

# Development of a social impact assessment methodology for recycling systems in low-income countries

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## Abstract

**Purpose** Informal recycling is one of the most significant activities within waste management systems in low-income countries. The main aspect of a number of recently implemented waste management systems has been to organise the informal recycling sector. The implementation of formalisation is expected to eliminate social problems related to the informal sector, but this has not been precisely measured and evaluated. A lack of methodology to assess social impacts persists, as does the comparison of different formalisation approaches. The goal of this work is to develop a methodological procedure for assessing the contribution of formalised recycling systems in low-income countries in terms of social impacts, in comparison with informal systems.

**Methods** Some existing social assessment approaches were evaluated by a review of literature. This investigation focuses on the development of the social life cycle assessment approach, the analysed social aspects, proposed indicators and characterisation models within this framework.

**Results and discussion** This study proposes an approach for the social assessment of recycling systems based on formalisation approaches in low-income countries oriented towards the social life cycle assessment methodology (sLCA). The approach developed considers 3 social impact categories, 9 social subcategories and 26 semi-quantitative indicators for the assessment of the social impacts on formalised recyclers. It includes a characterisation procedure that takes into consideration the application of a score

system and the calculation of average scores at both the indicator and subcategory levels.

**Conclusions** This research shows that it would be feasible to apply a sLCA-based methodology to evaluate recycling systems based on formalisation of the informal sector. The impact categories and subcategories identified represent the social problems of informal recyclers. The 26 semi-quantitative indicators and the proposed characterisation approach attempt to measure the social impacts that currently are only qualitatively assumed. The applicability and validation of the indicators and characterisation procedure will be determined by further research. The methodology developed will be tested using data from three recycling systems in Peruvian cities.

**Keywords** Formalisation · Low-income countries · Recyclers · Recycling system · Social life cycle assessment

## 1 Introduction

The informal sector plays an important role in waste management systems in low-income countries. This sector is defined as individuals or groups that carry out various activities within the waste management system (collection, recycling, treatment and disposal) without formal assignment. It focuses mainly on recycling and contributes significantly to the waste management of low- and middle-income countries. Several cities in low-income countries have identified the need to recognise the economic, environmental and social contribution of the informal recycling sector to waste management systems. Some cities in India, Peru, Brazil, the Philippines and Colombia have developed their recycling systems by the formalisation and inclusion of the informal sector (Rathi 2006; UN-HABITAT 2010; Gutberlet 2011; Wilson et al. 2009; Medina 2000).

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The most common social problems of informal recycling are inappropriate working conditions which endanger health and safety, social rejection, exploitation and poverty. Customarily, socially disadvantaged individuals or groups work in informal recycling (e.g. children, pregnant women and the elderly). It is assumed that formalisation leads to the reduction or elimination of such problems, although this has not been precisely measured and evaluated. A methodology for assessing the social impacts of formalisation within waste recycling systems in low-income countries has not been developed.

In contrast, there are several methodological proposals for assessing the social impacts of products and production chains using a variety of characterisation procedures that gauge the various social aspects of those products. One of them is the social life cycle assessment methodology (sLCA) notwithstanding its procedures, and characterisation methods of impact categories and subcategories are still under development.

The goal of this work is to develop a methodological procedure for assessing the contribution in low-income countries of formalised recycling systems, in terms of social impacts, compared to recycling systems using informal recyclers. In order to develop this methodology, research of the existing methodologies for social impact assessment including several experiences with the sLCA was carried out. The intention was to identify similarities and differences regarding the social impacts, their definition and interpretation. Further aspects such as characterisation approaches, definition and type of indicators, and data collection have also been analysed for their suitability of application for the social assessment of formalisation approaches in recycling systems. This methodology seeks to follow and to adapt the steps defined in the UNEP–SETAC guidelines for sLCA (2009) and to apply them to the social assessment of formalised recycling systems in low-income countries. The applicability and the relevance of the methodology developed will be tested on three Peruvian case studies with different formalisation approaches.

## 2 Waste management in low-income countries

Low-income countries have some similarities regarding their socio-economic conditions. In these countries, waste management systems are often not efficient and operate to low standards (Wilson et al. 2006). Scheinberg et al. (2006) define waste management systems in low-income countries as a “pre-modernised system based on a single disposal technology (dumping or landfilling). The waste management system is managed by a single major stakeholder: the local government sometimes supplemented by private waste collectors. Other actors—like recyclers—operate at the margins, and have the status of informal sector”.

The deficiencies of waste management systems in low-income countries can be demonstrated by their low national coverage rates. Gamarra and Salhofer (2007) give some examples of waste collection rates in Latin America (in Peru 74 %, Mexico 70 % and Uruguay 71 % in terms of percent waste collected) and compare them with the waste collection rates in Central Eastern Europe and Central Europe, which are nearly 100 %. Regarding the final waste disposal, the authors specified the use of controlled dumps, uncontrolled dumps and sanitary landfills as the most commonly used disposal systems in Latin America. The presence of informal recycling is identified at uncontrolled and controlled dumps. This situation along with the deficient collection rates allows the participation of the informal recycling under inadequate and uncontrolled conditions. Figure 1 presents, as an example, a flow diagram of a common waste management system in Peru including informal recycling. The material flow corresponding to recyclable waste (plastic, glass, metal, paper and cardboard) and mixed waste (organic waste, non-recyclable waste materials and recyclable waste materials) is represented in this figure.

## 3 Informal recycling and formalisation approaches

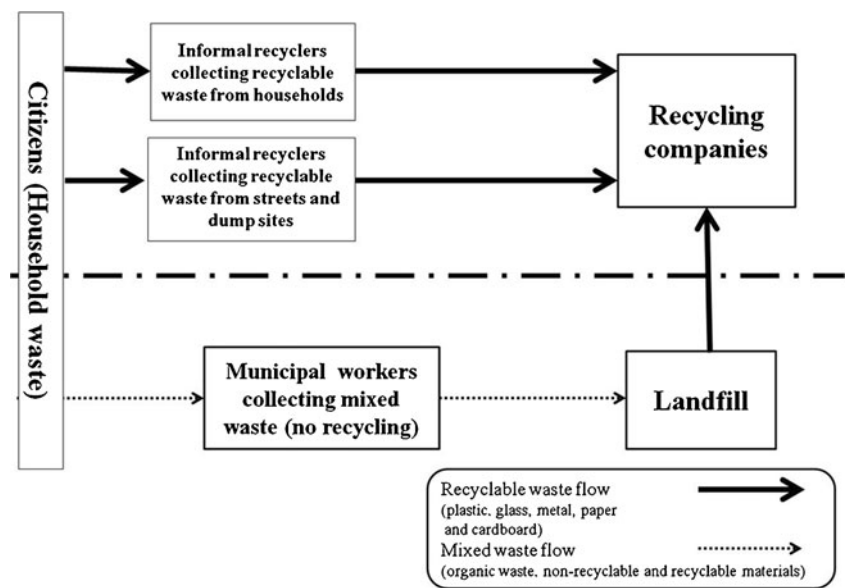
### 3.1 Informal recycling

The informal sector in waste management comprises individuals or groups that have no access to formal recycling activities. Such people are referred to by many names depending on the local language, but they are usually known as scavengers, waste pickers or rag pickers (Medina 2000). Other authors prefer to name them “recyclers” (Gutberlet 2011) as a form of recognition of their recycling activities and their contribution to the recycling market in low-income countries. For this work, it has been decided to use “recycler”.

They extract recyclable materials from dumping places, from street bins, communal collection sites, etc. and they sell them in order to enhance their livelihoods (Scheinberg et al. 2006). They perform their activities under poor working conditions which represent a high risk to their health. Numerous studies have shown the presence of diseases connected with waste working (Medina 2000; Countreau 2006; Wilson et al. 2006; Zurbrügg and Schertenleib 1998). Informal recycling contributes significantly to the recycling rates in low-income countries. Table 1 shows some examples of their contribution (UN–HABITAT 2010; Wilson et al. 2009; Scheinberg et al. 2010).

This is reflected by their economic contribution to the formal sector. For example, in Mumbai (India), it was estimated that the cost of the waste system without the informal sector was around USD 44 per ton of waste; however, in cooperation with the informal sector the cost amounts to

**Fig. 1** Example of a typical waste management system in low-income countries



USD 35 per ton (Rathi 2006). The same has been noted in Londrina, Brazil, where the integration of informal recyclers in the formal waste management system has cut the cost of waste collection from USD 42 per ton in 2001 to USD 24 in 2003. With respect to social issues, several studies have identified the same problems: child labour, truancy in schools, incomplete school education for adults and poor working conditions (Medina 2000; Wilson et al. 2006; Scheinberg et al. 2006; International Labour 2004).

### 3.2 Formalisation approaches

Political trends together with socio-economic and environmental problems related to inefficient waste management have led to several low-income countries attempts to bring their systems up to European or American standards (Scheinberg et al. 2006). This modernisation is characterised by a transformation to complex integrated systems with multiple formal stakeholders, a wide diversity of technical operations and the expulsion or rejection of the informal sector (Scheinberg et al. 2006). Despite these innovations, some cities have identified the need to recognise the contribution of the informal sector

**Table 1** Examples of the contribution of the informal sector in recycling rates in low-income countries

| Country         | City        | % recycling (formal/informal sector) |
|-----------------|-------------|--------------------------------------|
| Egypt           | Cairo       | 85 (11/74 %)                         |
| The Philippines | Manila      | 25 (2/23 %)                          |
| India           | Delhi       | 34 (7/27 %)                          |
| The Philippines | Quezon City | 39 (8/31 %)                          |
| Peru            | Lima        | 20 (0.3/19.7 %)                      |

and its inclusion in formal waste management systems as an effective strategy. As a consequence, some formalisation approaches have been implemented in recent years in order to improve the waste management systems. Various authors have written about the tendencies of the formalisation approaches in low-income countries. Medina (2000) describes some public policies that are based on a negative perception of informal recycling and try to encourage informal recyclers to engage in other occupations in order to reduce their informal activities (Medina 2000). Scheinberg et al. (2006) indicate that this approach fails to recognise that leaving their recycling activities would precipitate a reduction of their incomes to below the minimum level in these countries (Arroyo et al. 1998 cited by Scheinberg et al. 2006).

Alternative formalisation approaches prefer to encourage recyclers' activities. They focus on recognition of the environmental, social and economic benefits of informal recycling. Under this system, authorities support the formalisation of recycling activities, promoting the formation of recycling associations. Commonly, the cooperation scheme is based on the formation of public–private partnerships, collection and recycling contracts with recyclers, etc. (Medina 2000).

Further studies about formalisation in low-income countries describe as main features the creation and support of recyclers' associations, their inclusion in formal waste collection, the creation of a legal framework to support their integration (Peru and Brazil), the improvement of working conditions, betterment of incomes through cooperation contracts with local authorities, the elimination of child labour, educational programmes, diversification of services, etc. Strategies implemented in the Philippines, India, Colombia, Mexico, Brazil and Peru are based on these measures (Wilson et al. 2009; Rathi 2006; Medina 2000; Gutberlet 2011; Scheinberg et al. 2010).

#### 4 Social impact assessment as a part of a sustainability assessment

To establish sustainability, environmental, economic and social issues should be taken into consideration and brought together (Klang et al. 2003; Ness et al. 2007; Klöpffer and Ciroth 2011). Currently, there are several techniques for assessing the social impacts within a system. The studies performed by Brouwer and Van Ek (2004), Klang et al. (2003) and Kijak and Moy (2004) are examples of these approaches. They aimed to carry out sustainability assessments, applying different procedures for the social analysis. Common methodological aspects of these studies are the data collection procedures and data sources considered for the study: local social reports, the opinions of social experts and interviews with local stakeholders (citizens, companies, local authorities, etc.). These studies proposed the application of scores, e.g. + or – (Brouwer and Van Ek 2004), 1 to 5 (Klang et al. 2003; Kijak and Moy 2004) and the interpretation of results are performed based on the comparison with international or local social regulations, e.g. (Klang et al. 2003) for the social evaluation of management of demolition waste. Some examples of social aspects already evaluated are the perceptions of citizens in relation to landscape changes, communication (Brouwer and Van Ek 2004), physical and psychological working conditions for the workers in demolition recycling alternatives (Klang et al. 2003), odours and noise emissions, dust, impact on the public health, etc. (Kijak and Moy 2004).

In 2009, the UNEP/SETAC Life Cycle Initiative developed the social life cycle assessment methodology to assess impacts of products during their life cycle. The sLCA uses predominantly semi-quantitative indicators and proposes a list of social impact categories and subcategories to be considered according to international social conventions (e.g. ILO) and the stakeholders involved in a production system. However, the social aspects to be evaluated are constantly changing depending on the system and the stakeholders involved.

#### 5 Development of a social impact assessment methodology for recycling systems in low-income countries

In order to perform a social impact assessment of recycling systems, a methodology was proposed based on different social impact assessment methodologies (including sLCA) and several case studies about the application of these approaches. The methodology follows the four sLCA steps and seeks to adapt them to recycling systems with commonly implemented formalisation approaches. Figure 2 shows a flow chart of commonly implemented formalisation

approaches in low-income countries. In a further paper, the proposed methodology will be tested in three Peruvian recycling systems.

##### 5.1 Goal and scope

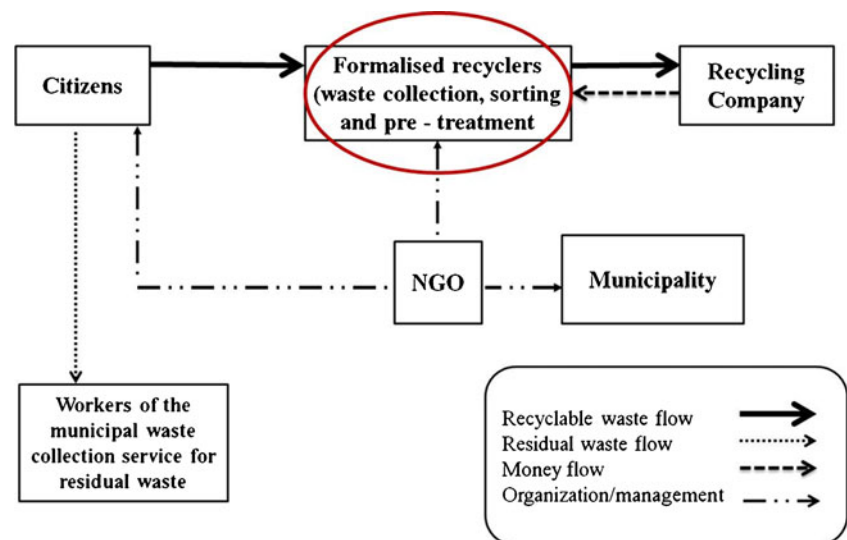
According to UNEP (2009), it is important to delineate the goal and scope in order to define the purpose of the analysis. It will ensure the fulfilment of the final application of the study. Jørgensen et al. (2008) mention two possible main goals of a sLCA: the comparison of products, production processes or companies and the identification of the improvement potential of products or processes.

The goal of this study is the assessment of recycling systems based on formalisation in terms of social impacts, in comparison to informal recycling systems in low-income countries. Formalisation approaches in recycling systems are mainly designed and implemented with the aim of reducing or eliminating the social problems that affect informal recyclers. The related social problems that often occur are in the areas of labour rights, working conditions and educational issues. This assessment attempts to objectively identify and measure the social impacts of frequently implemented formalisation approaches on the formalised recyclers compared to informal recycling systems. In order to perform this assessment, the functional unit is defined as the amount of household recyclable waste collected by one house during 1 year. Using the Peruvian national average waste generation rate and waste composition rate (MINAM. Ministry of Environment 2011), the functional unit is deemed to be 60 kg/inhabitant-year of collected recyclable household waste.

In low-income countries, the collection of recyclable waste can be carried out by the municipality, informal recyclers or formalised recyclers. Defining the functional unit allows for the methodology to be applied to different recycling systems. The recycling activities that are considered for analysis are recyclable waste collection and manual pre processing.

Other stakeholders are linked to recycling systems based on formalisation (e.g. citizens, recycling companies, waste disposal companies, informal recyclers beyond the formalised system, etc.). They can often be socially affected by the implementation of formalisation in relation to, e.g. environmental education and raising awareness, satisfaction about environmental amelioration, job creation, socio-economic impacts caused by the limited access to recyclable materials (for informal recyclers not included in the formalisation measures), etc. However, as the focus of this study is the social impact of formalisation on recyclers, only impacts related to that particular group will be considered. It should be pointed out that this methodology for social impact assessment contemplates only the social impacts occurring

**Fig. 2** Formalisation approach based on cooperation with recyclers' associations



as a result of the implementation and actual operation of formalisation. This methodology is not oriented to a preventive approach and does not analyse potential social impacts caused by planned or unimplemented formalisation process.

### 5.1.1 Impacts categories and subcategories

Social impacts are defined as the consequences of social interactions within a production system (production, use, final disposal) (UNEP 2009). Further studies (Klang et al. 2003; Brouwer and Van Ek 2004; Kijak and Moy 2004) describe social impacts based on an analysis of the stakeholders involved in each process and their relevant social actions. Social impacts can be grouped in categories which can be further subdivided into subcategories, representing the applicable social features to be assessed.

As mentioned above, informal recyclers carry out their activities under inappropriate conditions that often endanger their health and safety. They experience discrimination, poor working conditions, a low level of education, poverty and are sometimes even considered criminals. Their children are often involved in various stages of the picking process (mostly in dumpsites or at home). Children from families of recyclers contribute significantly to the family income (income varies from 10 to 50 % of an adult's income), and for this reason, it is difficult to convince their parents to allow the children go to school (International Labour 2004). Informal recyclers, who are frequently non-organised individuals, survive under very difficult social and physical environments. They are paid a pittance by the middlemen, who have a stronger negotiating position (Medina 2000; Wilson et al. 2006). Regarding health conditions, Medina (2000), Wilson et al. (2006) and Zurbrügg and Schertenleib (1998) have reported the presence of diseases related to contact with waste.

In reference to psychological working conditions, Scheinberg et al. (2006), Medina (2000) and Cozzensa et al. (2006) report

low job satisfaction and other negative psychological impacts because of the lack of employment security, lower social status, dangerous work places, unsatisfactory working conditions, irregular working hours and isolation, etc.

In order to measure the social effects of formalisation approaches, the social impact categories and subcategories in this study were chosen from a review of literature on the social problems of informal recyclers in low-income countries, and previous studies related to social assessment in general. The social impact categories that represent the social problems of recyclers were identified as human rights, working conditions and socio-economic repercussions.

It should be mentioned that the selected categories and subcategories relating to workers were also applied by others' social assessments on products (Manhart and Grießhammer 2006). Within the selected social impact categories, there are nine subcategories, which describe more precisely these social issues. Table 2 shows the social impact categories and subcategories to be assessed.

### 5.1.2 Social indicators

UNEP (2009) and Jørgensen et al. (2008) discuss the use of quantitative, qualitative and semi-quantitative indicators. The last is defined as a numerical description of qualitative information by using different scoring systems. The second criterion for the formulation of indicators is their direct or indirect measurement of the phenomena that cause the social impact. Direct indicators are a traditional quantitative and one-dimensional representation of a social impact (Jørgensen et al. 2008; Dreyer et al. 2006). One example is the frequently used indicator "number of employees under 15 years old" (Dreyer et al. 2010). This indicator measures child labour. However, further aspects pertaining to local context or special situations like the social responsibility of a company are not considered.

**Table 2** Social impact categories, subcategories and indicators for sLCA for recycling systems

| Impact category    | Impact subcategory  | Indicator   |  |
|--------------------|---|---|--|
| Human rights       | Child labour  | No child labour   |  |
|                    | Discrimination  | Formal policy against discrimination<br>No income differences between women and men   |  |
| Working conditions | Freedom of association and collective bargaining                            | Presence of collective bargaining   |  |
|                    | Working hours   | Fulfilment of overtime agreed in working contracts  |  |
|                    | Minimum income, fair income   | Average income according to legal framework<br>Absence of non-agreed income deductions<br>Regular payment for the workers<br>Minimum income according to legal framework  |  |
|                    | Recognised employment relationships and fulfilment of legal social benefits | Existence of legal working contracts for all workers<br>Access to legal social benefits<br>Access to further social support programmes for workers  |  |
|                    | Physical working conditions (health, security, working equipment)           | Absence of work accidents<br>Formal policy about occupational health and safety<br>Vaccination for workers<br>Training programmes for workers regarding occupational health and safety<br>Access to preventive health care programme for workers<br>Presence of medical equipment at the working place for the workers' use<br>Absence of diseases related to waste handling<br>Appropriate working equipment |  |
|                    | Psychological working conditions  | Willingness to continue working in the same company or sector<br>Work satisfaction<br>Willingness to be trained regarding the work activities   |  |
|                    | Socio-economic repercussions  | Education   | Educational level of children from families of recyclers<br>No school absence of children from families of recyclers<br>Existence of educational programmes for self-development |

The authors define indirect indicators as those based on preventive social measures. These indicators aim to assess the preventive management effort of a company rather than the reported impacts (Jørgensen et al. 2008). One example of these indicators can be the presence of management measures to ensure training for workers in relation to safety and occupational work, instructions for the safe use of machines, etc. (Dreyer et al. 2010).

This study defines 26 semi-quantitative indicators for the assessment of social impact subcategories. Among these, three indirect indicators are proposed. They are related to prevention policies regarding discrimination, occupational health and safety and training programmes. An attempt has been made to combine the use of direct and indirect indicators in order to more accurately detect the risk of threats to or negative effects on the social issues. Table 2 shows the selected social categories, subcategories and the indicators adopted.

Through research about the situation of informal recyclers in low-income countries, the most common social

problems affecting them were identified. As already described the social impact categories and subcategories as well as their indicators were proposed according this information. One common human rights concern in informal recycling is the presence of children working as informal recyclers at dumps and on the streets. They help their families by picking materials or sorting at home (International Labour 2004). Formalisation approaches seek to eliminate child labour. In order to measure the social performance of this issue, the indicator “no child labour” was defined. Further studies report the presence of discrimination particularly impinging upon gender, religion, social rejection, physical disability, etc. (Medina 2000; Wilson et al. 2006). Some of these forms of discrimination are somewhat typical for the country or region. The formalisation approaches implemented in low-income countries have a task of reducing or eliminating the factors which cause discrimination. Gender discrimination often manifests itself in lower incomes for women. A lack of strength, care children at home, pregnancy, etc. means women collect

lower waste amounts than men and they are not able to earn enough. Diverse formalisation approaches with special measures to deal with this topic were implemented in, e.g. The Philippines, India, Colombia and Brazil (Wilson et al. 2009; Mahadevia et al. 2005; Terraza and Sturzenegger 2010). The indicator “no income differences between women and men” was defined in order to identify the positive or negative performance of the formalisation approaches in relation to this matter. The indicator “formal policy against discrimination” also seeks to measure indirectly the risk or probability of discrimination within the formalised recycling activities.

Organising informal recycling has important consequences for income generation, working conditions and social status (Wilson et al. 2006). Several formalisation approaches are based on the organisation of recyclers and creation of recyclers’ associations. Wilson et al. (2000), Wilson et al. (2006) and further studies assert that this factor is essential for successful formalisation. The positive effects reportedly emanating from this measure are increased income, cooperation contracts between the recyclers and other stakeholders, diversification of services and the empowerment of recyclers. These experiences have led to the indicator “presence of collective bargaining and associations” to be chosen. The presence of active collective bargaining and associations validates a positive performance in reference to this impact subcategory.

Informal recyclers are notably vulnerable to long working hours, low incomes, unfair payments for the materials that they recover and sell to middlemen, and both variability and insecurity in their daily income. Formalisation approaches seek to eliminate this predicament by ensuring fair incomes in line with the legal minimum in the country, fair prices for recyclable material (fair trade of material from recyclers’ associations to recycling companies), etc. Furthermore, cooperation contracts between the authorities and formalised recyclers are signed in order to ensure the collection service and stabilise incomes for the recyclers. Some examples are described by Gutberlet (2011) in relation to the formalisation implemented in Londrina and Diadema, Brazil. The indicators chosen for the subcategories working hours and minimum, fair income try to determine if the formalisation approaches implemented fulfil their respective goals.

The target of formalisation approaches is to organise informal recyclers and to legalise their situation and their activities. Several studies on the general situation of informal recyclers in low-income countries report their illegal status, the failure to recognise their work, precarious daily incomes, expulsion from waste areas or a prohibition on gathering waste and a lack of access to social benefits, e.g. social security, insured pension plan, etc. (Scheinberg et al. 2006; Wilson et al. 2006; Medina 2000). Often, the formalisation approaches seek to mitigate these problems by

legalising their activities through cooperation contracts or public–private partnerships between the recyclers’ associations and local authorities or private stakeholders (Scheinberg et al. 2006). Recognised, legal business relationships are created, opening access to social support programmes and legal social benefits.

This methodology proposes indicators for legal work contracts, access to social benefits and social support programmes in order to evaluate whether the objectives of legitimising working activities and the creation of access to social support have been achieved.

Multiple studies about the general situation of informal recyclers in low-income countries report poor working conditions as a main problem. Informal recyclers work in hazardous conditions. They move waste around, searching for material, and are exposed to disease vectors, animals, infectious agents, injuries, etc. Formalisation approaches normally include several measures for the improvement of physical working conditions: accident prevention training programmes, occupational health policies, the implementation of preventive health care programmes including vaccination, work equipment, etc. This methodology seeks to determine the fulfilment or otherwise of the requirements that improve the quality of working conditions for recyclers involved in formalisation approaches. Two indicators are indirect and are based on preventive management measures (a policy regarding occupational health and safety, and training programmes about occupational health). The other indicators are directly related to current aspects of appropriate physical working conditions. For example, the presence of basic medical equipment in the working place which facilitates an adequately rapid response to work accidents as learned in the training programmes.

Concerning psychological working conditions, several studies assert that waste picking is related to low job satisfaction and further negative psychological impacts on informal recyclers because of the lack of employment security, lower social status, dangerous work places and working conditions, irregular hours and isolation, etc. (Scheinberg et al. 2006; Medina 2000; Cozzensa et al. 2006).

In order to measure the psychological working conditions, Klang et al. (2003) researched this point using workers at demolition waste recycling plants. The authors evaluated the percentage of workers that would considering remaining within the field and their willingness to continue with further training related to their work. Jørgensen et al. (2008) report the frequent use of psychological working conditions evaluations in terms of job satisfaction.

The primary goal of formalisation approaches is the improvement of working conditions. Stress and psychologically negative situations at work should be eliminated through formalisation. The organisation of recyclers and stimulation of their participation as formal stakeholders,

etc. strengthens their rights and social status. In this paper, the methodology proposed for the evaluation of work satisfaction is the willingness to receive job training and to continue working in the field. It is intended to measure the satisfaction level of the formalised recyclers only in relation to their recycling activities. Happiness or satisfaction in other areas of their lives is not evaluated.

For the assessment of the impact category socio-economic repercussions and the corresponding impact subcategory education, three indicators are proposed. As previously described various studies have reported child exploitation in waste picking activities in low-income countries (International Labour 2004; Medina 2000; Scheinberg et al. 2006; Wilson et al. 2006). Children work at dumps, on streets and also at home helping the parents to with the daily income. This makes it difficult to convince their parents to let the children go to school. Formalisation approaches strive to promote the presence of children of recyclers in schools. The purpose of the indicators proposed is to measure the performance of formalisation approaches in relation to school absence and the educational standard of children of recyclers which should be at the national average school level according to age group.

A further objective of formalisation approaches is to promote adult educational programmes for recyclers in order to support their self-development and social status. Informal recyclers often have a poor education and they do not have the chance to complete it (Wilson et al. 2006; Medina 2000). Several cities like Joao Pessoa in Brazil (Pimentel and Coutinho 2005) have implemented educational programmes as a part of a formalisation process (Scheinberg et al. 2006). The proposed methodology tries to determine whether this aspect in the evaluation of formalisation approaches has been fulfilled or not.

## 5.2 Social life cycle inventory

UNEP (2009) mentions as data collection methods both desktop research and local data collection through interviews with stakeholders involved into the system. In order to obtain balance, a comparison of the information given by the stakeholders is preferred. Jørgensen et al. (2008) support using local data and recommend that the data collection must be related to this local level and to the stakeholders within the evaluated system.

For recycling systems based on formalisation approaches, the major stakeholders involved in the implementation and operation of the formalisation will be interviewed (e.g. municipalities, recyclers, NGOs, etc.). As previously mentioned, there are other stakeholders within a recycling system (e.g. citizens, recycling companies, etc.). Since the data needed for the assessment are related to specific aspects about the implementation and functioning of the formalisation, the stakeholders to be interviewed are those who are directly involved in it.

A checklist of 56 closed and open-ended questions has been developed in order to collect the relevant information for the social assessment. They aim to obtain precise and logical answers in order to make a score assignment 1 or 0 (compliance or non-compliance of social criteria) possible. The same check list will be applied to all stakeholders with the exception of the subcategory psychological working conditions. In this case, the interviews will only be carried out with the formalised recyclers and workers at the recycling plant.

## 5.3 Life cycle impact assessment

### 5.3.1 Characterisation

Currently there is no international consensus on a characterisation method for social impacts. UNEP (2009) asserts that a scoring system can also be used in order to evaluate and interpret the social data. Dreyer et al. (2010) developed a methodology oriented towards a preventive approach that assesses social management measures and uses an elaborated scoring system. Spillemaeckers et al. (2001) developed a characterisation approach based on semi-quantitative indicators and the application of the scores 1 and 0 representing fulfilment or non-fulfilment of the social criteria (international or local social conventions). The average of the scores for each impact subcategory can subsequently be calculated. This approach concentrates on the assessment of human rights and working conditions and does not consider the social context of the company.

The characterisation procedure for this methodology proposes the application of a score system for each indicator and assigns the values 1 and 0, respectively, for the fulfilment or non-fulfilment of the social compliance criteria. The answers given by each stakeholder interviewed regarding fulfilment will be transformed into these values. Because several stakeholders will be interviewed, the average score for each indicator can be calculated.

$$\frac{\sum_{i=0}^n S_i}{n}$$

### 5.3.2 Equation calculation of average score

$S_i$  = Score for indicator  $i$  given by the stakeholder  $i$   
 $n$  = number of stakeholders interviewed

The result for each of the 26 indicators will be an average decimal score between 0 and 1. The average score calculated for each indicator represents the proportion of stakeholders affirming fulfilment of the social criterion. To interpret these average decimal scores, the following fulfilment criterion is applied: an average score of less than 0.5 denotes that the criterion for the positive evaluation of the indicator was not fulfilled and the score is rounded down to 0. In the



case that the average score reaches 0.5 or higher, the criterion for the positive evaluation of the indicator is fulfilled. The average score is then rounded up to 1. The reason for this interpretation is that at least 50 % of the interviewees (score 0.5) have to report the fulfilment of the social criterion.

Regarding the indicators for the impact subcategory psychological working condition, the only stakeholders to be interviewed are the recyclers. Score assignment and fulfilment criteria have been defined differently for the indicators of both impact subcategories. A scale of 1 (very bad), 2 (bad), 3 (medium), 4 (good) and 5 (very good) will be used by the recyclers to signify degrees of satisfaction. In order to transform the scores obtained to a similar scale to the one used by the indicators in other subcategories (0 or 1), the values of 0, 0.25, 0.5, 0.75 and 1 for the scale 1, 2, 3, 4 and 5 will be assigned, respectively. When the average scores given by the recyclers are calculated, a number higher than “medium” (0.5) means the fulfilment of the social criterion for the indicator and it receives the final score “1”. An average score lower or equal than 0.5 means non-fulfilment of the social criterion and the final score “0” is designated.

After obtaining the average scores of the 26 indicators, the score for each subcategory will be calculated and interpreted as follows: when all indicators within a subcategory obtain the score “1”, the subcategory obtains the overall evaluation “1” meaning the fulfilment of all the social criteria for the subcategory. In the case that one or more indicators within a subcategory receive “0”, the subcategory obtains the overall evaluation as “0” meaning the non-fulfilment of the social criteria related to the subcategory. Each indicator within a subcategory represents a basic social aspect to be fulfilled in accordance with social regulations. In order to achieve a positive result, all subcategory indicators have to be evaluated with “1”. It is important to mention that although this evaluation is based on scores, these results are not relevant as numeric values. The aim is to show the differences between the case studies in terms of their social aspects. The results indicate which aspects of a formalisation strategy are favourable or not.

## 6 Conclusions

This methodology was proposed to identify and measure social impacts caused by the implementation of formalisation approaches in recycling systems in low-income countries. Currently, different social impact assessment methodologies analysing products and productions chains have been established but no methodological approach exists for recycling systems. It can be concluded that impact categories related to the main social problems of informal recyclers have been identified. More detailed issues are addressed by the impact

subcategories and indicators as defined in this paper. By defining the functional unit as “60 kg/inhabitant-year of collected recyclable household waste”, it would be possible to assess social impacts before and after the implementation of formalisation approaches. This methodology focuses on the social impacts on recyclers, who perform the same service but under different conditions.

At the same time, this methodology measures social impacts caused by recycling systems after their implementation. Its application for assessing future scenarios is contentious. Several social factors such as regulations, tendencies, perceptions of satisfaction, quality of life, etc. can change and cannot be precisely predicted. The applicability of this methodology and its validation will be tested through further research in three Peruvian cities with different recycling systems.

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