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An analytical framework and tool ('*InteRa*') for integrating the informal recycling sector in waste and resource management systems in developing countries

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Abstract

In low- and middle-income developing countries, the informal (collection and) recycling sector (here abbreviated IRS) is an important, but often unrecognised, part of a city's solid waste and resources management system. Recent evidence shows recycling rates of 20–30% achieved by IRS systems, reducing collection and disposal costs. They play a vital role in the value chain by reprocessing waste into secondary raw materials, providing a livelihood to around 0.5% of urban populations. However, persisting factual and perceived problems are associated with IRS (waste-picking): occupational and public health and safety (H&S), child labour, uncontrolled pollution, untaxed activities, crime and political collusion. Increasingly, incorporating IRS as a legitimate stakeholder and functional part of solid waste management (SWM) is attempted, further building recycling rates in an affordable way while also addressing the negatives. Based on a literature review and a practitioner's workshop, here we develop a systematic framework—or typology—for classifying and analysing possible interventions to promote the integration of IRS in a city's SWM system. Three primary interfaces are identified: between the IRS and the SWM system, the materials and value chain, and society as a whole; underlain by a fourth, which is focused on organisation and empowerment. To maximise the potential for success, IRS integration/inclusion/formalisation initiatives should consider all four categories in a balanced way and pay increased attention to their interdependencies, which are central to success, including specific actions, such as the IRS having access to source separated waste. A novel rapid evaluation and visualisation tool is presented—*integration radar* (diagram) or *InterRa*—aimed at illustrating the degree to which a planned or existing intervention considers each of the four categories. The tool is further demonstrated by application to 10 cases around the world, including a step-by-step guide.

Keywords

Informal recycling, informal sector, solid waste management, developing countries, waste pickers, value chain, poverty alleviation, governance

Introduction

Solid waste recycling in developing countries is generally carried out by the informal sector (Gutberlet, 2010; Medina 2007). This was true at some stage in the past, in what are now high-income developed countries (Velis et al., 2009; Wilson, 2007). It is still the case in the low- and middle-income developing countries of Asia, Latin America and Africa, which are the main focus here. The informal recycling sector (IRS) also persists alongside the 'modern', formal sector recycling in Central and Eastern Europe (Istavan et al., 2010; Obersteiner et al., 2010); in emerging economies, such as Malaysia (Murad and Siwar, 2007)—now officially a high-income country; and is even reappearing in Southern Europe (Papaoikonomou et al., 2009), further amplified by the effects of considerable immigration influx combined with the current economic crisis.

Activities of the informal sector in waste management vary widely, ranging from groups organised in cooperatives providing

door-to-door collection of either recyclates separated at source or of mixed waste which they then often sort, to individuals scavenging in open dumps, transfer stations and communal bins (e.g. Medina, 2011; Wilson et al., 2006). Specifically, we use the definition from a 2006 GTZ study (Scheinberg et al., 2010b; Wehenpohl et al. 2007): '*the informal solid waste sector refers to individuals or enterprises who are involved in recycling and waste management activities but are not sponsored, financed,*

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recognised or allowed by the formal solid waste authorities, or who operate in violation of or in competition with formal authorities'. This definition is different to that of the informal sector in other contexts, where the term may be synonymous with the 'black economy'. In particular, informal sector waste and recycling workers and businesses can be, and often are, registered with the authorities and pay taxes [e.g. as in Brazil, Dias and Alves (2008)]; in this case, the definition of informality mainly relates to their lack of recognised status within the solid waste sector. Clearly, this definition does not include (organised) criminal activities, often evident in developed countries as, for example, the theft of valuable metals (Baillie, 2012), nor does it address issues around the status/rights of illegal immigrants who have been reported to participate in informal sector activities in some countries.

There is increasing consensus among all stakeholders and experts that the informal sector in general, and the IRS in particular, should not and, in fact, cannot be ignored while attempting to improve waste and resource management systems in developing countries (Agamuthu, 2010; Ali, 2006; Besiou et al., 2012; Chaturvedi, 2011; Dias and Alves, 2008; Gutberlet, 2010; Luken, 2011; Sang-Arun 2011; Scheinberg, 2012; Scheinberg et al. 2011). Accumulating evidence suggests that these activities can be beneficial to formal municipal waste and resource management, in addition to providing a livelihood to around 0.5% of the urban population (Scheinberg et al., 2010a; Wilson et al., 2012). Specifically, informal sector and micro-enterprise recycling, reuse and repair systems achieve considerable recycling rates—often 20–30% wt. in low-income countries (Wilson et al., 2009, 2012). They are also entirely market driven with their only income coming from selling the collected segregated, and often reprocessed, materials and can, thus, save local authorities around 20% or more of what they would otherwise need to spend on waste management, representing many millions of dollars per annum in large cities (Scheinberg et al., 2010b; Wilson et al., 2012).

However, persistent factual and perceived issues with the activities of the informal sector, such as occupational and public H&S, child labour, uncontrolled pollutant flows, untaxed activities, association with crime and political collusion, and incompatibility with the image of a modern city (Medina, 2000; Patwary et al., 2011; Wilson et al., 2006; Xu et al., 2012) result in poor inclusion/integration into official systems, despite the long-standing efforts of external support organisations, such as international donors and non-governmental organisations (NGOs) (e.g. Gunsilius et al., 2011). There is a major opportunity for win–win solutions—building recycling rates, protecting and developing people's livelihoods, addressing the negative aspects of current informal recycling on health and the environment, and reducing costs to the city of managing its wastes (Wilson et al., 2009)—if the informal sector can be included more successfully within an integrated and sustainable waste management system.

Over the last 10 years research has tried to account, analyse, comprehend and propose solutions to address the key challenges related to the integration/inclusion/formalisation of the informal

recyclers, considering waste management, material flows, and socioeconomic, governance and business aspects (Ahmed and Ali, 2004; Asim et al., 2012; Atienza, 2010; Chaturvedi, 2011; Fernandez, 2011; Gerdes and Gunsilius, 2010; Iskandar and Tjell, 2008; Mitchell, 2009; Moreno-Sanchez and Maldonado, 2006; Nas and Jaffe, 2004; Ojeda-Benitez et al., 2002; Rathi, 2006; Sanada and Yoshida, 2011; Sang-Arun, 2011; Schamber, 2010; Scheinberg, 2012; Sembiring and Nitivattananon, 2010; Spies et al., 2005; Suchada et al., 2003; Velis, 2004; Wilson et al., 2006). Such interventions are described variously as aimed at the 'integration', 'inclusion', 'formalisation' or 'legalisation' of the IRS. Here, we continue the earlier practice of using the first three terms fairly interchangeably, while acknowledging recent efforts to provide precise definitions to differentiate the use of each of these terms (Scheinberg, 2012), which, however, remain widely debated.

Recently, an International Solid Waste Association (ISWA) Task Force on Globalisation and Waste Management has been working towards preparing guidelines on how best to promote the inclusion/integration of the informal sector within a city's waste management system. To provide a sound basis for such guidance for use in developing country cities, we propose a novel framework for classifying and analysing possible interventions to promote inclusion and integration of the IRS in a developing country city's solid waste management (SWM) system, along with a tool for evaluating and visualising the focus of such interventions rapidly. This aims to be a comprehensive, integrated and structured systems approach, drawing from, and bringing together, all aspects of the phenomenon into a practically applicable tool designed to maximise the chances of success and deliver benefits to all stakeholders. We also provide 10 practical examples by applying the framework/tool to a selection of case studies.

Methodological approach towards the framework

The outcome of this research is also a methodology. It comprises a novel analytical framework for the better integration of the IRS activities in a city's waste management system, along with specific tools developed to support its hands-on application. Hence, this methodology section covers the general approach towards creating these items—their detailed description can be found in the *Results* section.

A substantial part of the current understanding on the subject comes from practitioners working on behalf of municipalities, consultancies and NGOs, not necessarily having the opportunity or the focus to publish in academic peer-reviewed journals. The methodology followed in developing this analytical framework and tools was designed specifically to capture this practitioner expertise, enriching the current academic knowledge. The key steps were as follows.

1. Literature review—ensuring that the work builds on the foundations laid in both the peer-reviewed and the 'grey' literature.

- This focused on existing frameworks and on recommendations for interventions to integrate the informal sector with waste management systems in developing countries.
2. Developing a preliminary typology of interventions, both successful and unsuccessful, and an interim template to gather systematic information on a series of case studies of previous interventions (Rocca, 2011).
 3. An international workshop, bringing together practitioners and experts from a wide range of stakeholder groups in an IRS Integration Workshop convened in June 2011, alongside an ISWA Beacon Conference on Waste Recycling, in Buenos Aires, Argentina. The typology of interventions was discussed and developed further.
 4. Details of seven sample case studies from Africa, Asia and Latin America were provided by the IRS Integration Workshop participants using an updated data-capturing template agreed at the workshop.
 5. We finalised the typology of interventions, arranged into four categories, to provide the final framework for analysis and decision-making presented below.
 6. We developed a new framework, and a rapid evaluation and visualisation tool in the form of a radar diagram (Integration Radar or *InteRa* hereafter).
 7. A total of 10 sample case studies were then used to test and demonstrate how the framework and tool could be used in practice. Data were initially captured and filled into the updated case study template, based on a critical review of the literature (3 cases), and on the personal experience of the international IRS Integration Workshop experts (seven cases); they were then transformed by us into intervention interface *importance* ratings.

Further methodological details and guidance on how to apply and interpret the newly-developed *InteRa* rapid evaluation methodology and visualisation tool are provided in the relevant sections.

Results

Existing approaches

A wide variety of recommendations for the integration/inclusion of the informal sector into a city's SWM system have been made by previous authors, as summarised in Table 1. Examining these possible interventions, various subgroupings can be suggested. For example, Gutberlet (2008) proposed three different systems that together could constitute an '*inclusive resource recovery*': '*Social and solidarity economy*', '*Resource management*' and '*Governance*'.

Analytical framework/typology of interventions to promote integration with SWM

These recommendations for priority interventions (Table 1) and the groupings proposed by Gutberlet (2008), are here re-arranged,

extended and developed into a proposed typology of interventions, resulting in an analytical framework comprising four complementary aspects or possible categories of interventions. We have described three of these as primary *interfaces* between the informal recyclers and the outside world, namely their interfaces with:

- (A) the formal SWM system from which the informal sector obtains materials for recycling;
- (B) the materials and value chain into which those materials are sold and which therefore provides their primary source of income; and
- (C) society as a whole, including various aspects relating to the acceptance of their activities by society.

The fourth category of possible interventions is different from, and underpins, the others, facilitating the conditions which enable actions under the three interfaces to be successful. To emphasise this point, we have used a different nomenclature for the label here:

- (O) Organisation and empowerment of the informal recyclers.

Within each *category* (A)–(C) and (O), 3–4 groupings of similar types of interventions have been identified and, within each of those groups, a series of individual *intervention points*. Typically, when one is considering how to promote informal sector integration/inclusion in a particular city, there will be a number of possible *specific actions* to achieve each *intervention point*. Inevitably, the four categories partly overlap, because some specific intervention points have key elements that fit into more than one interface or into the enabling category (O). However, for clarity and practical functionality of the analytical framework, each intervention has been allocated only to one category, which we judged to be the most appropriate.

Figure 1 summarises the overall analytical framework and typology of interventions, and depicts these interdependencies in the form of a Venn diagram. The three interfaces (A)–(C) are shown as three intersecting 'sets', each underpinned by the necessary organisation and empowerment of the IRS (O) on which their success depends. The intersections between the sets are important—not only do these highlight those actions which could be assigned to more than one of the interfaces, but the two actions at the centre, which 'belong' to all three interfaces, are, arguably, among the most critical to the success of any integration initiative, namely access to the waste and improving the quality of the materials available for recycling through separation at source.

The four categories of intervention

The full typology of potential interventions is detailed in Tables 2–5. Each specific action is explained or examples are provided.

(A) Interface with the SWM system. If the IRS is to function as a component part of a city's SWM system, then one set of

Table 1. Summary of literature review: Recommendations for the integration/inclusion of the informal recycling sector (IRS) into solid waste management systems

Reference	Recommendation
Van de Klundert and Lardinois (1995)	<ul style="list-style-type: none"> • Documentation of SWM system • Training and empowerment of the various stakeholders • Development of conditions favourable for all actors to work in
Haan et al. (1998) Lardinois and Furedy, (1999)	<ul style="list-style-type: none"> • Assessing and documenting existing SWM system • Pilot projects
Medina (2002)	<ul style="list-style-type: none"> • Legal recognition • National policies • Organisation • Allow conditions (legally, institutionally) • Microcredit initiatives
Nas and Jaffe (2004)	<ul style="list-style-type: none"> • High levels of organisation • Political context of support
Wilson et al. (2006)	<ul style="list-style-type: none"> • Acceptance by authorities of benefits that IRS can provide • Organisation • Formation of cooperatives/micro- and small-enterprises
Gutberlet (2008)	<ul style="list-style-type: none"> • Inclusion of IRS into waste management • Equity: gender, income, social security • Eco-health: social and environmental health • Eco- efficiency: packaging reduction, producer responsibility • Expansion of capital basis • Sustainability: long term perspective • Topography consideration
Cardenas (2009)	<ul style="list-style-type: none"> • Acknowledgment of benefits provided by IRS • Financial incentives • Regulations • Organisation of IRS • Participation of IRS in steering/ board meetings • Partnerships formation • Contracts for services • Support base
Scheinberg et al. (2006) Wilson et al. (2009) National Solid Waste Management Commission (2009)	<ul style="list-style-type: none"> • Enter new service roles and niches • Access to adequate sorting spaces • Better market leverage an/or diversification of activities through, e.g. , cooperatives and associations • Stakeholder communication • Environmental and occupational safety practices
Atienza (2010)	<ul style="list-style-type: none"> • Favourable policies • Organisation • Economic and technical assistance • Health and safety insurance • Law enforcement • IEC: information and education campaigns • Appropriate technology • National and local gatherings of stakeholders
Gerdes and Gusilius (2010) Gunsilius et al. (2011)	<ul style="list-style-type: none"> • Organisation (voice) • Acknowledgment of contributions (visibility) • Political and legal recognition (validity) • Financial sustainability (viability) • Collaboration of NGOs in first stages • Acceptance by the public • Political support • Good relationship with the receiving industries and the formal SWM system

Table 1. (Continued)

Reference	Recommendation
	<ul style="list-style-type: none"> • Pilot projects • Accurate data collection • National initiative-participatory approach
Sembing and Nitivattanon (2010)	<ul style="list-style-type: none"> • Establishment of partnerships between members of IRS • Shift in policy makers perception of the IRS • Improve quality of secondary raw materials
Chaturvedi (2011)	<ul style="list-style-type: none"> • Collection and channelisation mechanism • Capacity building/research and development • Infrastructure • Policies, dialogue and dissemination activities

SWM, solid waste management; IEC, information and education campaigns; NGOs, non-governmental organisations.

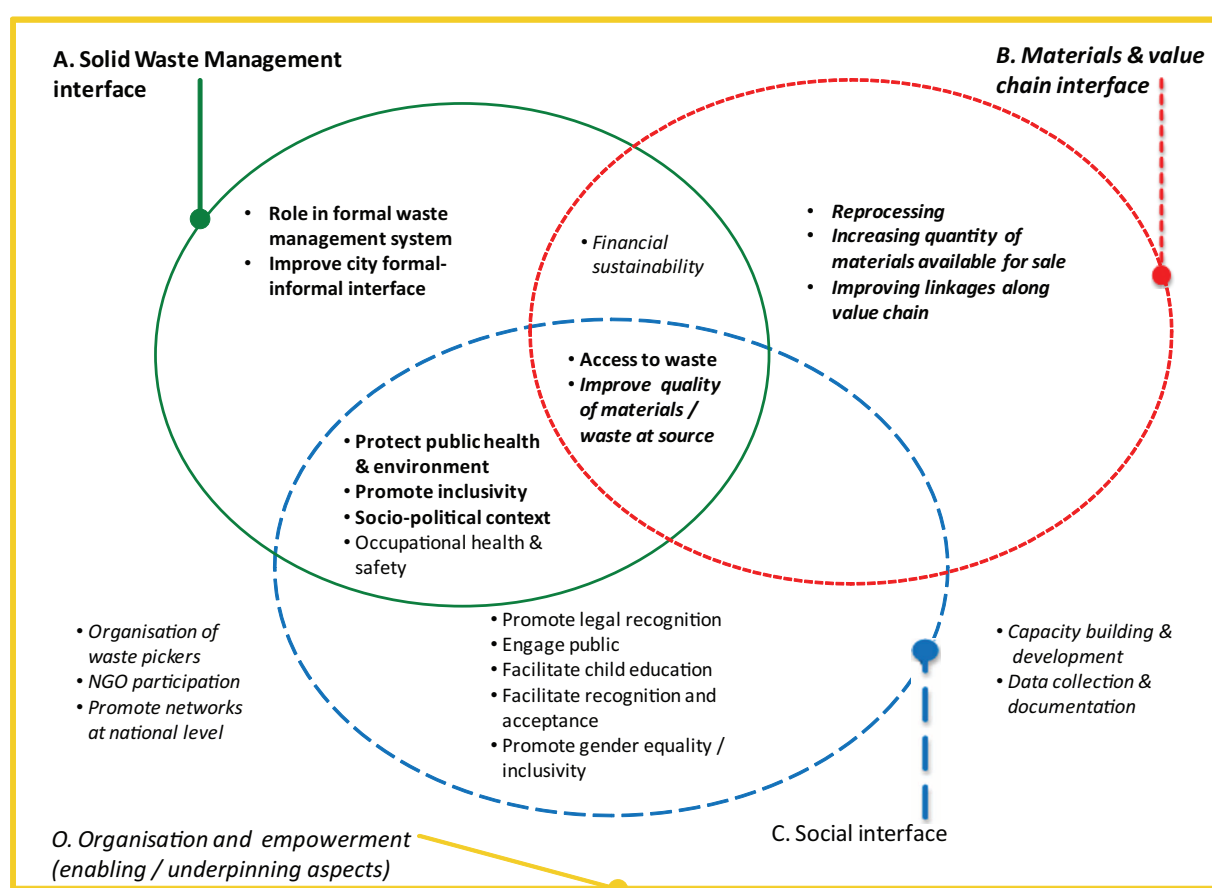


Figure 1. Overall analytical framework and typology of interventions, showing the interdependencies. The different fonts show how the subgroups of interventions ('intervention points', **Tables 2–5**) have been allocated to the four categories: (A) bold; (B) bold italics; (C) plain text; (O) italics.

interventions needs to address the interface between the two. Table 2 subdivides the possible interventions into four groups.

- *Access to the waste.* This includes both the legal right to recycle and also the physical role that the informal sector plays in the system, such as providing primary collection services. Example actions (interventions) could include memoranda of association or formal contracts between the municipality or

their formal sector contractors and groups representing the informal sector. Access is such a fundamental issue that it sits right in the middle of Figure 1, overlapping with both of the other interfaces (B and C).

- *Recognising the role of the informal sector.* A key issue is for the authorities to recognise the role and contribution of the informal sector. Medina (2002) classified current negative attitudes as *repression* (any kind of informal recycling

Table 2. Interface A – between the informal recycling sector (IRS) and the solid waste management sector

A	Group of interventions	Intervention points	Specific actions	Explanations/examples
Solid waste management (SWM) sector interface	Access to waste	Access to waste	Legal recognition of the right of pickers to collect waste, sell the materials separated and keep the income	<ul style="list-style-type: none"> • A legal right to access waste, obtain ownership and recycle (while accepting related obligations) • Granting controlled access to pickers at collection points under agreed conditions • For example, adjusting zoning and land use planning rules to enable sorting and storage in residential neighborhoods, i.e. near the sources of recyclables (Scheinberg, 2012)
			Waste pickers to have controlled access to waste at collection points	
	Recognising role of informal sector in SWM	Socio-political context towards informal sector	Role in formal SWM system	<p>Inclusion into/ integration with formal SWM sector collection</p> <p>Inclusion into/integration with formal SWM sector transport</p> <p>Official role in providing recycling within formal SWM system</p>
			<p>Institutionalising policies regarding IRS (so that they become robust to political shifts)</p> <p>Documenting the role and advertising benefits provided by IRS within the wider SWM system (acknowledgment of their role and contribution)</p>	<ul style="list-style-type: none"> • Moving from repression, neglect or collusion to active co-operation and stimulation (Medina, 2000) • For example, Belo Horizonte (CS2) • Measuring recycling rates and publicising the resultant cost savings to the city through avoided collection and disposal

Table 2. (Continued)

A	Group of interventions	Intervention points	Specific actions	Explanations/examples
		Promote inclusivity	Involve all stakeholders in SWM planning Institutionalise inclusivity of informal sector	<ul style="list-style-type: none"> • Setting up well-publicised pilot projects • For example, Linis Ganda, Manila (CS1) and Phitsanulok, Thailand (CS7) • Recognising IRS as important stakeholder, alongside others who do the physical work of collecting, sweeping and disposal • Establishing solid waste 'platforms' or committees • Surveys, feedback mechanisms • Transparent rules • Rights (as above) bring responsibility—pickers agree to simple control measures that are the enforced
	Protecting public health and environment	Protecting public health and environment	Control sorting in the street and ensure that residues after sorting are disposed of properly Regulate handling of hazardous wastes Promote the collection and disposal of waste from marginalized/low-income areas	<ul style="list-style-type: none"> • Agreements to facilitate provision of IS services brings public health benefits • Central to Guardianes Del Riachuelo (CS4)
	Strengthening interfaces	Improving formal SWM/informal interface	Smoothing take over from households or from waste collectors to the IS Easing take over from IS to municipalities or private contractors for secondary transport and final disposal	<ul style="list-style-type: none"> • For example, waste handed over at an agreed and reliable time • Waste to be delivered by an agreed time • Direct transfer to avoid 'double handling'
		National policies improving formal state/informal interface	National policies/legislation to promote recycling (considering IRS potential contribution)	<ul style="list-style-type: none"> • National laws facilitate local action at the city level • For example, Scheinberg, 2012: priced disposal and/or landfill bans; policy- or legal-based percentage or per capita diversion goals for recoverable materials
			National strategies for the inclusion of IRS within SWM	<ul style="list-style-type: none"> • The Philippines' national framework plan for the informal sector in SWM (National Solid Waste Management Commission, 2009) • Also in Brazil (CS2)

SWM, solid waste management; IS, informal sector.

activity is illegal); *neglect* (such activities are ignored); or *collusion* (the informal sector recyclers are tolerated in return for votes or payments). Interventions here are intended to instead provide active support and recognition from the authorities in such a way that this can continue irrespective of the political party in power. Of critical importance here is promoting inclusivity—strengthening and institutionalising the linkages. Possible actions include a ‘solid waste platform’ to give both service users and informal service providers a voice in how the system is planned and managed—examples include Belo Horizonte, Brazil; Bengaluru, India; and Quezon City, Philippines (Scheinberg et al., 2010a).

- *Protecting public health and the environment.* The focus here is both to control the public health impacts of informal sector recycling (e.g. by controlling sorting and littering on the street, and the disposal of residual wastes) and to promote public health benefits (e.g. by working with the informal sector to provide primary collection services in otherwise unserved areas). Occupational H&S of the informal recyclers is allocated under (C).
- *Strengthening interfaces.* This includes both the physical interfaces, for example to allow informal collectors/recyclers to deliver waste smoothly to the city’s contractor for secondary transport to the disposal site or to allow recyclers at the transfer station or disposal site to have time and space to pick over the waste without interfering with the safe operation of the site, and the national laws and strategies within which the informal sector can work.

(B) Interface with the materials and value chain. Informal recycling relies entirely on selling the materials it can recover for income, for example paper and plastics to local or international recycling markets; glass bottles to local drinks companies for cleaning and refilling; clean, source-separated food waste to local farmers as feed for animals; or composted organic wastes to the agricultural value chain. Value chain analysis is a technique designed to examine the *InteRactions* between the actors in the supply chain (Porter, 1998) as materials are processed and value added. It has been applied widely to the agricultural sector in developing countries (Royal Tropical Institute – KIT et al., 2006). This tool helps to identify different ways of empowering and strengthening the role of those groups at the ‘bottom’ of the value chain. Currently, applications to the IRS are gaining momentum (Bagadayeva, 2009; Hickman et al., 2009), including initiatives involving large consumer products companies integrating informal recyclers’ organisations into the value chain (Peinado-Vara, 2011). Value chain analysis is used here in categorising possible interventions (Table 3). The main *groups of interventions* are as follows.

- *Improving the quality of the source material* is another critical action at the centre of Figure 1, alongside *access to the waste* (from interface A). Promoting separation at source so as not to mix wet (organic) and dry wastes, and so avoiding contamination of both organic products and recycled materials, not only increases the quality and value of the products, but also addresses some of the basic ethical—actual

and perceived—concerns about the activities of the informal sector as being ‘dirty/unhygienic’. Another specific action here is negotiating contracts between (individual or groups of) recyclers and waste generators.

- *Adding value to the products sold.* Larger quantities of secondary raw materials generally attract a higher price. A first group of interventions increases the quantity available for sale, for example by equipping collectors with larger and/or wheeled containers, or making space available to store materials prior to sale. A second group focuses on *reprocessing* to add value to the product before selling it on. Even affordable and simple technologies like multiple stages of manual sorting or washing can double the price of a material. For example, the Zabbaleen in Cairo were supported by Oxfam and others in the 1980s to introduce technologies to manufacture both intermediate and final products (C.I.D. Consulting Group and GIZ, 2008).
- *Improving linkages along the value chain.* Improving communications can strengthen the whole value chain. Actions can include forums to promote dialogue and negotiating contracts.

(C) Social aspects and the interface with society. Many early efforts to ‘help’ the IRS have been criticised for focusing almost exclusively on ‘fixing the problems’ of child labour, unhygienic working conditions, etc. (e.g. Scheinberg, 2012), rather than seeing the issue in the broader context of poor people struggling to earn a sustainable livelihood. If a city is to build on existing recycling activities and integrate the informal sector as an integral part of its SWM system, then an essential category of interventions are those addressing the social aspects and the interface with wider society. Many of these interventions could equally be viewed as supporting functions for either interface A (Table 2) or B (Table 3). Table 4 distinguishes three primary *groups of interventions*, as follows.

- *Facilitating recognition and acceptance of the informal sector (by the wider society).* This includes legal recognition by government, essentially bringing what is described here as the ‘informal sector’, defined as such within the context of SWM, firmly within the formal economy. Key interventions include: facilitating registration; the IRS paying their taxes; providing informal sector recyclers and collectors with ‘respectability’, for example through the issuing of uniforms and identity cards and engaging the public in how they can effectively work together.
- *Work towards child education and gender equality and inclusivity.* Elimination of child labour (International Labour Office, 2004) requires both building people’s livelihoods so that a family can afford for their children not to work and making it possible for the children to attend schools. Gender equality is relevant owing to the prominent role of women in related activities, and in livelihood protection and enhancement (Alter Chen et al., 2004); it can be tackled, for example, by the provision of loans accessible to women, through their involvement in planning, in training and educational courses.

Table 3. Interface B, between the informal recycling sector (IRS) and the materials and value chain

B	Group of interventions	Intervention points	Specific actions	Explanations/examples
Materials and value chain interface	Improving quality of materials for recycling at their source	Improving quality of the source materials/ reducing cross-contamination	Source segregation	<ul style="list-style-type: none"> Separation of wet (organic) from dry wastes at the source vastly increases the potential quality and value of both organic products and recycled materials Variations can include itinerant waste buyers/doorstep collection, 'bring' containers, buy-back centres, etc. Used in 6 of the 10 case studies here: CS 1, 2, 6, 7, 8 and 9
			Contracts with waste generators	<ul style="list-style-type: none"> Individual 'contracts' for primary collection (e.g. Delhi) Collective contracts with gated estates (e.g. Linis Ganda, CS1) NGO-brokered individual contracts with companies (e.g. Bengaluru) Rights to the waste from a particular property
	Adding value to the secondary raw materials/products sold	Increasing quantity available for sale	Use of larger containers/bags by IRS collectors	<ul style="list-style-type: none"> Providing collectors of plastic bottles with larger more durable sacks
			Use of wheeled containers by IRS collectors	<ul style="list-style-type: none"> Hand trolleys, hand carts Tricycle carts Animal pulled carts Tractor and trailer, trucks Examples in CS3 and CS4
			Make storage space available	<ul style="list-style-type: none"> Storage spaces for individual recyclers Recycling centres/warehouses for organised IRS groups Examples include CS3, 8, 9 and 10
			Expanding the range of materials recycled	<ul style="list-style-type: none"> A key early action by Linis Ganda (CS1) in Manila was to work with small dealers and individual waste buyers to extend range of materials collected for recycling Also used in CS3 and CS8
		Reprocessing	Segregating collected materials into distinct categories	<ul style="list-style-type: none"> Plastics into type of product (bottles, film etc.) and type of plastic (PET, PVC, PE, etc.) Paper and card into different types/qualities Disassembling computers (CS3) Considered in all 10 case studies—key in 5: CS2, 3, 8, 9 and 10
			Washing/ removing contraries and contaminants	<ul style="list-style-type: none"> Washing plastic bags

Table 3. (Continued)

B	Group of interventions	Intervention points	Specific actions	Explanations/examples
			Densification (to decrease transport costs and increase density)	<ul style="list-style-type: none"> Baling, shredding, agglomerating, etc. (e.g. CS3)
			Processing to intermediate product	<ul style="list-style-type: none"> Melting, extruding, pelletizing a particular type of plastic (e.g. CS3)
			Manufacturing final products	<ul style="list-style-type: none"> Moulding, blowing, etc. (e.g. CS3) Making hand-crafted paper or textile products (e.g. CS3)
	Improving linkages along value chain	Improving linkages along value chain	Strengthening relation between IRS and recycling industries	<ul style="list-style-type: none"> Mechanisms for dialogue between the IRS and their customers (Luken, 2011) Direct links between large consumer products companies and IRS, as a form of 'producer responsibility', e.g. P&G in Cairo and the Philippines Constitute boards or forums with equitable representation of waste pickers, traders and government officials (Gunsilius et al., 2011)
			Contracts with specific middlemen/recycling industry	<ul style="list-style-type: none"> 'Contracts' between individual waste pickers and middle men (dealers) (e.g. Linis Ganda CS1)
			Bypassing middlemen	<ul style="list-style-type: none"> Waste pickers sell directly to industries
			Organising middlemen	<ul style="list-style-type: none"> Cooperatives of small dealers (e.g. Linis Ganda, CS1)

NGO, non-governmental organisation; PET, Polyethylene terephthalate; PVC, polyvinylchloride; PE, polyethylene.

- *Occupational H&S.* Manually separating waste is hazardous work. The risks can be alleviated, for example by providing and promoting the use of protective clothing; the availability of accessible health care; and ensuring that hazardous wastes are separated out from other wastes at source. However, prevention is better than cure, hence the emphasis that is placed, both in Figure 1 and in Table 3, on the separation of wet and dry wastes at source so that the work of the waste-picker becomes much less dirty in the first place. Special provisions should be in place for IRS activities related to the handling of waste electrical and electronic equipment (WEEE), where risks are considerably higher (Chi et al., 2011; Xu et al., 2012).

(0) *Organisation and empowerment.* All of the interfaces between the IRS and (A) the formal SWM sector, (B) the value chain and (C) society as a whole are underpinned by a set of

enabling interventions related to the organisation and empowerment of the informal sector itself (Table 5).

- *Organisation of IRS (into larger structured groupings).* Some sort of self-organisation is a crucial step to achieve recognition as working partners from the city and also to allow for collective bargaining with others in the value chain from a position of strength; indeed, many have argued that this is an essential first step in any intervention programme (e.g. Gunsilius et al., 2011). The type of organisations used varies widely depending on local culture and circumstances (Medina, 2000). Discussion at the IRS Integration Workshop suggested that integration initiatives in Asia tend to focus on entrepreneurship, such as micro-small enterprises (MSEs), while in Central and South America they tend towards cooperatives or similar associations, and community-based organisations (CBOs). The

Table 4. Interface C, between the informal recycling sector (IRS) and society as a whole

C	Group of interventions	Intervention points	Specific actions	Explanations/examples	
Social aspects and interfaces with society	Facilitating recognition and acceptance of the IS	Promoting legal recognition	Issuing of birth certificates and other legal documents	<ul style="list-style-type: none"> Bringing the 'informal sector' (IS), defined as such within the context of SWM, firmly within the formal economy and paying their taxes 	
			Rights and duties: right to vote, land property rights, duty to pay taxes, etc. 'Light' regulations	<ul style="list-style-type: none"> Find a way to provide contributory social security, health care and pension provision (Gunsilius et al., 2011) Tax exemptions, facilitate creation of MSEs For example, Guardines del Riachuelo (CS4) For example, creating a simplified registration and/or legalisation process, in which an association of informal recyclers can provide umbrella registration for its members without them having to register individually (e.g. TransWaste project for Hungarians collecting reusables in Austria) (Scheinberg, 2012) 	
			Recognising waste-picking as a profession	<ul style="list-style-type: none"> Occupational recognition at the national level in the national register of occupations or professions) National policy in Brazil since 2002 (CS2) 	
	Work towards children, education, and gender equality and inclusivity	Facilitating child education	Engaging the public in the intervention	Issuing of identity cards	<ul style="list-style-type: none"> Used by Linus Ganda to gain access for 'eco-aides' (itinerant waste buyers) to high-income gated estates (CS1)
				Provision of uniforms Through awareness raising campaigns	<ul style="list-style-type: none"> Also used in Phitsanulok (CS7) Leaflets Environmental education courses
				Through involvement in planning the intervention Through promoting source separation	<ul style="list-style-type: none"> All three approaches to public engagement used in CS 6, 7 and 8 For example, separating clean materials, such as newspapers or bottles, for sale to itinerant waste buyers
Work towards children, education, and gender equality and inclusivity	Facilitating child education	Engaging the public in the intervention	Work to eliminate child labour	<ul style="list-style-type: none"> International Labour Organisation (ILO) has a specific focus on eliminating child labour in waste-picking 	
			Incentives to attend school	<ul style="list-style-type: none"> In Cairo (CS3), children are paid by the manufacturers to collect and recycle shampoo bottles (to prevent their filling and resale)—participation requires attendance at the Recycling School (NGO 'Spirit of Youth' initiative) 	
			Providing schools for waste pickers' children		

(Continued)

Table 4. (Continued)

C	Group of interventions	Intervention points	Specific actions	Explanations/examples
		Promoting gender equality/inclusivity	Involve women in planning and delivering specific interventions aimed at women	<ul style="list-style-type: none"> In Cairo (CS3), separate projects involve girls in making paper and textile projects (Association for Protection of the Environment), and in dismantling computers—the income pays for their education
			Loans accessible to women	<ul style="list-style-type: none"> Without specific intervention, credit is often less accessible to women
	Occupational health and safety	Ensuring health and safety standards at work	Safety equipment	<ul style="list-style-type: none"> Gloves, uniforms: (usable and replaceable), etc.
			Access to health care	<ul style="list-style-type: none"> As in Guardianes del Riachuelo (CS4)
			Ensure hazardous waste sorted separately	<ul style="list-style-type: none"> Ensure only adequately trained and equipped recyclers have access to hazardous waste, which should be separately sorted at source

IS, informal sector; SWM, solid waste management; MSEs, micro–small enterprises; NGO, non-governmental organisation.

Table 5. Category 0 - Enabling actions - Organisation and empowerment of the informal recycling sector (IRS) - which underpin all the (A)–(C) interfaces

0	Group of interventions	Intervention points	Specific actions	Explanations/examples
Enabling actions - organisation & empowerment	Organisation of informal sector	Organisation of waste-pickers	Encourage organisation into groups, e.g. cooperatives, associations, CBOs, MSEs	<ul style="list-style-type: none"> Collective groups have more bargaining power than individuals Municipalities more likely to recognise and negotiate with a group than with individuals Form of organisation varies widely—culturally dependent Successful organisation depends on self-confidence and trust between informal sector workers An important part of 5 of the 10 case studies here—CS1, 2, 4, 5 and 6
		NGO participation	NGO participation—helping the IRS to organise and help themselves	<ul style="list-style-type: none"> As facilitators or initiators of the process. Can assist the IRS to communicate with the city, the recycling industry and other stakeholder groups. Often bring good political connections Examples in CS1, CS2, CS3 and CS4
		Promote networks on national level	Organising national forums and meetings	<ul style="list-style-type: none"> Several groups [e.g. WIEGO (Fernandez, 2011)] now also promoting international organisation among pickers

Table 5. (Continued)

0	Group of interventions	Intervention points	Specific actions	Explanations/examples
			Creating a national network of waste pickers	<ul style="list-style-type: none"> As in Brazil (CS2)
	Financial viability	Financial sustainability	<p>Access to capital for the IRS</p> <p>Reduce vulnerability to market shifts on prices of materials</p> <p>Dependent on market revenues rather than governmental/NGOs/project-related subsidies</p>	<ul style="list-style-type: none"> Micro-credit, accessible loans Working capital for itinerant waste buyers to purchase source-separated materials Providing third-party guarantees for loans CS6 (Londrina) failed due to financial problems and a drop in the market price Fixed-price deals Negotiate contracts with city authorities on the basis of services provided Broaden materials recycled and activities performed Strengthen value chain
	Capacity building	Capacity-building and development	<p>Training courses</p> <p>Literacy courses</p> <p>Involvement in intervention steering committee</p> <p>Understanding buyer's requirements (secondary raw material specifications to be met)</p>	<ul style="list-style-type: none"> General professional development: numeracy, literacy, ability to read maps, to comply with laws, registering a business in the right place on a zoning map, etc. Improve managerial skills: business and financial management, market awareness, marketing, environmental and H&S standards, etc. Improve technical skills: waste management in general; sorting effectiveness and efficiency (e.g. materials recognition); understanding of environmental considerations, etc.
		Data collection and documentation	Record keeping of workforce, tonnes collected, costs and earnings	<ul style="list-style-type: none"> Basic business and accountancy skills are key—identified as a cause of failure shared in common in several case studies

NGO, non-governmental organisation; CBOs, community-based organisations; MSEs, micro-small enterprises; WIEGO, Women in Informal Employment Globalizing and Organizing; H&S, health and safety.

support of NGOs has been found to be important in dealing as a neutral broker between the different actors/stakeholders and in supplementing the governmental resources (e.g. Tukahirwa et al., 2010). National, and even international, networks and forums, such as Women in Informal

Employment Globalizing and Organizing (WIEGO), Informal Waste Management Thinking Group, Red Lacre, and informalwastesector.net, are beginning to emerge (Fernandez, 2011; Peinado-Vara, 2011), which are important in giving the IRS a collective and unified voice.

- *Financial viability.* Most informal sector recycling depends for its income entirely on selling into the secondary materials market, in which prices are often volatile. Hence, one group of actions focuses on reducing vulnerability to market fluctuations. Any move to add value and to improve their relative position in the value chain is likely to require both working and investment capital. For example, every itinerant waste buyer purchasing newspapers from householders needs the cash flow to buy his/her materials before selling them on at a profit; therefore micro-credit facilities to allow easy access to capital, and the provision of third-party guarantees for such loans, are important interventions. At the same time, it is relevant to the IRS and to the long-term viability of the intervention to ensure it is not dependent on external subsidies, unless this is a contractual payment from the government for the service provided, as was the case of Diadema, Brazil (Diaz and Alves, 2008). Currently, substantial international actor efforts are emerging in support of the entrepreneurial side of the informal recycling (Peinado-Vara, 2011).
- *Capacity building.* Many of the other interventions, across all of the interfaces, involve the informal sector in operating as a business. Hence, a key group of interventions is to build capacity in the sector across a whole range of entrepreneurial and business management skills, perhaps also underpinned by basic personal development at adult education level. At the IRS Integration Workshop it was stressed repeatedly that many integration attempts fail owing to the difficulties related to the practical management of the informal sector's organisation, for example book-keeping, data collection and financial management.

InteRa: a rapid evaluation and visualisation tool

A novel visual representation of the *intervention typology* for IRS integration is introduced through a radar diagram (*InteRa*). The *InteRa* is a concise and implementable methodological tool to evaluate broadly the relative focus (*importance*) of each integration/formalisation intervention case study, with reference to the four different *categories* [*interfaces* (A)–(C) and enabling aspects (O)] that are important to be considered and a clear way to display visually and communicate such findings.

To apply the tool, use is made of the listings of possible interventions for each of the four categories (Table 2–5). Scores are allocated against each of the *specific actions*, according to the level of attention it has received within this particular intervention case. There are three possible assessment outcomes, depending on whether the *specific action* was treated as a key action (*K*), or considered to a medium degree (*C*) or was ignored (*I*) in the implementation of the intervention scheme. Each assessment outcome is translated into numeric values: $K = 1$, $C = 0.5$ and $I = 0$. If no information is available, a zero score is allocated, as if the *specific action* was ignored.

As a next step, an average score is obtained for each *intervention point* (column 3, Table 2–5), calculated as the arithmetic

mean of the values for the *specific actions* relating to this particular *intervention point*. Finally, averaging of the scores of the component *intervention points* within each specific *category* gives the overall score for this *category*. As a result, each *category* is marked with a score from 0.0 to 1.0, which indicates the *importance* of the *category*.

The four average *importance* values obtained, each for one of the (A)–(C) and (O) *intervention categories*, are plotted on a four-side radar diagram on a scale from 0.0 to 1.0. Radar diagrams are an established approach to integrating results of multiple sustainability indicators. This representation allows for a simple display of the focus (or 'main aim') and thoroughness of an integration/formalisation initiative. A well-balanced integration intervention that considers all three *interfaces* (A)–(C) and the enabling/underpinning organisation and empowerment *category* (O), would result in a balanced rombe, with all sides equally distant from the centre; a thorough intervention would result in a rombe with sides well away from the centre and vice versa. A worked example providing step-by-step guidance on applying *InteRa* is provided in Appendix A.

The metrics of *InteRa* has implications for the potential outcome and its interpretation. There are two discrete situations in which *InteRa* can be applied: (1) *a priori* application—the tool applied when a new intervention is planned/designed to provide confidence that a comprehensive and well-balanced approach is followed, and this is the key use intended; and (2) *a posteriori* application—the tool applied to an existing intervention, to evaluate the current baseline situation and identify opportunities for improvement. In the latter application, information may not be available on a particular *specific action*, especially if the case is evaluated solely from usually incomplete literature data or by practitioners not directly involved in the integration intervention and with limited access to the documentation. In this case, because a zero (0) score is allocated for absence of information, generally lower overall values will result in comparison to application during planning where it can be assumed that all information is available. The zero scoring in the absence of data may under-score some interfaces, but equally avoids the pitfall of subjective marking or speculation leading to over-scoring. It may also help to motivate programme managers to publicise the information and those doing the scoring to seek out all relevant information.

Technically, the *InteRa* tool introduces four new sustainability-type indicators [*categories* (A)–(O)]. These types of indicators were chosen to be developed here because they have been found to be generally suitable for communication at the decision- and policy-maker level (Bell and Morse, 2008; Dahl, 2012), and have been applied extensively to environmental problems (e.g. Dewulf and Van Langenhove, 2000). Regarding data intensiveness, 61 attributes are required in total (interface A: 17; B: 15; C: 17; category O: 12); all data inputs are qualitative and could be readily available. Only three scoring levels were selected for a particular *specific action*, because it may be inefficient and difficult to obtain conclusive evidence on finer levels of detail about the *specific actions* of an intervention.

Application in 10 integration/inclusion/formalisation case studies

A total of 10 case studies of interventions aiming at integrating informal sector recycling activities were examined to test the new framework/tool and demonstrate how it could be applied in the future. The case studies are summarised in Table 6 and further details are available elsewhere (Rocca, 2011). Figure 2 shows the radar diagrams of the case studies considered. Notably, the use of the case studies is illustrative. Because the sample is very small and not fully representative (most of the cases are from Asia and Latin America, and none from sub-Saharan Africa; other cases with greater focus on interface B may be available, etc.), results should be taken only as indicative, and not used for drawing general conclusions about the IRS or the likely efficacy of past interventions.

The *InteRa* results (Figure 3) show that within the sample of cases examined there is wide variability regarding the focus of each integration initiative; that integration efforts are usually not well balanced between the four interfaces; and that the average level of importance per intervention point is often in the range 0.2–0.4 for all four categories (A)–(O). No statistical outliers were noted. All categories are normally distributed, apart from SWM (A) for which the Shapiro-Wilk test indicates a non-normal distribution ($P = 0.025$), showing two peaks: one low around 0.22 and one high around 0.45. The median importance of the all three interfaces (A)–(C) is very close, all in the range of 0.24 to 0.26; and two-sided *t*-test at 95% level of confidence reveals no statistical differences between each pair of A, B and C. Only category O has a median at a discretely higher level (0.38). Regarding variability, measured by interquartile range (IQR), all categories are at similar absolute levels (range: 0.15–0.22).

Discussion

Analytical framework/typology of interventions

A framework—or typology—has been developed for classifying and analysing possible interventions to promote the integration of informal sector recycling within a city's SWM system. This represents a crystallization and culmination of collective experience around the world over the last 30 years. Here, we attempt to consider all the different approaches applied to integration/formalization/inclusion of the IRS in systematic way, and clarify and combine its various aspects into a comprehensive, composite, and yet succinct, tool (*InteRa*) with direct practical utility.

The typology assigns each possible intervention action to one of four categories (A)–(O). It is self-evident that any move to integrate the informal sector with a city's formal SWM system inevitably needs to address the interface between the two (A). Similarly, the IRS relies on income, either entirely or mainly, from selling the collected and reprocessed secondary raw materials/products into the materials value chain, so that is the second interface (B). A major constraint to integration/inclusion is the perceived image

of the informal sector, which can be very negative—unhygienic, polluting, untaxed, relying on collusion with corrupt officials for its existence—thus, the third interface is with society as a whole (C). In order to improve its own position and to negotiate across these interfaces, some sort of self-organisation by the informal sector is necessary; hence, the fourth category of enabling interventions, focusing on organisation and empowerment (O), underpins the three interfaces, and it could be considered partly as a pre-condition of any successful intervention.

When the typology is outlined in this way it could be expected that, in order to be successful, any project initiative aimed at promoting the integration of the informal sector in a city's SWM system should combine a selection of individual interventions, chosen both to give a balanced set, with components selected from each of the four 'categories', and tailored to be appropriate to the local needs and circumstances.

Notably, two key points of intervention sit right in the middle of Figure 1, where the three interfaces (A)–(C) intersect. These are access to the waste (categorized here under interface A) and improving quality of materials for recycling by separation at source (under B). Source separation of wastes emerged at the IRS Integration Workshop as the one single intervention most likely to improve quality of products and, thus, revenues. These issues also go to the heart of the 'old' way in which the informal sector was often been perceived—'stealing materials' from the city waste (linked to access and ownership issues) and being in some way 'dirty'. If the citizens of a city discard their wastes mixed together, then any manual separation for recycling will, inevitably, be 'dirty'. If the citizens separate their wastes into wet and dry components, then the work of the IRS will immediately become much 'cleaner'. Other important actions that appear at intersections of categories are financial sustainability and access to finance, and health and safety of both the public and the informal sector workers.

The fact that two such critical points of intervention could be assigned to any one of the three main interfaces emphasises the slightly arbitrary nature of the allocation and indicates that it is important not to be overly concerned as to just which category a particular point of intervention should belong to, as long as they are considered as key points to intervene and counted in one of the categories. Indeed, it could be considered as a fundamental strength of the framework that such cross-cutting and significant interventions are highlighted in the central, cross-section area of Figure 1. Another example is the group of interventions on financial sustainability, categorised under the underpinning (O), but potentially also related to interfaces (B) and (A)—enabling access to capital is clearly another key intervention. Potentially, if needed, the tool could be modified by adopting alternative approaches to the metric, for instance by adding emphasis via increased weighting of the scores allocated to such intervention points that are central to integration efforts.

The two issues of access and separation at source also link directly to the transition from waste management as a liability (prevention of loss of amenity, protection of public

Table 6. Case studies of informal sector integration used to demonstrate the *InteRa* visualisation tool

Case No. (Name, City, Country)	Description	Case study author or published references
CS1 (Linis Ganda, Metro Manila, The Philippines)	Linis Ganda was founded as a NGO in 1983 with the aim of strengthening the existing system for collection and recycling of source-separated household wastes. Helped junk-shop owners to form cooperatives and work with itinerant waste buyers ('eco-aides'), negotiated access with private housing estates. Eco-aides provided with T-shirt uniform, push carts, identity (ID) cards—collect recyclables on fixed itineraries and at set times. Junkshop owner-members helped to access loans and encouraged to buy a wider range of recyclable materials. Good links with authorities—national strategy for informal sector in place. In 2011, 575 junkshop-owner members and 2000 eco-aides, covering 17 cities within Metro Manila. Recycled 6% of total city municipal solid waste in 1997 and 24% in 2009.	Medina (1993) Lapid et al. (1999) Medina (2000) Wilson et al. (2009) National Solid Waste Management Commission (2009) Cardenas (2009) Linis Ganda Foundation (personal communication)
CS2 (Belo, Horizonte, Brazil)	City of 2.5 million. Waste-pickers active since 1930s. NGO helped found waste-pickers association, ASMARE, in 1990. City partnered with ASMARE in 1993 to source-separate materials for recycling. In 2008 the system comprised 156 city collection (drop-off) sites; a door-to-door service serving 80,000 citizens; and two recycling centres being used by ASMARE and recycling 450 tonnes per day in 2008. Public participation, and thus recycling rates relatively low.	Dias and Alves (2008) Dias (2009)
CS3 (Cairo, Egypt)	The Zaballeen community have been collecting waste from richer districts of Cairo and recycling since 1930s. A series of NGO-led and internationally-funded projects have worked with them since the 1980s. Parallel focus on improving livelihoods by introducing technologies to add value and on education/social initiatives. Recent problems of access to the waste since city contracted out SWM to international contractors.	Velis (2004) Medina (2007) C.I.D. Consulting Group and GIZ (2008) Gerdes and Gunsilius (2010)
CS4 (Guardianes del Riachuelo, Buenos Aires, Argentina)	Guardianes del Riachuelo is a pilot program designed by, and for, the community of a Buenos Aires riverside slum housing 40,000 immigrants: Villa 21–24 in Barracas. A team from 16 neighborhoods, later the <i>Guardianes</i> , designed a door-to-door primary collection service, 5 days per week, linking to secondary collection provided by the municipal SWM enterprise Urbasur. Guardianes paid by the city, no fee charged to residents. Recycling revenues fund community projects.	Case study information provided by Andrea Ferrarazzo, Fundación Ciudad
CS5 (Payatas Sanitary Landfill, Quezon City, The Philippines)	Payatas was a large open dump until a major landslip in 2000 killed 200 waste-pickers. Upgraded in 2004 to a controlled landfill and later to a sanitary landfill, receiving 1200 tonnes per day. Two thousand waste-pickers organised into 8 associations, each operating a Materials Recovery Facility (MRF) on the site. Vehicles deliver waste to MRFs for sorting prior to residue being landfilled. The private landfill operator established a Payatas Poverty Alleviation Foundation in May 2011 to further help the waste-pickers improve their living conditions and develop alternative sources of livelihood in preparation for the final closure of the facility (due 2014).	Case study information provided by Lizette Cardenas, SWAPP SWAPP (2006)

Table 6. (Continued)

Case No. (Name, City, Country)	Description	Case study author or published references
CS6 (Curbside collection programme, Londrina, Brazil)	City of 500,000. In June 2001, CMTU—municipal SWM enterprise—redeployed landfill scavengers to form associations and run curbside-separated recyclable collection system. CMTU transported recyclables from local accumulation points to the sorting unit of each association. By 2005 (phase 1), 29 associations and 500 pickers covered 100% of the city with a 70% public participation rate. By 2009 (phase 2), various problems combined into a crisis: CMTU diverted resources elsewhere; weaknesses in organisation of the associations; earnings were low and employment conditions poor; global market prices crashed. Currently (phase 3), the city is trying to recover the status of phase 1. Project restructured in 2009, CMTU contracted cooperatives to provide the recycling service. Today, Coopersil is the only cooperative hired by CMTU.	Case study information provided by Penido Monteiro and Graziela Figueiredo, Cia. Municipal de Limpeza Urbana do Rio De Janeiro (CONLURB)
CS7 (Participatory waste management, Phitsanulok, Thailand)	City of 90,000 in northern Thailand. Waste quantities increased threefold in four years to 1996, leading to a crisis as the disposal sites filled up. City focused on diverting waste to recycling, working with the existing informal sector to build up source segregation for recycling and composting. Residents encouraged to sell or donate materials to itinerant buyers or waste banks. Waste-pickers and itinerant buyers trained and upgraded to 'volunteer for environment', provided with uniforms and ID cards. Municipality collects only non-recyclable waste—quantities reduced by 40% in first 3 years. Stable thereafter—able to charge higher fee to residents as they earn extra income from selling the recyclables.	Sang-Arun et al. (2011) Sang-Arun and Bengtsson (2011)
CS8 (U.R.R.A! (Unidad de reciclado de Rauch) (Recycling unit of Rauch,) Rauch, Argentina)	City of 15,000 in southeast of Buenos Aires province—relies on farming. Open dumping led to disease among pigs in 1984—prompted action. New system introduced source-separation into: organic/wet, dry recyclables, hazardous/pathogenic. Organic fraction (60%) sent to composting. Dry recyclables sorted at URRRA by 35 trained recyclers into 27 products for sale—residues sent to sanitary landfill. URRRA operating successfully since 1998—revenues from sale of recyclables managed by NGO/cooperative—re-invested in the recycling centre and in the community.	Case study information provided by Leticia París (Municipal Director of Environment, responsible for U.R.R.A.)
CS9 (PIRUSA – Programa Integral de Residuos Sólidos Urbanos Saladillo Saladillo, Argentina)	City of 30,000 in centre of Buenos Aires province. City collects and disposes of waste in open dump. Recently introduced pilot project for source separation of wet and dry fractions; recruited waste-pickers as city workers at the composting plant and materials recycling facility. Workers paid a wage and profit from sale of recyclables. Plans to extend scheme to whole city.	Case study information provided by Mariela Incollá
CS10^a (General, Pico, Argentina)	Fast-growing city of 60,000 in La Pampa province. City concerned with pollution from dumpsite and issue of waste picking. City helped form a cooperative of waste-pickers, funded development of a materials recycling and composting facility run by the cooperative. Pilot source separation project covers 3000 households, plan to extend that to all 25,000.	Case study information provided by Municipality of General Pico

^aLevel of detail provided was low, which has decreased the scores recorded in the *InteRa*.
NGO, non-governmental organisation; SWM, solid waste management.

health, preservation of local and global environment, such as contributing to global warming potential), relating to *interface A*, to a largely resource-driven management of resource-rich potential secondary raw materials, relating to *interface B*. Key considerations relate to the legal ownership of waste at the point it arises and the responsibility of handling it appropriately and safely. Legislation can, and should, clarify ownership status, offering solutions on the novel definitions of waste as resource-rich materials (Pongrácz, 2002), as has been explored recently for construction waste in the UK (Zakar and Clift, 2010). For situations that involve the integration/inclusion of informal sector recyclers, solutions should be sought to distribute the risks equitably between stakeholders (people as municipal solid waste generators and public health beneficiaries; local authority responsibility for public health—private SWM industry liability while providing services meeting contractual obligations with a local authority) and sharing benefits (with an equitable distribution of the financial benefits of recycling between the informal recyclers, the formal service providers, downstream industries using the secondary raw materials generated and the general public through the local authority).

Recent developments (Luken, 2011) suggest that the ability of the IRS to collect waste and reprocess it to a suitable secondary raw material status has attracted the attention of the final industrial users of these materials, and direct communication pathways are currently being built between them. Given that the IRS represents a very small cog in a long supply chain, often dominated by much larger and financially-stronger players, it could be argued that there is a need to re-structure the supply chain towards more equitable distribution of gains, so as to provide sustainable livelihoods for the waste-pickers. For example, systems similar to those which aim to improve the livelihoods of poor farmers in developing countries, who sell their agricultural produce into what is now an international commodity market, could be further explored.

Traditional development approaches to integration of the informal sector at one time tended to focus on 'helping' waste-pickers on the grounds that they lack financial and social assets, and 'alleviating their poverty' because they are often chronically poor—this being relevant to achieving the United Nations Millennium Development Goals. However, these approaches—focusing primarily on *interface C*—were criticised for objectifying the informal sector because the IRS were not necessarily asked what they want and were not always recognised as a legitimate and important stakeholder group (Scheinberg, 2012; Scheinberg et al., 2006). The typology developed here reflects an emerging consensus that what is required is a broader systems approach, which analyses the informal sector as undertaking a range of economic activities within both the overall waste management system (*interface A*), to which they make a very substantial financial contribution in terms of avoided direct costs; and the materials value chain (*interface B*), where their activity is the basis of all subsequent added value. Modernisation solutions are sought which develop and strengthen the IRS economic and

operational niches, while not compromising necessary standards of waste and resources management.

Applying the rapid evaluation and visualisation tool, InteRa

The set of case studies (CS1–10, Table 6) covers examples from three distinct continents and includes extremely different types of interventions. For example, CS5, considering the intervention performed by the government in order to close the Payatas Landfill, is sensibly dissimilar to CS3 where the Zabbaleen work in MSEs and have considerable expertise in reprocessing materials and manufacturing products, or to CS2 from Belo Horizonte which constitutes a more socially-based initiative in collaboration with the municipality. However, the general limitations noted in the *Results* section apply, for example all of C8–C10 cover similar interventions in small Argentinean cities, which may be atypical of IRS integration efforts elsewhere.

While local solutions may require focus to be placed in one direction more than others, it could be argued that paying balanced attention to all four *categories* could enhance the possibilities for a successful intervention. Only one of the intervention cases (CS1: Linis Ganda) has a distinctively 'better' profile than the others considering both balance [(A)–(O) at a similar level] and comprehensiveness [each of (A)–(O) comparatively high at 0.4–0.5]. In most cases, initiatives are clearly focused towards one or, at best, two interfaces. For example, in Belo Horizonte (CS2) emphasis was placed on organisational aspects (O), while in Cairo (CS3) it was primarily on materials and the value chain (B). Balanced cases (similar importance level from A to O), such as the Linis Ganda (CS1), are unusual within the dataset considered.

The normality of the distributions of only 10 cases and the variability of the results indicates that the *InteRa* seems capable of capturing the focus of integration interventions; the indication of lack of normality for the SWM interface (A) should be further explored with a higher number of cases.

In a hypothetical, ideally comprehensive integration intervention, all the *specific actions* marked in *InteRa* could have been considered and acted upon. However, given that the selection of an appropriate set of actions must be based on the local circumstances and that an *importance* of 1 would indicate that all the potential actions had been 'key', an overall score much lower than 1 can be anticipated. The fact that *InteRa* is demonstrated here not with planned interventions but with existing cases for which data is missing, and hence penalised with zero score allocations (e.g. typical case CS10), makes the resulting *importance* scores seem reasonable. Specifically, the existing case studies set (CS1–10, Table 6) results suggest that an *importance* of 0.2 for a particular *interface* is a readily implementable level of attention and that an *importance* of 0.3–0.5 could denote that considerable attention is paid to the interface for existing cases—similarly, for importance of 0.4–0.6 for planned interventions, where all information is by default available, all zeros arise from absence of planning a certain *specific action*. However, more cases will

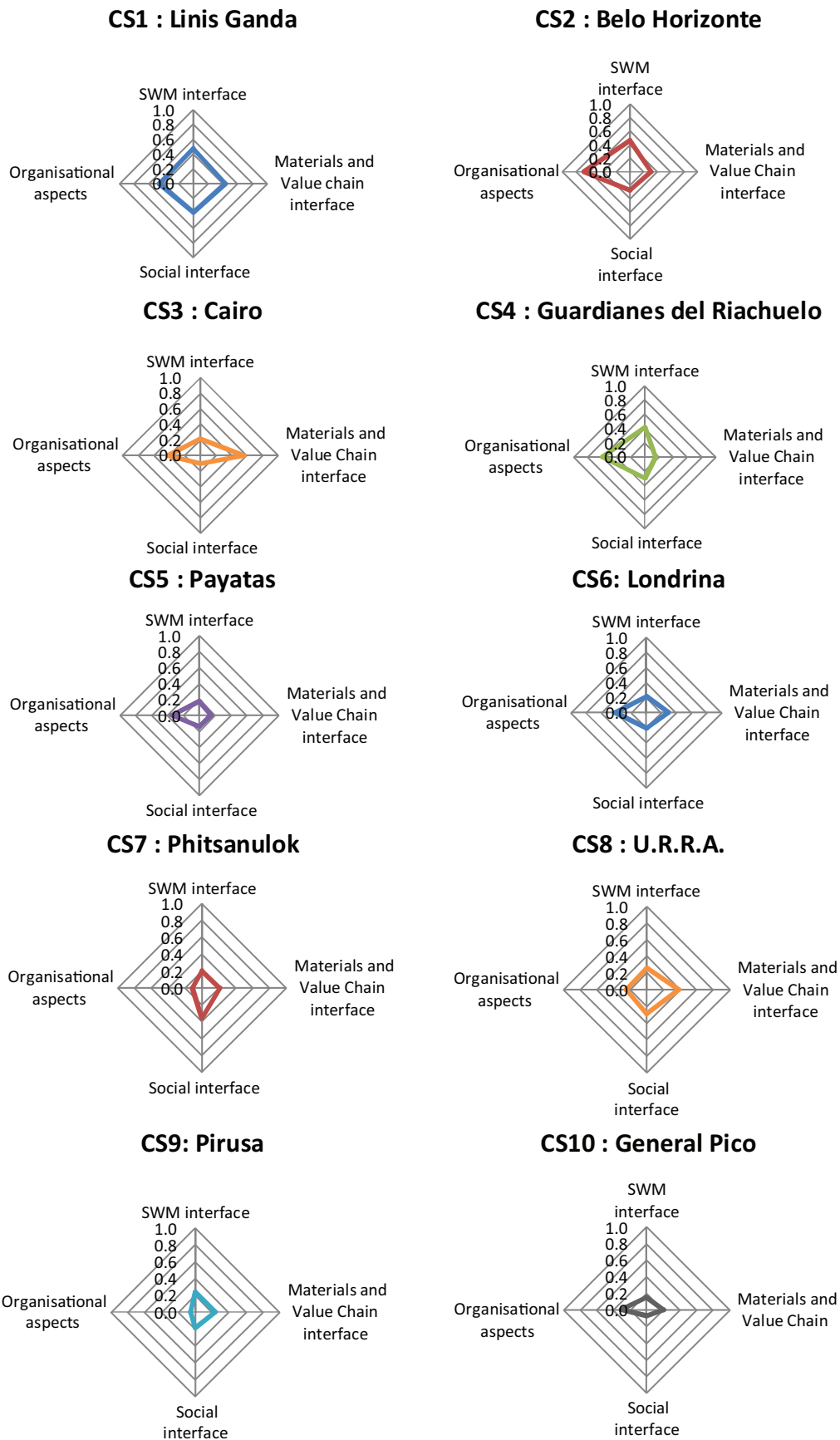


Figure 2. Application on 10 cases studies around the world (Table 6) of the *InteRa* rapid evaluation metric and visualisation tool (radar diagram) for assessing and illustrating the focus and comprehensiveness of planned or existing interventions to integrate informal sector recycling into a city’s waste and resources management system. The three interfaces (A)–(C) and the enabling/underpinning category (O) are detailed in Tables 2–5.

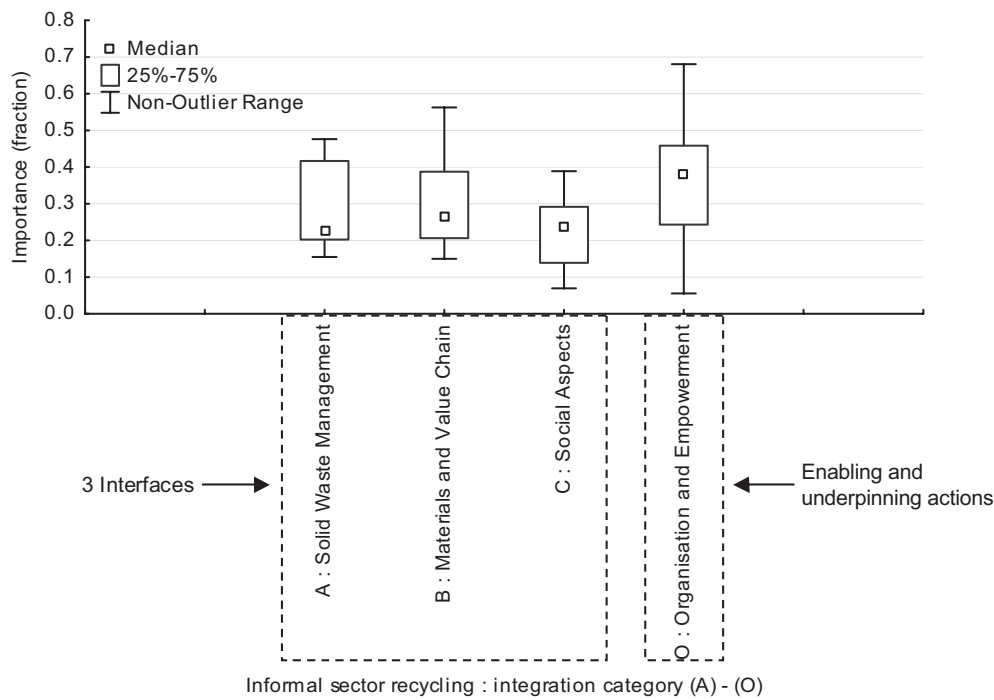


Figure 3. Comparative statistics for the 4 integration categories (A)–(O) of 10 cases studies. Box-plots of non-parametric statistics are shown. Interquartile range (IQR) shown as the 25–75% box.

provide a better understanding of what are the practically achievable levels for each category.

These preliminary results suggest that there is wide scope for improvement when planning and implementing interventions aimed at the integration of the IRS into SWM. Improvements are feasible toward designing more balanced initiatives, where applicable—namely, placing similar emphasis on all 4 categories (A)–(O). While it could be assumed that balanced interventions could be more viable overall, arguably interventions of specific focus could also be beneficial in certain local circumstances. The consistently relatively low importance of SWM (A) in the sample set of case studies is in line with the impression prevailing amongst SWM practitioners that, in many cases, this critical element has not been successfully addressed so far and remains a source of unresolved tension between key stakeholders. Systematic efforts are needed in this direction.

The indicator for the enabling O category is defined in a slightly less robust way than the (A)–(C), because it has fewer intervention points [12 vs 15–17 for (A)–(C)] and some of these contain only one specific action, i.e. there is no averaging, which makes category O more sensitive to data accuracy. Despite that, O shows the most normally distributed results in comparison with the three interfaces, suggesting a good function as an indicator. The high variability of the O category results from the relatively high scores being non consistent across all the case studies, but it still indicates that such enabling actions relating to organisation and empowerment receive considerable attention. This seems to provide evidential support that category O serves as a pre-condition for implementing interventions; hence, it receives considerable attention most of the time.

A general trend appearing to emerge from examining the individual intervention points is that attention of reported integration interventions concentrates on high and general level challenges, such as the ‘Socio-political context towards informal sector’, ‘Access to funding’, ‘Organisation of waste pickers’ and ‘NGO participation’; but the down-to-earth practicalities or hard-to-address topics, such as ‘Protecting public health & environment’, ‘Improving formal/informal interface’, ‘Data collection and documentation’, ‘Facilitating child education’, ‘Ensuring occupational health and safety standards’, and ‘Promoting gender equality/inclusivity’ remain far more difficult to address or are not selected to be communicated when information is put in the public domain. While the high level integration aspects are significant enabling systemic factors, the major challenges lie in identifying and implementing workable solutions for the more practical aspects.

The *InteRa* methodology/radar diagram visualisation tool allows a quick overview of the focus of IRS integration interventions and enables comparisons between different cases. However, the tool does not claim to be able to measure the sustainability or to predict the long-term viability of a planned intervention. For example, the case of Londrina (CS6), appears to have considered all the different categories (although it does score relatively low in all them) and to be a relatively ‘balanced’ intervention, while it is known that the initiative declined after a drop in the prices of the recyclables and other institutional and SWM problems encountered. Notwithstanding this caution, the *InteRa* methodology forms an advanced starting point to build comprehensive and balanced interventions from, and it considers all key aspects of triple bottom line approach to sustainable development (environmental,

social, financial capitals), encouraging a balanced approach between the different framework aspects. This could be further amplified by additional research, focusing on collecting tangible and possible quantitative evidence, identifying a few critical measurable factors that could indicate good chances of designing a resilient and sustainable intervention.

Key reflections

This work has used a systems approach to develop a framework and a visualisation tool to be used when designing a set of interventions to promote integration/inclusion of the IRS within in a particular city's solid waste and resources management system. The framework proposed is based on a typology for classifying and analysing the possible interventions, and represents a formalisation and culmination of collective experience around the world over the last 30 years.

The framework suggests that when designing an intervention, consideration should be given to implications on three key interfaces. While there are no easy or off-the-shelf answers on how to approach integration interventions, any win-win solution needs to understand and act upon opportunities and challenges relating all three *interfaces*, i.e. the contribution informal recyclers make to the SWM system- (*interface A*) and the recycling/materials chain (*interface B*), along with the social situation (*interface C*), collecting and building upon baseline data. It can be argued that a necessary pre-condition to enable change is organisation and empowerment of the informal recyclers—the city and other stakeholders need reliable partner organisations to work with, and organisation brings bargaining power and enables individual 'producers' to get a better deal in the value chain. Hence, any intervention should also be addressing this underpinning and enabling this fourth category (O). The *InteRa* radar diagram is a comprehensive tool to guide the planning of such an intervention process and rapidly catch its focus, providing both a structured approach and a rapid visualisation aid.

A key suggestion is that a balanced intervention needs to bring together specific actions chosen from across all these four *categories*. The selection of interventions will depend on the local needs and circumstances. Vital interventions are likely to include those at the overlap between the interfaces, including both access to the waste and separation at source; financial sustainability and access to finance; and H&S of both the public and the informal sector workers.

Application of the framework and *InteRa* tool to a wider set of case studies on IRS integration interventions is necessary to test and further validate its functionality, and prove its practical utility in designing balanced and comprehensive interventions. The testing here has, necessarily, had to focus on a *posteriori* application to previous interventions, while the main application proposed is for the *a priori* design of new interventions. Such a wider application could also provide greater insights about the current level of attention placed on the different aspects of integration interventions around the world.

Author's note

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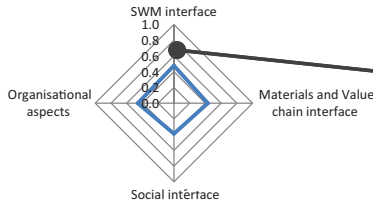
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Appendix A

A step-by-step guide is provided here, explaining the sequence of actions needed to calculate the *importance* (0.0–1.0) of each intervention *category*, which can then be visualised by plotting in an *InteRa* radar diagram.



Step 1: Consider integration 'interface' A

Step 2: Gather and evaluate information for each 'specific action'

Step 8: Plot the 4 'importance' scores on the InteRa radar diagram to get the focus of the intervention

Step 7: Repeat process for 'interfaces' B and C and underpinning 'category' O

Step 6: Average (arithmetic mean) over 'intervention points' to get the overall score for 'category' A ('importance')

Step 5: Average (arithmetic mean) to get the score for each 'intervention point'

Step 4: Translate into numeric values: key (K) = 1; considered (C) = 0.5; ignored (I) = 0; no information (n.a.) = 0

Overall score for interface	Intervention points	Average score per intervention point	Resulting marking per specific action		Level of consideration / I in the intervention	Specific action
			0	1		
0.44	Access to waste	0.33	0	1	n.a.	Legal recognition of the right of pickers to collect waste, sell the materials separated and keep the income
			0	n.a.	k	Waste pickers to have controlled access to waste at collection points
	Role in formal solid waste management system	1.00	1	1	K	Waste pickers to have controlled access to waste at transfer stations, disposal sites or other waste facilities
			1	1	K	Inclusion into/ integration with formal SWM sector collection
			1	1	K	Inclusion into/ integration with formal SWM sector transport
	Socio-political context towards informal sector	0.75	0.5	1	C	Official role in providing recycling within formal SWM system
			1	1	K	Institutional policies regarding IS (so that they become formal)
	Promote inclusion	0.50	0.5	0.5	C	Document by IRS within the formal sector
	Protecting public health & environment	0.00	0	0	n.a.	Control
	Improving formal SWM/informal interface	0.25	0.5	0	C	Promote
0			0	n.a.	Smoothen transition of informal collectors to the IS	
National policies improving formal state/informal interface	0.25	0	0	n.a.	Easing take over from IS to municipalities or private contractors for secondary transport and final disposal	
		0.5	0.5	C	National policies / legislation to promote recycling (considering IRS potential contribution)	
						National strategies for the inclusion of IRS within SWM

Step 3: Decide if each 'specific action' was:
key (K) or just considered (C) or ignored (I) or no information is available (n.a.)