adequacy of national SWM framework	*L/M*		*M*		*L/M*		*M*		*H*	
6L		Degree of institutional coherence	*M*		*M/H*		*L/M*		*M/H*		*H*	

Key: CIGRES - an association of 30 municipalities in the State of Rio Grande do Sul, in Southern Brazil; MSW - Municipal solid waste; GNI - Gross National Income. Qualitative indicators assessed into five categories based on: low performance - L - red; low/medium performance - L/M - red-amber; medium performance - M - amber; medium-high performance - M/H - amber-green; and high performance - H -green. Quantitative indicators also colour coded (for scaling, see Table 2).

Feedback on using the indicators and on-going development work

Feedback from those practitioners who have so far used the ISWM indicators suggests that they are useful, but some constructive criticism has also been received. In particular, as many of the criteria which make up the qualitative indicators are subjective in their nature, it is noted that it is important to provide clear guidance to the assessors, and that it may be useful also to have an 'independent arbitrator' whose role is to check that individual assessors have interpreted the available information in a consistent manner. A few cases were identified where the criteria overlap, implying that the indicators may not be entirely independent of each other; a particular concern here is management control and supervision of service delivery, which is assessed under the physical indicators for both collection (criterion 1Q.4) and environment-disposal (2Q.4) and under the governance indicator local institutional coherence (6L.5). An unexpectedly controversial point was the selection of just three components to summarise a city's waste composition, when e.g. the EU requires reporting on 51 such components (Eurostat, 2011) – the addition of at least one more component, metals, has been suggested as a compromise, due to their importance for sustainable resources management. While metals and other materials are of interest in SWM systems in both low-income and high-income countries, the stakeholders involved in their recovery and the extent to which the flow of this material fraction is measured and documented in low-income countries differ a lot from those in high-income countries. This point illustrates well one of the major challenges we have faced in developing the revised indicator set: that is producing one set of criteria that can be applied equally in both high-income cities, operating state-of-the-art modern solid waste management systems; and in low-income cities at an early stage of their own modernisation process.

A final round of testing is currently in progress in a range of cities around the world, at all levels of income. In parallel, a peer-review by both practitioners and researchers is underway. These results will be added to those from the initial demonstration cities reported in Table 9, based on which the choice and definition of criteria for derivation of each composite indicator, and the guidance on their use will be finalised. The final ISWM benchmark indicator set will be prepared for publication in the peer-reviewed literature, with the accompanying guidance documents freely available on the web.

Conclusions

This paper has outlined a set of ISWM benchmark indicators to characterise the state of the solid waste management system in any city around the world. The set combines relatively standard, quantitative indicators for the three main physical components – collection, (treatment and) disposal and recycling – with a corresponding, qualitative, composite indicator for the 'quality' of service provision for each physical component, as well as five further qualitative, composite indicators which assess performance for the three main aspects of governance, namely inclusivity of stakeholders, financial sustainability and sound institutions & proactive policies.

This has been a progress report; by the time of publication, work will be nearing completion on what we believe is a powerful tool. We hope that the ISWM benchmark indicators will be widely applied as a standard methodology, which will allow rapid benchmarking of a city's solid waste management performance; comparison of cities, both high- and low-income, on a common basis; and monitoring the progress of a city over time, towards a sustainable solid waste management system which meets the needs and aspirations of its citizens and contributes to sustainable resource management.

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