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Cruz (Silvia), Paulino (Sônia), Paiva (Delhi), « Les dynamiques d'innovation de service dans le secteur des déchets solides. les projets de décharge MDP »

Résumé – Cet article est consacré à l'innovation de services dans le secteur des déchets solides. Il examine les bénéfices mutuels résultant de deux projets de décharge relevant du Mécanisme de développement propre (MDP). Des indicateurs sont proposés pour évaluer les résultats sociaux et environnementaux de ces décharges MDP. L'article s'appuie sur deux cadres théoriques complémentaires : le modèle fondé sur les caractéristiques et les réseaux d'innovation public-privé dans les services (ServPPIN).

Mots-clés – ServPPIN, innovation dans les services publics, mécanisme de développement propre, secteur des déchets solides, décharge

Cruz (Silvia), Paulino (Sônia), Paiva (Delhi), « Service Innovation Dynamics in Solid Waste Sector. CDM Landfill Projects »

Abstract – The aim of this paper is to analyze the dynamics of service innovation in the solid waste sector, examining the generation of co-benefits resulting from two Clean Development Mechanism (CDM) landfill projects. Indicators are proposed to evaluate the social and environmental outcomes from CDM landfills. Data collected are organized and analyzed based on two complementary theoretical frameworks: the characteristics-based model and the public-private innovation networks in services (ServPPIN).

Keywords – ServPPIN, public service innovation, clean development mechanism, solid waste sector, landfill

SERVICE INNOVATION DYNAMICS IN SOLID WASTE SECTOR

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INTRODUCTION

CDM encompasses activities aimed at reducing greenhouse gas (GHG) emissions by establishing projects across a wide range of sectors, including landfill sites. In line with article 12 of the Kyoto Protocol, these projects must also contribute to promote sustainable development in host countries by generating social and environmental co-benefits. Although CDM projects have this twofold goal, the United Nations Framework Convention on Climate Change (UNFCCC) only recently began to consider the evaluation of co-benefits generation (UNFCCC,

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2012a, 2012b, 2012c). The aim of this paper is to analyse the dynamics of service innovation in the solid waste sector in order to assess the co-benefits generated by Clean Development Mechanism (CDM) projects, within the context of carbon markets. Two landfill projects are considered: *Bandeirantes*, a public project and *Caieiras*, a private project.

In line with the Marrakech Accords (Decision 17/CP. 7), the responsibility for determining whether a CDM project activity contributes to sustainable development is defined by the host country and resides with a Designated National Authority (DNA) (UNFCCC, 2001). Furthermore, the CDM Executive Board requires stakeholders' participation through the entire lifecycle of the activity.

In Brazil, in order to promote local sustainable development the specification of projects must be based on information provided in Annex III of Resolution n.1 of the Inter-Ministerial Commission on Global Climate Change[5]. This establishes both the benefits to the local area and how project activities contribute to each of the following aspects: environmental sustainability, improvement in working conditions and net job creation, income distribution, training and technological development, and finally, regional integration and working in conjunction with other sectors (Brazil, 2003).

Resolution nº 1 (Brazil, 2003) also points out the importance of the effective participation of civil society throughout the CDM project's approval process. In the case of Brazil, project proponents should send letters of invitation to all project stakeholders, including local authorities and the chamber of deputies of all municipalities involved, municipal and state environmental departments, NGOs and social movement forums; community associations both directly and indirectly involved in project activities, and State and Federal Public Prosecution Offices.

The DNA issues a Letter of Approval (LoA), a document confirming that the project contributes to the sustainable development of a particular country. The approval is exclusively based on the expected results (local contributions) of the project in terms of sustainable development and not on verified results. Within this context, several studies focusing on the analysis of CDM results have demonstrated the difficulties (or even the failure) of GHG reduction projects in contributing to the promotion

5 Inter-Ministerial Commission on Global Climate Change is the Designated National Authority (DNA) in Brazil.

of local benefits and guaranteeing stakeholder participation (Olsen and Fenhann, 2008; Boyd *et al.*, 2009; Peskett *et al.*, 2007; Kolmuss, 2008; Nussbaumer, 2009; Sutter and Parreño, 2007; Siebel *et al.*, 2013).

To address changes in landfills as a result of CDM implementation, 23 indicators are proposed to evaluate the social and environmental outcomes that may be generated by CDM landfills, organized into social and environmental dimensions and subdivided into five themes: three involving the social dimension (participation, stakeholder interaction and benefits, and two involving the environmental dimension (environmental quality monitoring and gas emissions monitoring). The data collected by applying these indicators are organized and analyzed using two complementary theoretical frameworks: the characteristics-based model developed by Gallouj and Weinstein (1997), updated by Gallouj (2002) and Gallouj and Savona (2010); and the public-private innovation networks in services (ServPPIN) concept (Gallouj *et al.* 2013).

This paper is structured into three sections: following this introduction, section 1 discusses the theoretical frameworks used to analyze the public service innovation dynamics, the characteristics-based model and ServPPIN concept. Section 2 focuses on methodology, presenting the empirical cases (the profile of the landfills selected and the identification of stakeholders involved in these landfills) and development and validation of indicators. Section 3 shows the results followed by our conclusions.

I. THEORETICAL FRAMEWORKS TO ANALYZE THE PUBLIC SERVICE INNOVATION DYNAMICS: The characteristics-based model and ServPPIN concept

Djellal and Gallouj (2012) highlight the importance of public services according to their social or civic output. For the authors, "Public services 'outputs' contribute to social cohesion, solidarity and collective and civic identity" (p. 11). Another aspect of public service provision is the difficulty in identifying and demarcating activities that should be attributed to the public sector as opposed to the private sector, as many services and activities in the public sector are integrated with

the activities of the private sector and vice-versa (Bugge *et al*, 2010; Potts and Kastelle, 2010). This is observed with regard to municipal solid waste services, generally carried out via concessions granted to the private sector.

According to Bugge *et al.* (2010) and Bloch and Bugge (2013) the multi-faceted and heterogeneous nature of the public sector is the result of multiple interfaces which characterize public organizations: 1) interface with the private sector; 2) interface between the public sector and citizens; and 3) internal interfaces within the public sector (between government levels and between different areas of activity). These various interfaces illustrate public sector heterogeneity and the permeability between organizations belonging to the private, public or third sector (Gallouj *et al.*, 2013).

This study adopted an integrated approach to service innovation. This involves using a global perspective to explain service innovation, providing a broad framework, addressing technological and non-technological innovation and taking into consideration all actors involved in the service.

The purpose of this section is to present: 1) the characteristics-based model, an adequate tool for describing the vectors of service competences, techniques and final characteristics interact; and 2) the ServPPIN concept, useful to identify and systematize aspects related to agent interaction, emphasizing the participation of associations and cooperatives close to the landfills.

THE CHARACTERISTICS-BASED MODEL

Gadrey (2000), based on service relations, suggests the following services definition:

> […] a service activity is an operation intended to bring about a change of state in a reality C that is owned or used by consumer B, the change being effected by service provider A at the request of B, and in many cases in collaboration with him or her, but without leading to the production of a good that can circulate in the economy independently of medium C (Gadrey, 2000, p. 375).

Gadrey's (2000) concept of 'service triangle' helps us to understand service production as a social process constructed by actors participating

in the service production process and by the context in which these actors find themselves (cultural, social, institutional, economic, etc.). Thus, these relationships, characterized by the interaction between the client/user and the service provider, highlight the service interface component, as well as the competences (technical and/or human) required for service provision. In this study, the solid waste service is considered by using Gadrey's service logic (2000) and applying it to the context studied, from its generation to its final disposal.

According to Gallouj and Weinstein (1997), within a "characteristics-based approach", the product (good or service) can be described as a set of interrelated vectors of characteristics and competences. This model, updated by Gallouj (2002) and Gallouj and Savona (2010), includes the technical characteristics of both providers and customers, their competences and the service or final characteristics (or use value) provided to the customer. In Figure 1, [Y] represents the service characteristics, [T] the internal technical characteristics, [T'] the external technical characteristics, [C] the internal competences and [C'] the external competences, internal and external respectively referring to the service provider and the customer.

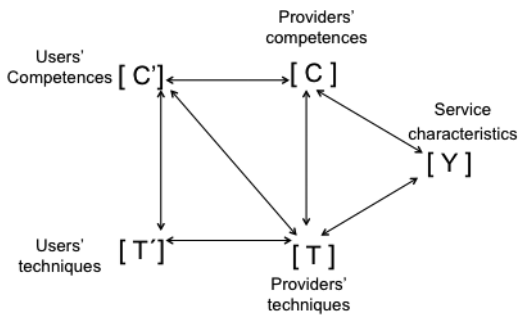

FIG. 1 – The product as a conjunction of vectors of characteristics and competences (in a characteristics-based approach). Source: Gallouj and Savona (2010).

Thus, a service can be defined as the mobilization of internal and external competences and internal or external techniques (tangible or intangible) to produce the final characteristics of a good or service.

A recent contribution to the model was proposed by Windrum and García-Goñi (2008) suggesting the inclusion of the government in the Gallouj and Weinstein (1997) and Gallouj and Savona (2010) model. Windrum and Garcia-Goni (2008) show that the quality of a good or service depends on the sets of competences belonging to service providers/producers and users. Service provider competences are split into *back office* competences and *user facing* competences, required for user interaction.

Different types of actors are involved in the innovation process. In this way, the multi-agent service provision model enables the development of complementarities and synergies between the various agents, each with specific goals and competences (Windrum and García-Goñi, 2008; Weber and Heller-Schuh, 2013; Windrum, 2013). Having outlined the characteristics of multiple interfaces and the heterogeneity of the public sector, the ServPPIN concept can be useful to identify and systematize the aspects related to agent interaction.

THE SERVPPIN CONCEPT

One of the factors behind the interest in examining Public-Private Innovation Networks is the growing recognition of the important role played by public sector organizations in the innovation process. Public administrations are thus no longer restricted to playing a supporting role in these processes.

Similar to public-private partnerships (PPPs), ServPPINs are collaborative networks involving public and private organizations. However, in contrast to traditional PPPs, they are more comprehensive, open and flexible. In PPPs, relations between actors tend to be more rigid, involving predefined functions, rules and formal procedures (particularly contracts), making the process more bureaucratic, thus limiting its potential for innovation. The high number and diversity of participants in a ServPPIN tend to lead to a multi-faceted and intensive process of interaction. Given the many channels that are opened, large amounts of heterogeneous information and knowledge (tacit and non-tacit) are likely to be exchanged. In other words, ServPPIN can be thought of as a multi-agent service relationship system (Djellal and Gallouj, 2013).

The innovation network concept is biased towards manufacturing and technology. Traditionally, this concept has several deficiencies, namely, a technology bias (where tangible technological innovation

predominates), a manufacturing bias (linked to the latter), and a market bias (the private sector is central to innovation dynamics). In short, this means that innovation networks are mainly focused on technological innovation produced in collaboration with private actors in the manufacturing sector.

The ServPPIN concept provides a way of overcoming these various biases (Djellal and Gallouj 2013; Gallouj *et al*., 2013; Labarthe *et al*. 2013, Windrum, 2013). It goes beyond the technologist view of innovation[6], providing a broader perspective which incorporates non-technological types of innovation. These include organizational innovation, ad hoc innovation defined by Gallouj and Weinstein (1997) as interactive solutions to the specific problems of particular clients, social and bricolage innovation defined by Fuglsang (2010) as innovation resulting from non-programmed activities, trial-and-error processes and adaptation to random events.

Through the ServPPIN concept, Gallouj *et al.* (2013) emphasize the importance for service innovation of multiple links and feedbacks (interfaces) between the public and private sectors, as well as users – in our case, the representatives of the association from the communities surrounding the landfills – and policy-makers. As pointed out by Djellal and Gallouj (2013):

> ServPPINs are *multi-agent service relationship systems*. The actors involved in interaction have to deal with the ill-defined nature of their respective products, their non-stockability, a diversity of systems of interaction, the multiplicity of possibly competing value systems and the fact that their products are located in different spatial and temporal scales. ServPPINs introduce the traditional research questions of service economics into network-based analyses of innovation. (Djellal and Gallouj, 2013 p. 30).

Thus, the multi-agent framework is particularly well-suited to studying the public-private innovation networks concept. The Windrum and García-Goñi (2008) model[7] (inspired by Gallouj and Weinstein, 1997), in

6 The technology issue is taken into account in the designs of carbon market projects and in the promotion of social and environmental local co-benefits. In the cases studied, all Project Design Documents (PDD) and Validation Reports indicate the development and dissemination of technologies through project implementation, highlighting the following aspects: training, technology development and transfer.

7 See also Windrum (2013).

particular, is an analytical framework representing interactions between the various agents from the political, economic and social spheres.

In short, this model differs from the other in that it includes the government as an important agent in the innovation process in order to highlight the importance of considering the preferences of different actors. Furthermore, this model also emphasizes the importance of organizational and relational competences – in particular with regard to the interaction between service providers and users – in steering the trajectory of service characteristics.

According to Bučar *et al*. (2013), ServPPINs can be understood as a space for social interaction and the construction of social relations aimed at innovation. Nevertheless, when considering all case studies addressed in the ServPPIN research project[8], a considerable number were not explicitly oriented towards innovation. For example, in some hospital case studies the main objective was to reduce the costs of using technologies.

Similarly, the explicit aim of the CDM landfill projects we examined was the reduction in GHG emissions rather than the promotion of service innovation. In fact, technology and innovation appear to be additional outcomes of the local co-benefits generation. Interesting changes and innovations are likely to emerge from such networks which may then be retrospectively labelled 'innovation networks'. With regard to non-technological, incremental and unprogrammed innovations (ad hoc, *bricolage*, rapid application etc.), it is also possible to consider even those networks not explicitly (or immediately) oriented towards innovation as ServPPINs.

ServPPIN contributes to introduce the traditional innovation network concept to new actors, that is, market and third sector organizations (NGOs, associations etc.). It extends potential forms of participation to specific actors, for example, civil society, involved in decision-making and consultation processes. This is particularly the case with regard to civil society's role in the ServPPIN context – helping to translate social preferences not fully reflected by market prices (Fuglsang, 2013).

8 ServPPIN is an EU-funded research project which focuses on the role of public and private services on growth and welfare and the particular role of public-private innovation networks. For more information: http://www.servppin.com/. The main results of the project are also published in Gallouj, Rubalcaba and Windrum (2013).

In addition to highlighting the importance of integrating users into the service innovation process, the ServPPIN Research Project findings indicate that the participation and involvement of both non-profit organizations and service users (citizens) is still limited. Thus, as argued by Labarthe *et al.* (2013), it is not end-users, or individual users, who are integrated within networks, but rather, the collective organizations representing these groups – and in our case, the representatives of associations of the communities surrounding landfills.

II. METHODOLOGY

This section describes, first, the geographical boundaries of the research, featuring the case studies and stakeholders. It subsequently presents the procedures used to validate the indicators for co-benefits evaluation.

RESEARCH CONTEXT AND EMPIRICAL CASES

The São Paulo Metropolitan Area comprises 39 municipalities with approximately 20 million inhabitants, generating around 16,000 tonnes of solid waste per day (Cetesb, 2013). Landfill CDM projects are concentrated in the south-eastern region of the country, 23 of which are located in the State of São Paulo (UNEPRisoe, June, 2015). Thus, our research focuses on the São Paulo Metropolitan Area and outlines two CDM projects. The landfills in this empirical research were selected on the basis of the following criteria:

a) Project scope: landfill projects;
b) Location: São Paulo metropolitan area;
c) Methodology used to measure GHG emissions reduction: ACM0001 – flaring or use of landfill gas;
d) Monitoring period established: at least one monitoring period to the beginning of the empirical research (February, 2014).

Given the criteria above, the following landfills were selected: Bandeirantes and Caieiras. CDM landfill projects data were collected

from 2003 to 2014 and obtained through documentary research using two databases: The United Nations Environment Program (UNEPRisoe) database and UNFCCC – CDM Registry which enabled access to monitoring reports project design documents (PDDs) and project documentation based on Annex III of Resolution No. 01/2003 of the Inter-ministerial Commission on Climate Change (CIMGC) (document describing the promotion of social and environmental co-benefits).

In order to map stakeholders, specific and additional information on the representatives of the associations from the communities surrounding landfills directly affected by the activities of the enterprises was analyzed. The following databases were examined:

- The recyclable material cooperatives register, available from the Department of Environment of São Paulo State website – SMA[9];
- The "register of civil society organizations – 2009-2011 database", available from the Integrated Water Resources Management System (SIGERH)[10], taking into account data related to the Alto Tietê Basin Committee for the geographical area selected for the study;
- The websites of the municipalities affecting Caieiras;
- The websites of the sub-district Perus (city of São Paulo);
- Minutes of public audiences on carbon credits;
- FEMA (Environment and Sustainable Development Fund) and Confema (Special Fund for the Environment and Sustainable Development Council) resolutions related to CDM projects (in this case, exclusively for Bandeirantes);
- Direct searches with the Google web search engine, using the following keywords: the names of the landfills, cooperatives and associations/communities surrounding the landfills.

9 <www.ambiente.sp.gov.br>
10 <www.sigrh.sp.gov.br>

INDICATORS: DEVELOPMENT AND VALIDATION

In order to evaluate the social and environmental co-benefits of CDM projects in landfills, 23 indicators were proposed and organized into the social and environmental dimensions and subdivided into five themes:

- Social Dimension: a) *Participation*, concerns the quality and coverage of the participation of different stakeholders in all phases of the CDM projects development; b) *Stakeholder interaction*, concerns the interaction between agents involved in the CDM projects, encompassing public and private sectors and users (associations and representatives of civil society, recycling cooperatives; etc.); c) *Benefits*, concern the benefits promoted by the CDM with reference to urban solid waste;
- Environmental Dimension: d) *Environmental quality monitoring*, relates to identifying the potential for reducing the negative environmental impacts of the landfill sites; and e) *Gas emissions monitoring*, concerns the efficiency of the landfills' biogas capture systems.

The process for developing indicators was participatory: the indicators were presented and discussed with stakeholders and they took into account expert validation using the Delphi technique (Linstone and Turoff, 1975; Ristola, 2012; Tuominen *et al.*, 2014). The literature on Delphi clearly indicates that not only (technical) experts may be involved in the validation process, but also decision-makers and other relevant stakeholders able to provide information on the topics covered by Delphi (Linstone and Turoff, 1975; Ristola, 2012; Varho and Tapio, 2013; Tuominen *et al.*, 2014).

In this research, 2 experts participated in the pre-test phase (October, 2014), 10 in the first round (November, 2014), and 9 in the second round (January, 2015). The online questionnaire was divided into two sections with the following main objectives: a) to evaluate the significance level of the indicator (based on the Likert scale: very low, low, moderate, high, and very high); and b) to qualitatively analyze the indicators' descriptions. The instructions given to evaluate the indicators were, essentially: a) to analyze the indicators' description; and b) to evaluate the indicators' level of significance. Table 1 shows the indicators organized into social

and environmental dimensions and into the five topics – participation; stakeholder interaction; benefits; environmental quality monitoring; and gas emissions monitoring.

Social Dimension		
Topic I: Participation		
Indicators	Description	Variables
Number of participants and stakeholders involved	Identifies the number of participants both in meetings and public audiences related to CDM projects; and participants and stakeholders involved	Number of participants in the meetings; number of participants in the public audiences related to CDM projects
Channels for recording complaints	Identifies the number of complaints / year; % of complaints resolved in order to first, evaluate the existence of channels for recording complaints and second, to identify responses	Number of complaints / year; % of complaints resolved
Projects' acceptance by the population and environmental non-governmental bodies	Identifies the number of formal complaints and/or suggestions / year by the population and environmental non-governmental bodies related to CDM projects	Number of formal complaints / year; Number of formal suggestions / year
Disclosure to stakeholders of the activities proposed in PDD, based on Annex III aspects	Identifies the number of published documents (including digital media) disclosing to stakeholders the activities proposed in the PDD based on Annex III aspects in order to evaluate whether actions are disclosed to stakeholders, as well as the means of communication used	Number of published documents
Language and clarity of documents	Identifies suitability of documents; evaluates the language and clarity of key documents related to the project	Suitable; unsuitable

Consultation period	Identifies the suitability of the public comments and consultation period (30 days) established by the UN/UNFCCC (after validation by the Designated National Authority)	Suitable; unsuitable
Public consultation before implementation and during project execution	Identifies the number of meetings conducted in order to evaluate whether users were consulted before the implementation and during project execution; the level of stakeholder satisfaction with the consultation conducted; and whether the landfill post-closure plan was participatory and included the communities surrounding the landfills	Number of meetings; satisfactory, not satisfactory
Topic II: Stakeholder Interaction		
Indicators	Description	Variables
Communication between municipal departments	Identifies the number of meetings and/or number of published and/or disclosed documents in order to evaluate whether there is Communication between municipal departments on the CDM projects	Number of meetings; Number of joined up initiatives and activities focusing on CDM projects
Communication between municipal departments and concession-holders managing the landfills	Identifies the number of meetings and/or number of published and/or disclosed documents in order to evaluate whether there is Communication between municipal departments and concession-holders managing the landfills	Number of meetings and/or number of published and/or disclosed documents

Communication between municipal departments and representatives of associations from the communities surrounding the landfills	Identifies the number of meetings and/or number of published and/or disclosed documents in order to evaluate whether Communication between municipal departments and representatives of associations from the communities surrounding the landfills exists; and the level of stakeholder satisfaction with procedures adopted	Number of meetings and/or number of published and/or disclosed documents
Communication between municipal departments and concession-holders responsible for LFG[i] recovery and power generation	Identifies the number of meetings and/or number of published and/or disclosed documents in order to evaluate whether Communication between municipal departments and concession-holders responsible for LFG recovery and power generation exists	Number of meetings and/or number of published and/or disclosed documents
Communication between concession-holders managing the landfills and concession-holders responsible for LFG recovery and power generation in relation to the landfill closure plan	Identifies the number of meetings and/or number of published and/or disclosed documents in order to evaluate whether Communication between concession-holders managing the landfills and concession-holders responsible for LFG recovery and power generation in relation to the landfill closure plan exists	Number of meetings and/or number of published and/or disclosed documents
Communication between concession-holders responsible for LFG recovery and power generation and representatives of associations from the communities surrounding the landfills	Identifies the number of meetings and/or number of published and/or disclosed documents in order to evaluate whether Communication between concession-holders responsible for LFG recovery and power generation and representatives of associations from the communities surrounding the landfills exists	Number of meetings and/or number of published and/or disclosed documents

Topic III: Benefits		
Indicators	Description	Variables
Cooperatives benefiting from CDM revenues	Identifies the number of cooperatives benefited and the number of people benefited in order to verify whether CDM landfill projects have benefited cooperatives surrounding the landfills	Number of cooperatives benefited / Number of people benefited
CDM projects contributions to environmental education initiatives	Identifies whether CDM landfill projects contributed to improve/develop environmental education initiatives; Number of people benefited; training; in order to verify projects' contribution to environmental education initiatives aimed at USWM[ii]; and the level of stakeholder satisfaction	Number of environmental education initiatives provided by CDM; Number of people benefited; Training
CDM projects contributions to technology and methodology development	Identifies the number of technologies and methodologies developed by landfill CDM projects	Number of technologies and methodologies
Environmental Dimension		
Topic IV: Environmental quality monitoring		
Indicators	Description	Variables
Surface and underground water monitoring	Identifies the number of Samples taken every months and the Number of nonconformities every 6 months, obtained from surface and underground water monitoring results	Sampling / 6 months; Number of nonconformities / 6 months
Leachate monitoring	Identifies possible changes in leachate (litres/hour) provided by monitoring results throughout the project development period	Nonconformities samples during the entire project development period

Geotechnical monitoring: soil stability	Identifies the Samples taken every 6 months and the Number of nonconformities every 6 months obtained from the geotechnical monitoring results on soil stability in order to prevent accidents caused by landfill slope movements	Sampling / every 6 months; Number of nonconformities / 6 months
Landfill closure plan	Identifies Suitability of compliance with landfill closure plan	Suitable; unsuitable
Odors	Identifies air quality (odors) monitoring; the quality of data obtained; and the number of complaints / year by stakeholders regarding unpleasant odors.	yes; no; Suitable; unsuitable; number of complaints / year
Topic V: Gas emissions monitoring		
Indicators	Description	Variables
Fugitive gas emissions	Identifies volume of fugitive gas every 3 months from monitoring results	Volume of fugitive gas / 3 months
Biogas capture	Identifies the amount of biogas captured Nm / year, allowing for adjustments and corrections in the landfill gas drainage system in order to eliminate odors	Volume of biogas captured Nm / year

i. Landfill gas
ii. Urban solid waste management

Tab. 1 – Proposed indicators subsequent to Delphi rounds.

During the two Delphi rounds, the answers provided by the experts in accordance to the Likert scale were tabulated using the Minitab® statistical software and statistically represented by the median, the first and third quartiles. At the end of two rounds, the interquartile ranges were analyzed – comparing the differences between the first and third interquartile of the first and second rounds. Qualitative

data on indicators descriptions were compiled to identify trends and/or discrepancies between Delphi participants' responses. Stakeholder data were collected in face-to-face interviews, using a semi-structured questionnaire applied in April 2015.

III. RESULTS

This section will first present the results of the characteristics-based approach model adapted to the CDM landfill context, followed by results based on the ServPPIN concept, to identify the promotion of social and environmental co-benefits through innovation and stakeholder participation.

THE CHARACTERISTICS-BASED APPROACH MODEL ADAPTED TO THE CDM LANDFILL CONTEXT

The Gallouj and Weinstein's (1997) characteristics-based model and additional contributions were adapted[11] to the CDM landfill context in order to analyze competences and techniques and examine the potential mitigation of environmental impacts resulting from this activity, taking into account soil, air, surface and groundwater contamination.

Considering the context studied, is it important to highlight the relevance of regulations (especially aimed at controlling odors emissions and gas monitoring) affecting the use and selection of techniques by direct and indirect service providers. Figure 2 shows the representation of products related to the final disposal of solid waste in the CDM landfills.

11 Contributions made by Gallouj (2002), Gallouj and Savona (2010), and Windrum and Garcia-Goñi (2008).

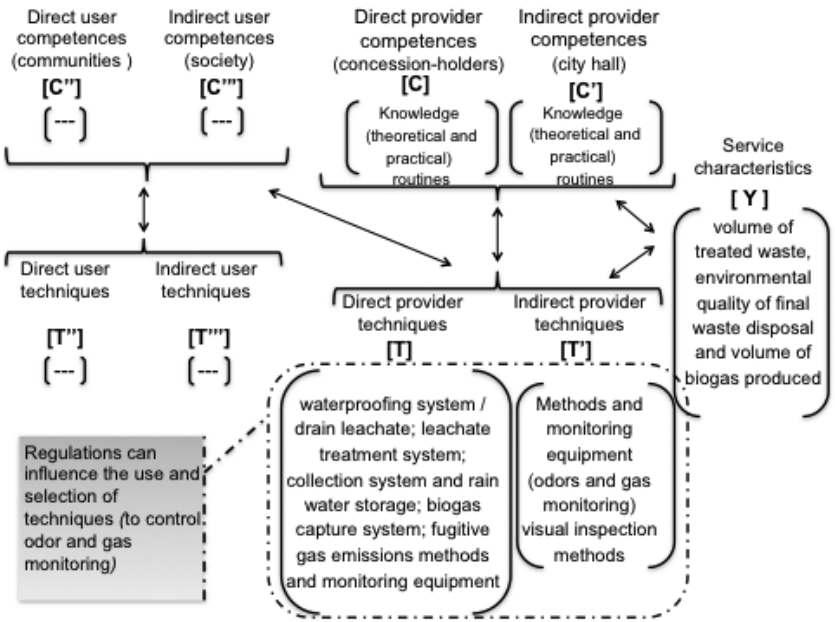

Fig. 2 – The product as a conjunction of vectors of characteristics adapted to the CDM landfill projects context[12].
Source: The authors.

The *service characteristics vector [Y]* highlights the key features which justify applying resources to the services related to final waste disposal in the CDM landfills. These service characteristics (Y) include volume of treated waste, environmental quality of final waste disposal and volume of biogas produced. The focus on providers and users techniques ([T], [T'], [T''], [T''']) and competences ([C], [C'], [C''], [C''']) to produce services related to final waste disposal takes into account soil, air, surface and groundwater contamination. With regard to the analyzed context, the importance of emphasizing the role of regulations (particularly focused on odor control and gas monitoring) was observed, given their potential influence on the use and selection of techniques by direct and indirect service providers.

12 The elements included in each vector are not exhaustive, but just examples.

The representation of services in terms of their characteristics is a theoretical approach which enables the move from the conception of product (good or service) towards a conceptualization of innovation, based on the changes in service characteristics and considering the different agents influencing service production. In general, technological and non-technological innovations are identified and focus on the operational efficiency of the landfills' biogas capture systems: the final cover layer in the landfill post-closure phase and the biogas generation prediction model. It became apparent that air quality monitoring linked to odor emission control – considered as a key-point for the communities surrounding the landfills – is a problem, thus exposing the deficiencies of methods, standards and competences in the researched context, that is, odor emission control is a co-benefit which has not yet been achieved.

As previously discussed, in Brazil, the public service of urban solid waste management is mostly performed by private companies. The Government grants concession-holders the right to perform this service. Therefore, based on the theoretical model adopted, municipalities are considered to be indirect service providers, and concession-holders, direct service providers. The communities surrounding the landfills are considered direct service users, and society at large, indirect service users, given the emphasis on the generation of local co-benefits from the CDM landfill projects.

The direct [T] and indirect [T'] service providers' technical characteristics vectors and the direct [T'] and indirect [T''] users' technical characteristic vectors make up a set of techniques used to produce a product. These techniques may be tangible (computers, machinery, equipment, and other infrastructure items) or intangible (mathematical methods, working methods).

In the researched context of CDM landfill projects, the key difference between the direct service providers (concession-holders) and indirect providers (public sector) techniques relates to the fact that the former are responsible for sample production, development and analysis and the latter, for the supervision/inspection of the procedures performed by the direct providers. No direct or indirect user techniques ([T''] and [T''']) which influence service characteristics were identified.

Direct service provider techniques [T] encompass waterproofing system/drain leachate, leachate treatment system, collection and rain water

storage systems, biogas capture system, fugitive gas emissions methods and monitoring equipment. Tangible techniques predominantly relate to landfill maintenance equipment, machinery and materials. In the CDM landfill projects the incorporation of new equipment, particularly in relation to the thermal power plant operation and the final waste cover, is highlighted. Intangible techniques relate to adjusting (tropicalization) the model to provide for potential biogas production. The aim of gas monitoring is to detect possible gas migration and the risk of explosions. The results of the monitoring analysis enable adjustments and corrections to be made in the landfills' gas drainage systems, eliminating odors and assisting in the efficient and safe handling of gas.

Indirect service provider techniques [T'] relate to the supervision of activities carried out by concession-holders. They comprise rainfall recording monitoring methods, checking the performance of surface drainage equipment used, monitoring and piezometric levels readings, physiochemical and microbiological analyses of surface, groundwater and leachate samples in order to check for possible deviations over the monitored period. Methods for monitoring the biogas produced were also incorporated. In terms of equipment, the main instruments used by the indirect service providers to conduct landfill inspections were superficial signs of landslide, water level meters, piezometers and gas manometers. In terms of intangible techniques, visual inspection methods to identify geotechnical problems are highlighted.

Competences are incorporated into individuals, a group of individuals or an organization and are the result of activities such as training, experience and interactions. These competences are tacit and not likely to be transferable.

Direct service provider competences [C] relate to knowledge (theoretical and practical) and routines. The theoretical and practical knowledge for adapting and applying biogas estimation models considering the parameters compatibles with the Brazilian panorama are highlighted. The first step in biogas capture for power generation includes initial theoretical studies which must take into account parameters, tests and experiments appropriate to each case analyzed (Kaimoto *et al.*, 2006). This results in the need to provide more conservative parameters, adapted to the Brazilian biogas production context, considering that the first CDM landfill projects did not meet generation estimates for certified emission

reductions (CER) during the first accreditation period. To address this shortfall, new theoretical knowledge was acquired by adapting the model to predict the biogas production potential. Initially, the projects applied the United States Environmental Protection Agency (US EPA) model in order to reduce uncertainty in biogas generation throughout the project development phase. Other methodologies were applied by the CDM projects that took part in the second accreditation period. In relation to the practical knowledge of direct service providers [C], CDM implementation required extensive initial training to guarantee landfill maintenance in accordance with the PDDs during the entire project cycle. Project expertise is required for the gas capture and treatment operation system. Practical competences for biogas capture drainage regulation and operation stand out, as do biogas capture supervision system records.

In general terms, essential practical knowledge required for biogas capture activities in landfills relate to handling systems, equipment and technological resources suitable for biogas capture; inputting information into the systems according to the standards required by the CDM/designated operational entities (DOE)/Environmental Sanitation Technology Company (CETESB); identifying solutions for problems caused by the inappropriate use of systems and work equipment; care in the use of systems and equipment; quick decision-making relating to operational problems; sharing relevant information; identifying potential operation system errors, equipment and technological resources.

In relation to routines, the Designated Operational Entities (DOE) are the international or national bodies responsible for validating CDM landfill projects. DOEs are involved in the initial phases of project design, validation, registration and also throughout the accreditation period. Project monitoring takes place periodically and the CDM Executive Board is requested to issue CERs with mandatory validation by the DOEs. The validation process may change or introduce new procedures and processes in landfills, affecting routines, processes and operations.

Indirect service providers competences [C'] relate to knowledge (theoretical and practical) about the biogas capture system. Subsequent to the implementation of the biogas capture system, the identification of cracks and/or leakage in landfill sites becomes a relevant topic. Thus, in relation to routines, trained technicians conduct careful visual inspections in

order to identify signs of geotechnical problems. If anomalies are perceived, they are recorded and analyzed, instigating appropriate actions, interventions and/or repairs.

No direct or indirect users' competences ([C''] and [C''']) influencing the service characteristics in the final waste disposal of CDM landfill projects were identified. In this context, the need to develop regulations to control odor emission and gas monitoring is highlighted. Regulations can influence direct and indirect service providers in their choice and use of techniques.

It is important to note that when the system of capture, drainage and combustion in isolated wells, and the waste cover system perform correctly, in accordance to environmental standards, sulfur dioxide (SO_2) and other gases are eliminated, preventing their release into the atmosphere, thus mitigating a side-effect that particularly afflicts the communities surrounding the landfills. However, air quality monitoring linked to odor emission control was considered a priority by the communities surrounding the landfills. Thus, the lack of development of techniques and competences by service providers to control odor emissions is a service provision deficiency.

SERVPPIN AND THE RELATIONAL ASPECT IN THE INNOVATION ANALYSIS

Returning to the literature on ServPPIN, to analyze innovation within the context studied, five types of interaction are considered: a) between concession-holders and direct users; b) between different concession-holders (private enterprises); c) between public organizations; d) between public organizations and direct users; and e) between public organizations and concession-holders.

Interaction between concession-holders and direct users

The use of extremely technical terms in the documents prevents direct users from attending meetings. This situation can be remedied by developing the competences of direct and indirect providers' ([C] and [C']) to produce illustrative/easily understandable material containing the main points of the project and future actions to be taken with CDM resources.

It is important to note that the 30-day period provided by UNFCCC for stakeholders to submit comments and suggestions to the projects is too short. Direct and indirect providers have the opportunity to develop techniques ([T] and [T']) and competences ([C] and [C']) in order to close the communication gap, seeking new interfaces with users and providing appropriate access to information about CDM projects. For this to take place, direct and indirect providers, and direct users ([C], [C'] and [C'']) are required to have competences comprising knowledge/qualifications in understanding and communication, taking into account user needs.

Direct users are unaware of Annex III aspects. Once again, it is important to highlight the difficulties in understanding the content of documents related to the projects due to the technical language and terms used. Therefore, direct and indirect providers, and direct users ([C], [C'] and ([C'']) need to develop competences to establish an effective common language among different agents. A possible solution would be the development of community newsletters/brochures describing the actions to be taken in the community with project resources. However, in this study, local cooperatives benefiting from CDM resources have not been identified.

Interaction between private concession-holders

The Bandeirantes landfill is operated by two direct service providers. In this case, the interactions between the private concession-holders can be subdivided into technical report information, changed routines, meetings in the "AS5" landfill area, and the landfill closure plan. Compared to other experiences of landfills managed by a single concession-holder (managing the site and operating the biogas system) which tend to be more successful in terms of tasks and activities performed, in Bandeirantes, a considerable amount of time is spent in disagreements and other bureaucratic issues, because there are two direct service providers operating in the same site.

In both landfill cases studied (Caieiras and Bandeirantes), the development and dissemination of technologies related to project implementation are cited in the PDDs and validation reports. According to the data analyzed, incremental innovation resulting from CDM implementation stands out with regard to the improvement in the biogas system of collection, drainage and combustion in isolated wells, resulting in

greater biogas capture efficiency, that is, in a reduction in the amount of fugitive gas from the landfills (a direct service provider technique [T]).

In addition, there has been progress in terms of direct service providers techniques [T], as the advances observed in the model used for establishing parameters to estimate LFG generation adapted to the reality of the landfills. These innovations required the establishment/improvement of direct service providers competences [C] related to the acquisition of theoretical and practical knowledge (to develop and apply methods and technologies) and routines for monitoring landfills.

Interaction between public organizations

In general, public sector participation in CDM projects is very small, especially in projects developed by the private sector. However, the public sector, as the body responsible for service provision, must ensure that the service is being adequately provided. Thus, the public sector must have a leading role as a regulator, in surveillance, in providing support and as a planner.

This study shows that indirect service providers [C'] need to develop relational competences, routines, communication channels and information sharing strategies to interact with other stakeholders, particularly with direct service users. Therefore, further interaction between private-public sectors and joint actions should be implemented to improve and produce co-benefits related to CDM projects.

Interaction between public sector organizations and direct users

No competences ([C'] and [C''']) or techniques ([T'] and [T''']) influencing co-benefits generation related to service direct providers and direct users interaction have been identified.

It was observed that the programs, projects and activities to be carried out with carbon credits resources are based on fuzzy and superficial guidelines and deadlines. Thus, it is important to highlight that direct service providers need routines and communication channels [C´] to interact with other stakeholders, particularly with direct users.

Interaction deficiencies and the direct users' lack of access to data/information prevent the landfill from adequately fulfilling local demands. This study highlighted the need to develop the indirect service providers'

competences [C'] to monitor whether municipal budget projections are being met, in addition to indirect service providers' techniques [T'] on access to data and accountability methods and procedures.

Interaction between public sector organizations and private concession-holders

Innovations also include further developing the indirect service providers' techniques [T'] related to methods for monitoring and investigating the activities performed by direct service providers through the visual inspection of geotechnical problems perceived. Furthermore, it is worth noting the importance of the indirect service provider engineers and technical staff supervising the landfills regarding knowledge [C´] related to handling systems, equipment and technological resources, as well as knowledge on understanding the biogas capture process.

According to the direct service providers, indirect service providers need to develop competences [C´] to promote innovation, in particular with regard to establishing effective routines and communication channels. Currently, communication occurs through the submission of environmental quality monitoring reports and on-site periodic inspections of indirect service providers.

Another point to highlight relates to regulations and standardized methods for odors and gas monitoring and sampling. The periodic inspections are performed on a case-by-case basis, according to the criteria set out by the inspector visiting the landfill. Therefore, techniques [T'] must be developed to define procedures to evaluate the adverse impacts produced by landfills activities.

CONCLUSION

The aim of co-benefit indicators is to contribute to the innovation dynamics analysis so as to clarify service changes and expose deficiencies in terms of the mitigations demanded by stakeholders in fulfilling the requirements of promoting CDM project co-benefits. By using the characteristics-based model and the ServPPIN concept, the main goal

of this study was to evaluate to what extent the projects have fostered innovation in landfills whilst promoting social and environmental co-benefits and the participation of stakeholders.

The focus on competences and techniques related to services produced contributes to a better understanding of the opportunities and challenges for innovation in the CDM projects studied in the waste sector. The focus on the interaction between public and private sectors and users is based on the ServPPIN theoretical approach, highlighting the importance of relational aspects.

Finally, in terms of the implementation of CDM projects, it is suggested that the development of techniques, competences, and stakeholder interaction should be stimulated so as to contribute towards the improvement of solid waste public services in the context researched, in particular, during the last stage of service provision: the final disposal in landfills.

REFERENCES

Bloch C., Bugge M. (2013), "Public sector innovation – From theory to measurement", *Journal Structural Change and Economic Dynamics*. DOI: 10.1016/j.strueco.2013.06.008

Brazil (2003), Comissão Interministerial de Mudanças Globais do Clima – CIMGC, "Resolução n.1" de 11 de setembro de 2003.

Bučar M., Stare M., Jaklič A. (2013), "Weak institutional framework as incentive for service innovation networks: focus on knowledge-intensive business services", in Gallouj F., Rubalcaba L., Windrum P. (eds), *Public-Private Innovation Networks in Services: the dynamics of cooperation in service innovation*, Edward Elgar publishers, p. 326-348.

Bugge M., Hauknes J., Bloch C. and Slipersæter S. (2010), "The public sector in innovation systems: Module 1 – Conceptual Framework", Research project report Measuring Public Innovation in Nordic Countries: Toward a common statistical approach': Module 1: Examining the heterogeneity of public sector.

Cetesb (2013), "Inventário Estadual de Resíduos Sólidos Urbanos". Available from <http://www.cetesb.sp.gov.br/userfiles/file/residuos-solidos/residuosSolidos2013.pdf> (retrieved 08.10. 13).

Djellal F., Gallouj F. (2013), "How Public-Private Innovation Networks in Services (RPPISs) differ to other innovation networks: What lessons for theory?", in Gallouj F., Rubalcaba L., Windrum P. (eds), *Public-Private Innovation Networks in Services: the dynamics of cooperation in service innovation*, Edward Elgar publishers, p. 21-58.

Fuglsang L. (2010), "Bricolage and invisible innovation in public service innovation", *Journal of Innovation Economics*, vol. 1, n° 5, p. 67-87. DOI: 10.3917/jie.005.0067.

Gadrey J. (2000), "The characterization of goods and services: an alternative approach", *Review of Income and Wealth*, Series 46, Number 3, September, p. 369-387.

Gallouj F., Weinstein O. (1997), "Innovation in Services. Research Policy", vol. 26, p. 537-556. DOI: 10.1016/s0048-7333(97)00030-9.

Gallouj F. (2002), *Innovation in the service economy: the new wealth of nations*, Cheltenham, UK, Edward Elgar Publishing Limited.

Gallouj F., Rubalcaba L., Windrum P. (2013), *Public Private Innovation Networks in Services*, Cheltenham, UK, Edward Elgar Publishers. DOI: 10.4337/9781781002667.00006.

Gallouj F., Savona M. (2010), "Towards a Theory of Innovation in Services: A State of the Art", in Gallouj F. and Djellal F., *The Handbook of Innovation and Services*, Cheltenham, UK, Edward Elgar, p. 27-48.

Kaimoto L. S. A., Leite E. F. & Coelho M. G. (2006), "Considerações sobre aproveitamento do Biogás em Aterro Sanitário", simpósio internacional de tecnologias e tratamento de resíduos sólidos – Rio de Janeiro.

Labarthe P., Gallouj F., Djellal F. (2013), "Effects of institutions on the integration of end-users' knowledge in ServPPINs: lessons from two case studies in agro-environmental knowledge-intensive services", in Gallouj F., Rubalcaba L., Windrum P. (eds.), *Public-Private Innovation Networks in Services: the dynamics of cooperation in service innovation*, Cheltenham, UK, Edward Elgar publishers, p. 303-325.

Linstone H. A., Turoff M. (1975), *The Delphi Method: Techniques and Applications*, Massachusetts Addison-Wesley Publishing Company.

Nussbaumer P. (2009), "On the Contribution of labelled Certified Emission Reductions to sustainable development: A multi-criteria evaluation of CDM projects", *Energy Policy*, Vol. 37, nº 1, p. 91-101.

Olsen K., Fenhann J. (2008), "Sustainable development benefits of clean development mechanism projects: A new methodology for sustainability assessment based on text analysis of the project design documents submitted for validation", *Energy Policy*, Vol. 36(8), p. 2819-2830.

Peskett L., Slater R., Stevens C., Dufey A. (2007), "Biofuels, Agriculture and Poverty Reduction, Paper produced for the DFID Renewable Natural Resources and Agriculture Team", ODI, London.

Potts J, Kastelle T. (2010), "Public sector innovation research: what's next?" Innovation: *Management, Policy & Practice*, vol. 12(2), p. 122-137.

Ristola P. (2012), "Impact of waste-to-energy on the demand and supply relationships of recycled fibre", Aalto University School of Science (Espoo, Finland) VTT Science 4. 190.

Siebel M., Rotter V., Gupta J. (2013), "Clean Development Mechanism – A Way to Sustainable Waste Management in Developing Countries?" Österreichische Wasser- und Abfallwirtschaft, vol. 65, nº 1-2, p. 42-46.

Sutter C., Parreño J. (2007), "Does the current CDM deliver its sustainable development claim? An analysis of officially registered CDM projects" Climatic Change, Vol. 84, p. 75-90.

Tuominen A., Tapio P., Varho V., Tuuli J., Banister J. (2014), "Pluralistic backcasting: Integrating multiple visions with policy packages for transport climate policy", *Futures*, Vol. 60, p. 41-58.

UNEP Risoe (2015), United Nations Environment Programme. "Capacity Development for the CDM, CDM projects in the pipeline Analysis and

Database", June 2015. Available from: <//www.cd4cdm.org/> (retrieved 07.06.15).

UNFCCC (2012a), United Nations Framework Convention on Climate Change. "Benefits to Clean Development Mechanism". Available from: < http://cdm.unfccc.int/about/dev_ben/ABC_2012.pdf>. (retrieved 09.11.13).

UNFCCC (2012b), United Nations Framework Convention on Climate Change, "Draft Voluntary Tool For Highlighting Sustainable Development Co-Benefits of CDM Project Activities and Programmes of Activities", EB 68, Annex 22. Available from: <http://cdm.unfccc.int/>. (retrieved 09.11.13).

UNFCCC (2012c), United Nations Framework Convention on Climate Change, "CDM Sustainable Development Tool". Available from: https://www.research.net/s/SD_tool_vers5 (retrieved 09.11.13).

UNFCCC, 2001. Marrakech Climate Change Conference – October 2001 Seventh Session of the Conference of Parties (COP7) / Fifteenth Sessions of the Subsidiary Bodies, 29 October – 9 November 2001, Marrakech / Morocco.

Varho V., Tapio P. (2013), "Combining the qualitative and quantitative with the Q2 scenario technique: The case of transport and climate", *Technological Forecasting & Social Change*, Vol. 80, Issue 4, p. 611-630.

Windrum P., Garcia-Goñi M. (2008), "A neo-Schumpeterian model of health services innovation", *Research Policy*, Elsevier, vol. 37(4), p. 649-672, May. DOI: 10.1016/j.respol.2007.12.011

Weber K. M., Heller-Schuh B. (2013), "ServPPIN as instruments for realizing system innovations: two case studies in passenger transport in Austria", in Gallouj F., Rubalcaba L., Windrum P. (eds), *Public-Private Innovation Networks in Services: the dynamics of cooperation in service innovation*, Cheltenham, UK, Edward Elgar publishers, p. 384-408.

Windrum P. (2013), "Multi-agent Framework for Understanding the Success and Failure of ServPPINs", in Gallouj F., Rubalcaba L., Windrum P. (eds), *Public-Private Innovation Networks in Services: the dynamics of cooperation in service innovation*, Cheltenham, UK, Edward Elgar publishers, p. 88-112.