



## Full length article

## Evaluating the performance of recycling cooperatives in their operational activities in the recycling chain

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## ABSTRACT

In developing countries, recyclable material collectors cooperatives are presented as a public policy model for managing urban solid wastes with recyclable potential (MSWRP). They are a fundamental part of the resources recovery chain. Thus, this study proposes a method to help analyse the management performance of cooperatives in their operational activities in the recycling chain (OARC): in waste collection management, in production management, in waste marketing management, and as an instrument of social inclusion, income generation and MSWRP reduction. To exemplify the application of the method, longitudinal research was carried out on some characteristics of cooperatives based in a medium-sized city in Brazil. For data treatment, the DEA-SBM models, Tobit regression and the Kruskal-Wallis test were used. The results indicated that cooperatives are heterogeneous, with different levels of management performance and administrative organisation. This presents communication difficulties and creates disparities in the rent paid by the collection centres for the collection trucks. In some cases, cooperatives are organised with separate administrative sectors, while in others all administrative functions are performed by the president. The results also indicated the need for maintenance and an increase in public actions to integrate the cooperatives and waste collectors with the aim to guarantee greater control in the collection, production and commercialisation of MSWRP. This is important as improvements in cooperatives' management performances in their OARC are fundamental to their survival and the improvement of their members' quality of life.

## 1. Introduction

Historically, solid waste has always been an unavoidable by-product of human activity. However, population growth, urbanisation, and economic and technological development have affected the modes of production, lifestyle and consumption, resulting in increases in the quantity and diversity of the solid waste generated. This fact, along with the limited financial resources available, basic technology for treatment and disposal, and the application of regulatory measures, has made waste management in developing countries a difficult and complex task (Chen et al., 2010; Fu et al., 2015).

According to the US Environmental Protection Agency (2004), recycling is the best strategy for dealing with municipal solid waste (MSW), followed by preventive reduction and reuse strategies for resources. Recycling is a key strategy in MSW management, which, among other benefits, provides a reduction in pollution, helps preserve natural resources, reduces the amount of waste intended for landfills, allows the implementation of recycling micro-enterprises and helps bring waste collectors into the labour market (Assim et al., 2012; Fidelis

et al., 2015; Gutberlet, 2015; ISWA, 2012; King and Gutberlet, 2013; Paul et al., 2012; Wilson et al., 2006; Zeng et al., 2015).

The informal recycling sector—usually composed of poor people excluded from society due to their age, social status, lower education level or lack of a place in the formal labour market (Wilson, 2006; Gutberlet, 2015)—has been a fundamental part of MSW management in developing countries, mainly in the accomplishment of collection, classification and commercialisation activities for MSW with recyclable potential (MSWRP) (Wilson et al., 2006; Medina, 2000; Paul et al., 2012; Assim et al., 2012; Sandhu et al., 2017).

In many cases, the work carried out by the informal sector subsidises the formal system and can be considered as the provision of a service of which cities take advantage (Campos, 2014), because the collectors survive only by virtue of the commercialisation of the materials collected (Wilson et al., 2006; Assim et al., 2012). Cities benefit ‘...without having to pay for it, because environmental gain is a by-product of the economic interests of informal recyclers’ (Spies and Scheinberg, 2010, p. 131). According to Wilson et al. (2006), it is possible to improve MSW management services as long as municipalities realise the

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importance of informal recycling.

According to the *IPEA (2013)*, the formalisation of waste collectors in collective enterprises (associations and cooperatives) is essential for the efficient management of MSWRP, since these enterprises emerge to strengthen waste pickers, who in turn constitute the most fragile link in the value chain of recycling. The cooperatives provide their members with both economic and structural feasibility for the tasks of collecting, storing, processing and marketing MSWRP (*MNCR, 2014; Medina, 2000*), which are vital to the resource recovery chain (*Gutberlet, 2015; Medina, 2000*) and to obtaining investments and rights from the federal, state and municipal governments.

In addition, the recycling cooperatives are presented as a model of public policy<sup>1</sup> for the management of MSWRP (*Ribeiro et al., 2009; Fidelis et al., 2015*). However, due to the lack of professional training (e.g. the capacity for the exercise of the activity, formal education and financial resources) and also due to cultural issues inherent to the collectors themselves, recycling cooperatives do not direct their actions in order to improve their operational activities in the recycling chain (OARC), which encompass the collection, classification, storage and commercialisation of MSWRP. Cooperatives have a high degree of heterogeneity, with different levels of performance and organisation in their OARC, limiting and conditioning the effectiveness of efficient public policies (*IPEA, 2010; Tirado-Soto and Zamberlan, 2013*).

Cooperatives should increase their performances in their OARC in order to (1) improve the income and quality of life and work of their members, and (2) to ensure their inclusion in the formal system of MSW management, since it is necessary that these meet the needs of municipalities in the collection and treatment (classification and marketing) of MSWRP.

Thus, this study proposes a method to assist in the analysis of the performance of recycling cooperatives in terms of their OARC, in four stages: performance in the management of the collection of MSWRP; performance in production management, which consists of the steps of storage, sorting of waste by type of material and pressing of materials (internal flow); performance in the management of the commercialisation of materials; and the performance of cooperatives as an instrument of social inclusion, income generation and MSWRP reduction, taking into account environmental, economic and social aspects. To exemplify the application of this method, we analysed recycling cooperatives based in a medium-sized city.

This study makes some significant contributions in the following ways: (1) by conducting a longitudinal survey of some characteristics of cooperatives in their OARC; (2) by make a comparative assessment between recycling cooperatives, because their isolation due to social exclusion induces collecting communities to develop their own habits and values (*Wilson et al., 2006*); (3) by analysing the performance of cooperatives in the collection, production and marketing sectors, and identifying factors that may contribute to increase their performances; (4) by analysing the performance of cooperatives as an instrument of social inclusion, income generation and MSWRP reduction; and (5) by presenting a method for analysing the management of MSWRP featuring socio-productive inclusion of collectors with a focus on the specific characteristics of each cooperative.

## 2. Proposed method

The method proposed consists of defining the variables (indicators) of productivity, applying the DEA-SBM and DEA-Window models to determine the performance indexes, using the Kruskal-Wallis test to verify the stability of the performance indexes of cooperatives in

relation to time, and verifying the factors (inputs and outputs) that significantly affect the performance indexes through a Tobit regression model.

### 2.1. Variables

The performance indexes of the cooperatives were obtained through the DEA model, which is generally used to estimate the relative performance of production through the relation ‘outputs/inputs’.

The proposal of inputs and outputs used to determine the DEA frontier was based on the socio-productive inclusion of collectors in the management of MSWRP, the OARC assigned to cooperatives and the inputs/outputs common to all cooperatives.

In this study, we did not work with information regarding costs and investments, because, due to the heterogeneity and different levels of organisation, most cooperatives do not have this information for certain periods of time. However, in countries presenting more specific situations related to MSWRP, this method can be expanded to consider local characteristics, with the inclusion or exclusion of variables.

The variables (*Table 1*) for the determination of the performance indexes of the cooperatives in the management of collection were defined taking into account the coverage of services provided, including the collection made door to door, by small-volume delivery stations and also following the study developed by *Chen (2010)*, which compared performance in the management of solid waste collection between urban and rural regions in Taiwan.

The variables (*Table 1*) used to measure the performance of production management were defined from the indicators of ‘high importance’ rooted by the evaluation of selective collection with social inclusion presented by *Bringhenti et al. (2011)*, added to the quantity of collectors involved in the work, since productivity is related to the efficiency and income from workforces directly involved in the execution of the task (*Schonberger and Knod, 1988*).

As previously described in the performance measurement of production management, the variables (*Table 1*) used to measure management performance in marketing were defined from the indicators presented by *Bringhenti et al. (2011)*, and instead of working with the ‘average price of marketing mix of recyclable material’, we worked with the average monthly price obtained from the sale of the five main materials, which represent more than 60% of the volume sold. In addition, an amount of marketed waste was added, since cooperatives have a tendency to commercialise items with the highest volume and commercial value.

In turn, the variables (*Table 1*) used to evaluate the performance of cooperatives as an instrument of social inclusion, income generation and MSWRP reduction were defined based on the National Solid Waste Policy of Brazil (NSWP) (*Brasil, 2010*) which is recognised by the report ‘Regional Assessment Report Services Municipal Waste Management in Latin America and Caribbean, 2010’, supported by the Pan American Health Organization, Inter-American Development Bank, and Inter-American Association of Sanitary and Environmental Engineering (*Espinoza et al., 2010*) as a breakthrough in the management of MSWRP with socio-productive inclusion of waste collectors. We also drew on a study by *Velis et al. (2012)* that presents a structure that classifies and analyses possible interventions in order to promote the inclusion and integration of the informal sector into the management system for a city’s MSWRP.

In general terms, the NSWP prohibits the use of uncontrolled landfills and obliges the federal government, states and municipalities to develop MSW treatment plans; recognises reusable and recyclable solid waste as an economic good of social value, a generator of work and income, and a promoter of citizenship; prioritises the integration of collectors in actions involving shared responsibility for the product life cycle; encourages the creation and development of cooperatives; requires that the municipal solid waste management plan contain/include programs and actions for the participation of interested groups, in

<sup>1</sup> Socio-productive inclusion of waste collectors in the management of MSWRP; income generation and improvement in the quality of work of waste collectors; reduction of pollution; preservation of natural resources; reduction of environmental impacts; reduction of waste destined for landfills and sanitary landfills; and generation of and improvement in the quality of work of waste collectors.

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