Journal of Environmental Management 167 (2016) 59–65

Contents lists available at ScienceDirect

Journal of Environmental Management

journal homepage: www.elsevier.com/locate/jenvman

Research article

Full cost accounting in the analysis of separated waste collection efficiency: A methodological proposal

Giuseppe D'Onza*, Giulio Greco, Marco Allegrini

Department of Economics and Management, University of Pisa, Italy

ARTICLE INFO

Article history:
Received 30 March 2015
Received in revised form
10 August 2015
Accepted 3 September 2015
Available online xxx

Keywords:
Full cost accounting
Waste collection costs
Standard costs
Variance cost analysis

ABSTRACT

Recycling implies additional costs for separated municipal solid waste (MSW) collection. The aim of the present study is to propose and implement a management tool – the full cost accounting (FCA) method – to calculate the full collection costs of different types of waste. Our analysis aims for a better understanding of the difficulties of putting FCA into practice in the MSW sector. We propose a FCA methodology that uses standard cost and actual quantities to calculate the collection costs of separate and undifferentiated waste. Our methodology allows cost efficiency analysis and benchmarking, overcoming problems related to firm-specific accounting choices, earnings management policies and purchase policies. Our methodology allows benchmarking and variance analysis that can be used to identify the causes of off-standards performance and guide managers to deploy resources more efficiently. Our methodology can be implemented by companies lacking a sophisticated management accounting system.

1. Introduction

Separated waste collection is at the core of the waste management system and represents a key cost driver. Waste collection can generate up to more than 70% of the municipal solid waste (MSW) system costs (Johansson, 2006; Tavares et al., 2009; Greco et al., 2015). Separated waste collection implies additional costs for which the sale of recycled waste often does not compensate. On the other hand, separated waste collection can lower the costs of landfill disposal or incineration (Angelelli and Speranza, 2002; Larsen et al., 2010). Proper estimation and monitoring of the waste collection costs are essential to define the most cost-effective waste collection strategy, increase the efficiency of the waste collection process and avoid excessive tax rates being imposed on the citizens (Fobil et al., 2008; Huang et al., 2011; Jacobsen et al., 2012).

Over the past 20 years, several studies analysed the costs of MSW management in different Countries and proposed a variety of methods and tools to measure the financial performance of the collection, the transportation and the disposal processes (Pires et al., 2011). These methods include the balanced scorecard, integrated waste management scoreboards, aggregate indexes, data enveloped analysis and others (Huang et al., 2011; Mendes et al., 2013). In the U.S., the early experience of the adoption of the full cost accounting (FCA) methods dates to the 1980s. Given the benefits that this method can offer, the U.S. Environmental Protection Agency has promoted the use of FCA since the mid-1990s to support local government's decision-makers with the design of their MSW programs, ensure an effective reporting of costs to citizens and adopt a pay-as-you-throw system (USEPA, 1997).

The U.S. experience shows that municipalities may face several problems upon implementation of the FCA, especially when they adopt cash flow accounting and they figure their expenditures in terms of their current budget (Gupta, 2009). Moreover, the use of different MSW schemes in waste collection and disposal increases the complexity of the waste management operations and the difficulties to track and evaluate the costs. The adoption of a separate waste collection scheme in particular modifies the flow of activities performed to collect, transport, treat and dispose the different types of waste, as well as the resources employed to carry out operations, which results in greater complexity in the measurement of the full cost of WM systems (Karagiannidis et al., 2008). While there is growing awareness of the importance of FCA for measuring the costs of waste collection, transportation and disposal, there is a lack of research on the theoretical and practical implementation of

* Corresponding author. Department of Economics and Management, Via C. Ridolfi 10, Pisa, Italy.
E-mail address: giuseppe.donza@unipi.it (G. D'Onza).

http://dx.doi.org/10.1016/j.jenvman.2015.09.002
0301-4797/

FCA in the waste management sector (Lim, 2011).

This study aims to fill this gap by presenting a procedure for the development of the FCA method, which can be used to measure the full costs of the MSW collection process of different types of waste: paper and paperboard; glass; multi-material (plastic, metal); organic and undifferentiated. We develop the procedure by using data provided by the waste management firms operating in a sample of Italian municipalities.

In this paper, we investigate the Italian setting, characterised by increasing pressure to reach the European Union Waste Directive's long-term objectives in terms of recycling waste (Lombrano, 2009; Passarini et al., 2011). Italian law sets the objectives for separated waste collection each year in accordance with the European Union directive. The target grew from 35% of the total waste collected in 2006 to 65% in 2012. Proper cost monitoring and cost savings are critical for Italian MSW management companies, which struggle with increasing costs and penalties for not reaching separated waste collection targets. This critical role of cost management, as well as the presence of incentives and penalties, makes the Italian context interesting for our research.

The remainder of the paper proceeds as follows: Section 2 introduces the FCA methods; Section 3 describes the procedure used to develop the FCA method to carry out the empirical analysis; Section 4 lays out the empirical findings. Finally, Section 5 includes the conclusions and the practical implications of our study.

2. Theoretical approach

A full cost accounting method is designed to identify all costs, direct and indirect, associated with providing products or services. In the U.S., several local governments are using the full cost accounting method to identify, calculate and report on the total costs of providing MSW management to citizens.

Prior studies analysed the application of FCA in the MSW lifecycle and highlighted several critical issues that emerge when the FCA is put into practice (USEPA, 1997; Gupta, 2009). For example, a key issue is which costs to incorporate in the full cost. The U.S. EPA handbook (1997, p. 6) indicates seven main cost categories: up-front, operating, back-end, remediation, contingent, environmental and social costs. The first three categories cover the entire lifecycle of the MSW activities from the "cradle" (up-front) to the "grave" (back-end) and include: the initial investment for purchasing the necessary equipment to collect and transport waste (up-front costs), the expenses of managing MSW on a daily basis (operating costs) and the expenditures to properly wrap up operations and take proper care of landfills and other MSW facilities at the end of their useful lives (back-end costs). The latter four categories include costs that are not strictly associated with the MSW lifecycle, such as the remediation costs at inactive sites (e.g. landfill) to avoid the contamination of water, land, etc., and the environmental and social costs that include the negative externalities generated by the MSW activities in term of pollution, degradation of the land, etc.

Several studies suggest including the environmental and social costs in the MSW full cost to give the local governments a more comprehensive view of the integrated performance of the MSW management processes using a "triple bottom line": environmental, economic and social results (Bebbington et al., 2001).

Another critical issue regards the allocation process of the indirect costs among the different MSW activities. Management accounting literature suggests four main criteria to identify the proper allocation bases: the cost-and-effect relationship (which is often indicated as the most preferable), the benefits received, the ability to bear and the fairness or equity (Horngren et al., 2013). The identification of the allocation bases inevitably increases in complexity when municipalities use different MSW paths like recycling, composting, land disposal, etc. In these cases, there are several potential allocation bases like the quantity collected, the quantity recycled, the time of performing activities, the number of employees and the cost of labour, to name a few. Consequently, the selection of the most appropriate and reasonable allocation bases for the indirect costs becomes more complex (Debnath and Bose, 2014).

The aim of our study is to propose and implement a management tool to calculate the full collection costs of different types of waste. In this study, FCA is applied to measure the collection costs of four types of waste: paper and paperboard; multi-material (glass, plastic, metal); organic waste and undifferentiated. Our analysis aims for a better understanding of the difficulties of putting full cost accounting (FCA) into practice in the MSW sector and adds to the knowledge of and experience in FCA that may currently be found in the literature.

3. Practical approach

To identify the sample companies, we adopt a stratified sampling process with proportional allocation and take several criteria into account. In total, 68 municipalities were sampled, with populations ranging from about 5000 inhabitants to 900,000 inhabitants. Forty-two waste management companies serve the 68 municipalities. We sent a questionnaire to the sample waste management firms to gather information about the quantity of bins, vehicles and workforce employed in the waste collection process and the cost data. Appendix 1 reproduces an excerpt from the questionnaire. Thanks to support from the National Italian Packaging Association (CONAI), all the sampled companies participated in the research. A one-day field visit was organised at each waste disposal firm to gather further data and request clarification. To check the robustness of the methodology, we carried out the research in 2009 and replicated it in 2011. In this paper, we present the results of the 2011 research.

The measurement of the full cost of the collection activities requires the estimation of direct and indirect costs. As our analysis focuses exclusively on the waste collection process, we took into accounting only the costs associated with the activities included in this process. According to the classification proposed by the U.S. EPA, these costs include: a) *up-front costs*, comprising the initial investment for purchasing the necessary equipment to collect waste, namely bins, vehicles and other types of equipment; b) *operating costs*, including the cost of the workforce, fuel and managing waste collection on a daily basis.

In our study, the direct costs include the bins, vehicles and workforce that are used or involved in the waste collection activities. Usually, once the companies identify the quantity and the unit price, measurement of the direct costs does not present a problem.

Since the initial purpose of the research was to calculate the actual collection costs of different types of waste, we firstly explored the possibility to use the data tracked in the accounting system of MSW management companies.

The analysis of the responses revealed noticeable differences among companies with regard to the purchase price, the maintenance costs and the depreciation rate of the bins and vehicles. Choices like the depreciation rate to be used may depend on earnings management purposes (i.e. the attempt to reduce income taxes), which has nothing to do with operations. Also, the purchase prices may be influenced by choices that are not driven by operational efficiency but by firm-specific or geographical context-