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A Glance at the World

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This column comprises notes and info not subjected to peer-review focusing on waste management issues in different corners of the world. Its aim is to open a window onto the solid waste management situation in any given country, major city or significant geographic area that may be of interest to the scientific and technical community.

Material Flow Analysis of Formal and Informal Household Waste Recycling Systems in Developing Countries. Case Studies from Peru

The informal sector plays an important role in waste management systems in developing countries. This sector focuses mainly on recycling and therefore contributes significantly to the recycling rate of many cities in developing and emerging countries. In Lima and Callao (Peru) for example about 19.7% of the municipal waste is recycled by the informal sector, while the overall recycling rate (formal and informal) is 20% (Scheinberg et al., 2010).

The informal sector carries out the recycling activities under inappropriate conditions that endanger the health and safety of the people working in this sector and their families (recycling activities on the streets, dumps, etc.). The economic contribution of this informal recycling sector to waste management systems and its environmental and social benefits are not recognized by the stakeholders of the formal sector. For this reason, the informal activities are frequently considered to be negative. In several developing countries the informal sector is rejected and policies to eliminate the informal recycling activities have been implemented.

Despite these trends some governments have identified the need to recognize the contribution of the informal recycling sector and they have started to consider its inclusion in the formal waste management systems as an effective strategy. For this reason, over the recent years, some formalization strategies have been implemented with the aim of organizing the informal recyclers and improving their working conditions, their wages, and eliminating child labor and introducing other socio-economic improvements.

Until now several studies have been focused on analyzing the environmental and economic impacts of the formalization strategies, but their social impacts are currently only assumed; they cannot be directly measured and currently there are no methodological standards for social impact assessment. In order to analyse the formalisation strategies in regard to their contribution to the social sustainability an approach based on sLCA Methodology (Social Life Cycle Assessment) was chosen for this research. The sLCA is defined as a methodology to assess the social or socio-economic aspects of products and their potential positive or negative impacts along their life cycle (UNEP, 2009). Because this method is still in development no social impact categories, indicators or characterization approach have been established to date.

The first aim of this work is to analyse the recycling material flows of two case studies from Peru. One case study corresponds to a recycling system with the inclusion of formalized recyclers and the second case study corresponds to a conventional recycling system entirely operated by the municipality without the integration of informal recyclers.

The second aim is the development of a methodological framework for applying the sLCA for waste management systems. Using sLCA methodology the social impacts of the formalisation strategies as well as the positive contributions to the social situation of the recyclers will be analysed.

Case studies

In both Peruvian communities the amounts of collected recyclables were analyzed in order to identify and to measure the waste material flows. In the first case study the municipality with the technical support of a NGO and the financial support of a private recycling company implemented a separate collection and recycling system based on the cooperation with the recyclers. This system serves 15% of households in the city. The formalized recyclers collect glass, paper, cardboard and plastics from the households for free. They transport the separated waste with tricycles and subsequently perform a more accurate manual separation in a sorting center with the purpose of selling the recovered materials. Some implemented social measures comprise awarenessraising campaigns and the identification of the citizens working with the formalized recyclers, an overview of vaccination campaigns, access to health prevention and health insurance programs and the improvement of recyclers' work equipment.

The second case study corresponds to a conventional recycling system operated exclusively by the municipality (without the integration of recyclers). Waste collection is carried out with waste collection vehicles and the more accurate sorting is performed using a sorting system with simple technology. Similar to the first case study the collected and recycled materials are glass, plastics, paper and cardboard, and metals. Currently, the recycling program covers 38% of the total households in the city. The identified positive effects of this system are mainly related to the improvement of working conditions of the formal workers and their access to health and social insurance.

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Table 1
Recycling rates of the two case studies.

	Paper and cardboard (%)	Other plastic materials[a] (%)	Plastic films (%)	Glass (%)	Non ferrous metals (%)	Ferrous metals (%)	Overall recycling rate (%)
Formalization of recyclers	47	43	2	76	17	43	34
Conventional system	7	14	2.5	25	0.5	1	9

[a] Plastic toys, plastic bottles, plastic cans and other plastics.

Waste recycling rates

The recycling rates of each recycled waste material and the overall recycling rate of both case studies were estimated and compared. The amounts of each recycled material sold were compared with the potential of recyclables generated in households.

Although the recycling system based on the recyclers' formalization has a lower coverage (share of household participating) than the conventional recycling system, higher recycling rates have been identified in the first system (see Table 1).

Methodological approach based on sLCA

The developed approach for the social impact assessment of waste management systems is based principally on the UNEP's sLCA framework. This approach proposes the use of several indicators and a scoring system. For the social assessment of the case studies only the social impacts in relation to the recyclers (case study 1) or to the formal workers (case stuy 2) have been considered. Based on a literature research the social impacts categories, subcategories and their corresponding indicators were determined as follows (see Table 2).

For this study 26 semi quantitative indicators were developed. Some examples of indicators are: non existence of working children, the absence of unjustified wage reductions, access to health prevention programs. Concerning the scoring system, the following numerical values were assigned: 1 to the compliance and 0 for non compliance of the evaluation criteria. Degrees of compliance are not considered for this method, therefore the result of each indicator will be either 1 or 0. The evaluation will compare the current social performance of the case studies with the minimum compliance criteria according to the international and local social and legal standards.

The characterization will be performed only according to the indicators impacting subcategories. The characterization procedure involves the calculation of the average score by summing the scores given by each interviewed stakeholder and dividing the sum by the number of stakeholders interviewed. To proceed towards a final aggregation to impact categories, the subcategories should be considered equally important or otherwise it would be necessary to apply a weighting system. In this case, the weighting application should be determined through interviews with local experts, sociologists and stakeholders. That is, by nature, a highly qualitative procedure and it may affect the impartiality of the assessment. For example: to consider that the impact subcategory "child labor" is less or more important than the right to "the freedom of association and collective bargain" is questionable due to qualitative local ethical, cultural, legal reasons, etc. An additional reason to perform the characterization only to subcategories is that the results of the assessment can be better understood and including more details than an overall result for each impact category. It should be noted that these results are not relevant as numeric values. The aim is to show the differences between the case studies in terms of their social impacts and to indicate which aspects of a strategy are positive or not. In a further phase of the research the proposed framework will be applied to measure and evaluate the social impacts of these case studies.

Table 2
Social categories and subcategories for workers.

Social impact categories	Social impact subcategories
Human working rights	Child labor Discrimination Freedom of association and collective bargaining
Working conditions	Fair wage, minimum wage Working hours Social benefits, social security Physical working conditions (e.g. health, security, equipment) Psychological working conditions (e.g. job satisfaction)
Society	Accessibility to education Acceptance / social inclusion

Conclusions

As result of the material flow analysis done in this reseach, it has been concluded that the recycling system based on the recyclers' formalization shows higher recycling rates than the conventional one. As mentioned by other authors, the main reasons are the good relationship between residents and recyclers as well as social awareness of the population regarding the positive social impacts on recyclers. In case study 1 neither good relationships nor awareness exists in case study 2. Another reason is that the recyclers' income in case study 1 depends on the amount of recycled material. Therefore, the recyclers select the materials more accurately than in case study 2, where the workers get fixed incomes.

It has been concluded that although originally sLCA was used for the analysis of products and to date, no standardized indicators or characterization methods have been established, this method is intended for the evaluation of waste management systems. By applying the indicators proposed in this approach and the characterization procedure it will be possible to measure the qualitative social impacts that previously were only assumed. The characterization only to social subcategories allows for a clearer understanding and interpretation of the results. Furthermore, the availability and reliability of the data from the local stakeholders linked to the waste management system is of vital importance for the value assignment ??of the indicators and therefore for the results of the evaluation. In a further phase of this work the applicability of the methodology will be tested on the mentioned cases studies.

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