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### OUTSOURCING ENVIRONMENTAL SERVICES: NEW INSIGHTS INTO THE FACTORS INFLUENCING THE CIRCULAR ECONOMY

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#### Abstract

Recent studies have demonstrated how buyers can influence the environmental performance of suppliers. However, although industrial waste accounts for much of the waste generated in the west, little is known about how industrial waste is managed downstream. We present an analysis of the drivers influencing the decision to opt for waste-to-recovery rather than disposal facilities. The drivers were investigated by a questionnaire survey. Findings show that the manufacturing industry is more likely to send waste to recovery rather than disposal facilities, as a result of factors such as the service provider's reputation, the presence of a broker in the transaction, and pressure from public authorities.

Keywords: environmental practices, external pressures, supply chain, waste management

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#### 1. Introduction

The integration of environmental affairs into a company's strategy and operations has become, a cornerstone of management studies (Haden et al., 2009). The scarcity of natural resources and the growing threat to their quality has made several companies act rapidly to make their production and consumption patterns more sustainable (Darnall et al., 2010; Delmas and Toffel, 2004; Gusmerotti et al., 2012). Driven also by external pressures, managers have understood that integrating environmental issues with their business decisions could be profitable (Hart and Ahuja, 1996; Simpson and Samson, 2010).

Baden et al. (2009) have shed light on the multifaceted effects of buyer pressure on suppliers in SMEs. However, less is known about the relations influencing the downstream management of industrial waste.

Waste management is not only a highly outsourced activity (Quélin and Duhamel, 2003), but it

is also a major environmental problem in Europe. In 2008, waste generated in the European Union (EU-27) amounted to a total of 2.62 billion tonnes, of which the waste generated by economic activities accounted for almost 92% of the total amount, while household waste was a mere 8% (Eurostat, 2011). By 2020, the OECD estimates that the EU may produce 45% more waste than it did in 1995 (OECD, 2007). In the west most, waste comes from industrial activities, thus the role of firms is crucial in reducing waste and closing the supply chain loop (Zhu et al., 2008). 67% of waste produced in the EU is either disposed in incinerators, or dumped into landfills thus generating critical environmental damage (OECD, 2007). Landfill requires valuable land space and, similar to incinerators, generates air, water and soil pollution, discharging carbon dioxide and methane into the atmosphere as well as chemicals into the soil and groundwater (Nouri et al., 2012; Zygadlo, 1998).

Business decisions on industrial waste management have been studied from several

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perspectives. Research has traditionally focused on technical issues related to waste generation (Cochran and Townsend, 2010; Hidalgo et al., 2008; Joosten et al., 1999) or technical alternatives for recovery (Pazos et al., 2009; Vermeulen et al., 2012). On the other hand, management studies have included these practices in the general environmental initiatives conducted at the firm level which may by driven by external institutions (Gusmerotti et al., 2012; Henriques and Sadorsky, 1996; Henriques and Sharma, 2005; Lanoie et al., 2011) or potential competitive advantages (Franchetti, 2011; Simpson et al., 2004; Söderholm, 2009).

The main alternative in waste management is between recovery (i.e. reuse, recycle or coincineration) and disposal (i.e. incineration or landfill). This is particularly true in open loop supply chains (Rizzi et al., 2013), i.e. in those contexts where economic, social and environmental efficiency cannot be addressed by reversing logistics and recovering materials within the original productive process. Here, a firm's decision to focus its industrial waste on recovery facilities rather than landfills or incinerators is often not driven by technical or legal issues. Although the requirements for waste to be accepted in a landfill or incinerators are becoming increasingly stringent, most typical waste produced bv manufacturing firms, such as waste packaging, construction and demolition waste, rejects, could be sent recovery and disposal facilities (Fatta et al., 2003; Monte et al., 2009).

Unlike the environmental initiatives typically research investigated by on environmental management, this decision is not related to a potential competitive advantage or to customer requirements. Firms cannot enhance their corporate image by opting for recovery rather than disposal to the same extent as they can by letting consumers know that the company uses recycled material to manufacture a product. At the same time, firms cannot generate an increase in resource efficiency and, as a consequence, reduce production costs. However, the choice of a firm to address its industrial waste to recovery facilities rather than to landfills or incinerators could generate significant environmental improvements.

The influencing factors of this decision should be examined by investigating relation-specific skills, knowledge sharing routines, resources and effective governance between supply chain partners that could characterize relational rents. This involves the need to search for the determinants behind the selection of service providers within the theoretical framework of the relational view theory (Asanuma, 1989; Dyer, 1996; Dyer and Singh, 1998). The relational view theory, suggests that relation-specific skills, knowledge sharing routines, complementary resources and capabilities and effective governance between supply chain partners can determine the competitive advantages of the firm (Dyer, 1996; Dyer and Singh, 1998). These dimensions are, in turn, linked to both the market environment (i.e. prices, flexibility of relationships, reputation, diversity and distribution of actors) and the external pressures that tend to shape it (i.e. technical requirements and policy measures). More in detail, according to Dyer and Singh (1998), firms can achieve supernormal profits by developing an idiosyncratic relationship within their supply chain in order to move away from arm's length market relationships, because competitors can easily duplicate this exchange relationship since there is nothing unique about the interactions between buyer and seller. What follows from the joint efforts of the partnering firms in forging a relationship beyond arm's length, is that rents are jointly generated and owned by partnering firms (Dyer and Singh, 1998).

Our research, moving from the relational view theory, uses data collected from Italian manufacturing firms in order to investigate what factors affect a firm's decision to focus its industrial waste through a waste recovery service provider waste on recovery operations. The research focuses explicitly on which characteristics of waste treatment service providers (i.e.: provider's reputation; flexibility; service quality; price and specificity of technical requirements) influence such a decision to use recovery facilities. In addition, since waste management is characterized by the prominent role of government and public institutions which impose rules in order to reach ambitious environmental objectives, the research investigates also the influence of the regulation and political framework.

The paper is structured as follows. Section 2 reviews the literature on the influence of supply chain relationships on the decision-making of firms and the pressures from regulations and policy framework on the waste management system. This section outlines the knowledge gaps concerning how these dyadic pressures influence corporate waste management decisions. Section 3 provides details on the data gathering process and describes the methodology for the statistical testing of a theory-based conceptual model. The results are shown in Section 4. Policy and implications derived from managerial the demonstrated relations between the above-mentioned aspects are presented together with the directions for further research in Section 5.

#### 2. Literature review and hypothesis

## 2.1. The influence of supply chain relationships on the decision-making of firms

Waste management is an interesting research setting in the field of supply chain management that intersects relevant aspects of environmental management. Supply chain management in firms reflects complex interactions between demand and supply dynamics. Traditionally firms have sought to increase the efficiency of logistics processes and supply chains to maximize value creation (Waters and Rinsler, 2014). However, more recently, value creation has started to come from less obvious approaches such as environmental consciousness (Sundarakani et al., 2010). Within this framework, the factors that influence the selection of suppliers within the supply chain have only been partly explored in the literature.

The adoption of environmental decisions by managers is not always driven by profit maximization (Delmas and Toffel, 2004). Borrowing from the resource-based view of firms (Barney, 1991) and the relational view (Dyer and Singh, 1998) several empirical studies show how internal and external factors might influence the adoption of environmental initiatives and generate improvements in the firm's performance.

On the one hand, several scholars focused on identifying which internal attributes can affect the adoption of a certain environmental practice including: managerial incentives, organizational culture, organizational identity (Howard-Grenville et al., 2008) and organizational norms (Von Borgstede and Lundqvist, 2006). On the other hand, others scholars focused on the role the role of relationships along a supply chain in improving environmental performance and gaining competitive advantage (Testa and Iraldo, 2010). The determinants of these initiatives may rely on ethical (e.g. reflecting the values of managers) and/or commercial issues (e.g. gaining a competitive advantage by highlighting environmental concerns) (Darnall et al., 2008; Nawrocka, 2008). This strand of research mainly focuses on the drivers for the adoption of initiatives aimed at improving environmental performance and resource efficiency all along the supply chain.

In the studies on the adoption of environmental initiatives, the decision to focus a firm's industrial waste on recovery rather than disposal facilities has been neglected. However, even if this decision has no direct impact on resource efficiency and barely concerns the typical drivers of environmental initiatives it could generate significant improvements for the general environment. As a consequence, it needs to be investigated by analyzing the attributes that a firm considers when it selects a service provider.

Looking at this broader field, many researchers have investigated issues related to the relationships between firms and service providers. Several quantitative and qualitative research studies have investigated the factors influencing the selection of a certain service provider (such as their quality standards, price, reputation, and relationship flexibility) and how those factors could influence managerial strategies and different practical decisions. Quality standards, reputation and price, which are considered the most important performance criteria in determining suitable suppliers/service providers (Choi and Hartley, 1996; Shin et al., 2000), have also been studied in relation to business decision making (Chen et al., 2008; Huang and Liu, 2006; Puncheva, 2008). In particular, quality standards have always been one of the most important selection criteria (Min and Kim, 2012). Many authors underline also positive reputation as a key factor in reaching an adequate supplier selection, which illustrates the importance of building image awareness (Kumar et al., 2014). Finally, several studies consider also price as a significant criterion that carries the most weight in the selection and evaluation of suppliers (Melnyk et al., 2014).

In addition, current market conditions require many supply chains to deal with sudden changes in demand and offer (Giannoccaro et al., 2003; Holweg and Helo, 2014). Service quality and information flows are sources of uncertainty that create a need for flexible suppliers that can deal with these possible changes (Quélin and Duhamel, 2003). Thus, a flexible relationship with the service supplier able to manage conditions of sudden changes might be also important criterion in driving suitable alternatives.

Focusing on the management of industrial waste, studies on supplier selection seem to be mostly oriented toward the management of industrial wastewater sludge. Within this area of research, several authors indicate as main drivers for supplier selection the specificity of technical requirements that firms need to achieve a desired quality of waste treatment (Hamouda et al., 2009). However, to our knowledge, it seems that these aspects, which may trigger a firm's decision to send different typologies of waste to recovery facilities, have not been previously investigated in the broader field of industrial waste.

On the basis of the above studies, it is possible to formulate the following hypothesis:

H.1 A waste recovery service provider affects a firm's decision to focus its industrial waste on recovery operations in term's of the provider's reputation; flexibility; service quality; price and specificity of technical requirements.

Adoption of intermediation is another upstream issue in supply chain management literature, which, even if it received a relatively little attention in past research, might carry enough weight in influencing a firm's choice. Indeed, the availability of a large number of alternatives can lead waste producers to have power dominance over service suppliers that results in multiple outsourcing services (Caniels and Roeleveld, 2009). In this context, brokerage reduces the negative effects of environmental uncertainty on supply chains (Melo et al., 2009), financial risks (Agrawal and Seshadri, 2000), and information costs caused by distance and volatility (Popp, 2000). According to Lay et al. (2009), new service-based business concepts offer the possibility not only of taking on additional risks, but also of making additional profit.

Brokerage has also been studied as a driver of decision adoption in firms related, for example, to social issues (Deephouse and Heugens, 2009). Supply chain management literature on this topic reports results that are ambiguous and seem to reflect the substantial discrepancy found in the field of industrial waste management. Within the waste management field, the concept of brokerage refers to a person or a firm arranging the recovery or disposal of waste on behalf of the other subject. To cite an example, the study by Nystrom et al. (2001) on refractory material confirms the crucial role of a broker in establishing the relationship with recyclers, thus also influencing a firm's choice of this possible recovery alternative. On the other hand, Liddick (2010) suggests that the employment of brokers redirects the choice towards the most economic (or even illegal) solutions. However, the potential that brokerage has on recovery decisions still needs to be investigated. This led us to the following hypothesis:

# H2. The adoption of a broker for waste management affects a firm's decision to focus its industrial waste on recovery facilities

Geographical proximity to the supplier/service provider is also another upstream issue proved to affect a firm' decisions. According to Tan (2002) factors related to geographical proximity have no impact on overall product quality, competitive position, or the ability to provide customer service. distance However, long relationships with supplier/service providers are more difficult to manage than local relationships (MacCarthy and Atthirawong, 2003) and geographical distance may increase transportation costs and complicate decisionmaking process due to longer lead times in the supply chain (Golini and Kalchschmidt, 2011). When focusing on a geographical dimension, industrial symbiosis (i.e. the establishment of close working agreements between normally unrelated companies such as the direct reuse of one company's waste stream as another's raw material) stresses the importance of inter-organizational relationships based on product flows, capitalizing on the unique opportunities offered by geographic proximity (Bansal and McKnight, 2009). In the case of industrial waste management, proximity is a key characteristic of resource recovery when there is a strong industrial symbiosis between firms (Jensen et al., 2011). We thus aimed to analyse whether geographical proximity can influence managerial decisions about recovery practices. We formulated the following hypotheses:

H3. Geographical proximity of waste treatment facilities affects a firm's decision to use recovery facilities

#### 2.2. Pressures from regulations and policy framework

Inter-firm relations are not the only force that guides strategic and operative decisions, institutional environments may exert significant pressures on organizations towards sustainability issues (Brammer et al., 2012; Henriques and Sadorsky, 1999; Hoffman, 1999). Beside reputation and staff motivation, Harwood and Humby (2008) suggest that political pressures appear to be the dominant drivers behind the uptake of practices that embrace ethical and sustainability challenges. In this environment characterized by social norms, cognitive systems, beliefs and rules, managers take decisions in order to conform to these boundary conditions and gain legitimacy.

DiMaggio and Powell (2000) identified three institutional mechanisms that influence the behaviours of an organization: normative, mimetic and coercive. Customer requirements or community and environmental interest groups may demand specific environmental initiatives that an organization is forced to follow in order to maintain its legitimacy (Delmas, 2002; Henriques and Sadorsky, 1996; Roberts, 1992). Furthermore, Testa and Iraldo (2010) emphasized the influence of competitors in the adoption of an "imitation-led strategy" concerning the cooperation with suppliers in order to reduce the environmental impact of products along the entire life cycle. Finally, by means of stringent regulations, regulators exert coercive pressures on companies to adopt environmental practices (Alberini and Segerson, 2002). A wide set of tools, on the basis of policy mix instruments, have been developed by public authorities to tackle environmental problems and the footprint of anthropic activities reduce (Gusmerotti et al., 2012). Mandatory and voluntary approaches based on market dynamics have often been combined and integrated to tail off local and transnational pollution.

The increasing relevance of environmental sustainability in determining these pressures enabled us to formulate the following hypothesis:

## H4. Regulation and political framework positively affect a firm's decision to focus its industrial waste on recovery facilities

The Command and Control (C&C) approach has been extensively applied in environmental regulations. The effectiveness of the C&C approach and its evolution in the course of time has been widely discussed in the scientific literature. Although some researchers have pointed out the low efficiency of direct regulation (Cole and Elliott, 2003; Gray and Shadbegian, 1998), new forms of direct regulations characterized by more flexibility may stimulate environmental performance improvements (Styles et al., 2009; Testa et al., 2012). These regulations are inspired by environmental principles that encourage businesses to adopt a managerial (e.g. voluntary agreements and environmental management systems). technical (e.g. extended producer responsibility and life cycle assessment, LCA) and economic approaches (e.g. "polluter pays" principle).

As direct regulations in the field of waste management have been subject to revisions and improvements for decades, it is possible to formulate the following hypothesis:

### H5. Direct regulation affects a firm's decision to focus its industrial waste on recovery facilities

Alongside direct regulations, policy makers have applied new instruments based on market mechanisms that offer several benefits and overcome the limits of the C&C approach (Gasbarro et al., 2013; Zylicz, 2009). Incentives, pigouvian taxes, and tradable permits can stimulate environmental performance improvements thus minimizing the cost for society (Sandoff and Schaad, 2009; Sterner and Isaksson, 2006), although an incorrect design may undermine their effectiveness (Turner et al., 1998).

In the European Union, waste management is characterized by the strict role of government and public institutions that impose mixed rules in order to reach ambitious environmental objectives (Costa and Ferrao, 2010). A mixed approach has been increasingly used to promote waste prevention and recovery practices combining C&C regulations (i.e. rules on waste collection and transport) and economic instruments (i.e. taxes for waste sent to landfill).

Unfortunately, the results are still unclear. For instance, by applying a multiple case study in Finland, Melanen et al. (2002) and Kautto and Melanen (2004) found that economic instruments were ineffective to stimulate waste prevention and recovery decisions that are more encouraged by customer pressure on firms than by public institutions. In their review of business cases on waste prevention, Wilson et al. (2012) identified eight types of policy interventions, from managerial and technical standards to incentives and voluntary agreements, and suggest that "these have each contributed to business waste prevention, but the balance between them varies significantly by sector". However, Monte et al. (2009) highlighted how EU directives on waste management have reduced the use of landfills in the pulp and paper sectors and have enhanced the use of incineration by reshaping the value chain throughout the supply chain. On the basis of these observations, we formulated the following hypothesis:

H6. Economic incentives affect a firm's decision to focus its industrial waste on recovery facilities

#### 3. Methodology

#### 3.1. Data description

investigation specifically included The manufacturing firms located in the region of Veneto for three main reasons; firstly, the region has a very high entrepreneurial density, which is clearly reflected by its GDP, enabling the region to be ranked in the top quartile of the richest regions in Europe (Eurostat, 2012). Secondly, according to previous research, the region has an extraordinary variety of regional productive systems (Alberti et al., 2011; Camuffo, 2003; Whitford, 2001). Thirdly, this region is a frontrunner in the achievement of structural independency in waste management thanks to the diversity of enterprises operating in the waste management sector.

The population of manufacturing firms present in the region was extracted from the Amadeus database edited by Bureau Van Dijk. A stratification process was undertaken before the sampling procedure, dividing firms of the population into subgroups according their homogeneous to manufacturing sector as covered by NACE Rev. 2. A random sampling was then performed in both subgroups. In order to test the hypotheses presented in the previous section, we developed a web-based questionnaire. The questionnaire was designed with the close collaboration of managers from a recovery facility and a disposal facility. It was pre-tested by four manufacturing companies. In details, this pilot questionnaire was issued to four firms in order to refine and confirm its wording. Responses of those four firms was not incorporated into the findings of the main survey.

The questionnaire was administrated electronically by e-mail to the environmental mangers of manufacturing firms. In details, we uploaded the questionnaire on a web-platform and sent the e-mail with the link to the questionnaire and detailed instructions for its compilation. Environmental mangers of target firms were then contacted by phone to provide assistance and assure a correct completion of the questionnaire.

The questionnaire was organized into three different sections:

• Section 1 - general information regarding the business sector, dimension of the company and the measure of recovery performance. Data retrieved in this section were also used to determine whether or not the respondents were qualified to answer the questions (e.g. non-manufacturing firms were discarded at this point).

• Section 2 - impact of relational, technical and economic aspects of the supply chain on recovery decisions.

• Section 3 - the impact of political and regulatory aspects on recovery decisions.

More information about the questionnaire are presented below (Table 1). A total of 60 firms answered the questionnaire (Table 2).

Many researchers state that social desirability as one of the most common biases affecting the validity of questionnaire research (King and Bruner, 2000; Tourangeau and Yan, 2007). According to Nederhof (1985) social desirability is "the tendency on behalf of the subjects to deny socially undesirable traits and to claim socially desirable ones, and the tendency to say things which place the speaker in a favourable light" (Nederhof, 1985). Therefore, this risk was overcome by guaranteeing the anonymity of those responding to the web-based questionnaire. Moreover, the questionnaire targeted several economic sectors located in a region with an extraordinary variety of productive systems in order to avoid a lack of generalizability, which is another drawback of questionnaire research. A lack of generalizability arises if and when the results of the research cannot be considered as representative for the whole population (Hillebrand et al., 2001).

#### Table 1. Questionnaire details

Section	Questions	Measures	Variable abbreviation
Section 1	Indicate the NACE rev.2 codes of your activity	Text field	NACE
	How many employees does your company have?	Four scale options (9 or less; between 10 and 49; between 50 and 499; more then 500)	EMPL
	Quantify the percentage industrial waste sent to recovery facilities	Five scale options (0%; more than 0% but less than 25%; between 25% and 50%; between 50% and 75%; and more than 75%.)	WREC
	Availability of local recovery facilities	Five scale options (Completely agree; agree; uncertain; disagree; Completely disagree)	LOCF
Section 2	Express your agreement on the importance of specificity of technical requirements for the selection of recovery plants.	Five scale options (Completely agree; agree; uncertain; disagree; Completely disagree)	SPE
	Express your agreement on the importance of service quality standards for the selection of recovery plants.	Five scale options (Completely agree; agree; uncertain; disagree; Completely disagree)	QUAL
	Express your agreement on the importance of cost of treatment for the selection of recovery plants.	Five scale options (Completely agree; agree; uncertain; disagree; Completely disagree)	PRI
	Express your agreement on the importance of flexible relationship with the service provider for the selection of recovery plants.	Five scale options (Completely agree; agree; uncertain; disagree; Completely disagree)	FLEX
	Express your agreement on the importance of reputation of the service provider for the selection of recovery plants.	Five scale options (Completely agree; agree; uncertain; disagree; Completely disagree)	REP
	Express your agreement on the importance of geographical proximity for the selection of recovery plants.	Five scale options (Completely agree; agree; uncertain; disagree; Completely disagree)	GPROX
	Indicate how often the company uses brokerage services for the selection of waste treatment plants	Four scale options (Always; Often; Rarely; Never)	BROK
Section 3	Express the influence of the regulatory and political framework on your organization decisions on waste management.	Three scale options (Significant influence, A low influence, No influence)	REG
	Express the influence of Command and control regulations on your organization decisions on waste management.	Five scale options (Highly significant; significant; uncertain; insignificant; highly insignificant)	CC
	Express the influence of Incentives impact on decisions on your organization decisions on waste management.	Five scale options (Highly significant; significant; uncertain; insignificant; highly insignificant)	INC

#### Table 2. Typologies of respondents

Typologies of respondents according to NACE rev.2 codes	Number	Percentage
Manufacture of basic metals and fabricated metal products	18	30%
Manufacture of food products and beverages	9	15%
Manufacture of rubber and plastic products	6	10%
Manufacture of chemicals, chemical products and man-made fibres	5	8%
Manufacture of wood and wood and cork products	4	7%
Manufacture of coke, refined petroleum products	4	7%
Manufacture of machinery and equipment	4	7%
Manufacture of other non-metallic mineral products	4	7%
Manufacture of pulp, paper and paper products	3	5%
Manufacture of textiles and textile products		5%
Total		100%

By studying a representative sample of firms, the survey approach may discover relationships that are common across firms and hence to provide generalizable statements about the hypotheses of study. More in detail, the survey methodology was chosen due to its flexibility. Many researchers underline that questionnaire to be flexible and easier to conduct and tabulate data finding (McNabb, 2008). In our case, such approach allowed us easily to determine different typologies data such as firms' opinions (e.g. the importance of service quality standards for the selection of recovery plants), frequencies (e.g. company usage of brokerage services) and firms' factual information (e.g. firms' business sector).

#### 3.2. Estimation methodology

The analysis of which factors influences the propensity of firms to address their waste to recovery facilities rather than disposal ones was performed by a regression. Regression analysis allows analysing relationships between a dependent variable and several independent variables, indicating if independent variables have a significant relationship with a dependent variable and the relative its strength. For such reasons, the regression analysis is generally adopted as dominant methodology to empirically test different hypotheses. The categorical nature of all the variables enabled us to perform an ordinal logistic regression.

In detail, the measure of the recovery performance of a firm has been used as dependent variable. The recovery performance, as presented in Table 1, was measured by asking the interviewed organizations to quantify the percentage of their industrial waste sent to recovery facilities. Respondents replied using a five-point scale: 0%; more than 0 but less than 25%; between 25% and 50%; between 50% and 75%; and more than 75%.

The use of this question as a proxy of a firm's decision to address their waste to recovery facilities rather than to disposal facilities relies on the fact that the types of industrial waste produced in manufacturing plants can be either be sent to recovery or disposal facilities. This statement was validated by five interviews with manufacturing firms and two onsite visits to local waste treatment facilities (one recovery and one disposal facility).

The measurement of factors that could influence a producer to select recovery plants for its waste was performed by asking the manufacturing companies their opinion on the importance of the following factors in the selection of a service provider operating in the waste treatment sector: specificity of technical requirements, service quality standards, cost of treatment, flexible relationship with the service provider, reputation of the service provider, and geographical proximity. All items were measured by categorical variables, where 1 indicated a low agreement, and 5 a strong agreement. The role of a broker was measured by asking how often the company uses brokerage services for the selection of waste treatment plants. Respondents replied using a four-point scale, indicating whether the use of a broker was "always", "often", "rarely" or "never".

The impact of environmental policies on a firm's decision to recover its industrial waste was measured in two ways. Firstly, in accordance with Lanoie et al. (2011), we measured the impact of the regulatory and political framework by asking organizations to assess its impact on their waste management decisions. Respondents replied using a three-point scale, indicating whether the policy framework had a "significant influence", "a low influence," "no influence". Using the replies to this question we constructed a binary variable assigning 1 if the impact of the policy framework was significant, and 0 otherwise.

Secondly, we investigated the effect of the two main approaches on waste regulations: C&C regulations (input bans, performance standards, etc.) and incentives (taxes, grants, etc). On the basis of the questions used by our group in a previous study (Testa et al., 2011), we analysed the level of agreement on the following statement: "C&C regulations (incentives) have a significant impact on decisions about waste management". Using the alternative responses of a five-point scale, we constructed two binary variables assigning 1 if the level of agreement on the significant impact of C&C regulations or public incentives was high or very high, and 0 otherwise.

In addition, we also considered the level of availability of local recovery facilities in order to capture the implications of the external context on the company's decision-making. Finally, we considered the organization's size by measuring the number of employees. Table 3 provides descriptive statistics for the study's variables.

More in detail, we propose the following equation (Eq. 1) to the test our hypotheses:

$$\begin{split} WREC &= \beta_0 + \beta_1 \times SPE + \beta_2 \times QUAL + \beta_3 \times PRI + \\ + \beta_4 \times FLEX + \beta_5 \times REP + \beta_6 \times GPROX + \\ + \beta_7 \times BROK + \beta_8 \times REG + \beta_9 \times CC + \beta_{10} \times INC + \\ + \beta_{11} \times EMPL + \beta_{12} \times LOCF + \varepsilon_1 \end{split}$$

Variable typology	Variable typology Variable		Std. Dev.	Min	Max
	Specificity of technical requirements (SPE)	3.383	0.886	2	5
	Service quality standards (QUAL)		0.561	3	5
Fastars in service provider selection	Treatment Price (PRI)	4.350	0.879	1	5
Factors in service provider selection	Flexible relationship (FLEX)		0.724	3	5
	Reputation (REP)	3.833	0.866	2	5
	Geographical proximity (GPROX)	3.616	0.884	2	5
	Broker (BROK)	0.500	0.504	0	1
Policy pressures	Regulations and political framework (REG)	0.033	0.181	0	1
	Command and Control regulation (CC)	0.350	0.480	0	1
Public incentives (INC)		0.300	0.462	0	1
	Availability of local recovery facilities (LOCF)	3.666 0.705 1		1	4

Table 3. Descriptive statistics of variables

One of the assumptions of this model is that the cumulative odds ratio for any two values of the covariates is constant across response categories (Peterson and Harrell, 1990). We positively tested this assumption by applying a likelihood ratio test, where the null hypothesis is that there is no difference in the coefficients among models. We also checked the presence of collinearity by computing the tolerance and variance inflationary factors (VIFs) for all variables. Low variance inflation factors (< 2.0) and a VIF less than 5 revealed that that multicollinearity was not present in our empirical model (O'Brien, 2007).

Since we performed a questionnaire survey to collect data, we investigated the presence of common method variance by conducting a post hoc statistical test, the Harman's single-factor test. This test is performed by including all the variables in an exploratory factor analysis and, if a single factor accounting for the majority of covariance among the variables emerges, it indicates that common method variance occurs. The test revealed six factors with an eigenvalue greater than 1.0, which accounted for 61% of the total variance. The highest factor only accounted for 15%.

#### 4. Results

Our study aimed to explore drivers influencing the decision of manufacturing firms to send their waste for recovery rather than disposal.

Firstly, we investigated which factors were taken into account when selecting the service provider, inducing a manufacturing firm to choose a recovery facility for its waste. Our results revealed that the reputation of a service provider is one of the most relevant factors in the service provider selection. Firms that consider corporate image as an important issue in the assessment of service providers have a three times higher probability to opt for recovery (the coefficient is significant at 95% and the odds ratio is 3.8). This is an expected finding in a sector where the mixtures between legal and illegal interests are well documented (D'Alisa et al., 2010; Liddick, 2010).

The role of a broker also impacts managers' decisions about waste management. Firms regularly adopting a broker in setting up commercial relations with waste treatment facilities have a 12-fold probability of opting for recovery. The legal and technical complexity of waste management influences the ability of manufacturers to identify the market opportunities related to their waste (Nystrom et al., 2001). Our results thus confirmed the crucial role of brokers in reducing the structural barriers that make it difficult to set up acceptable agreements between manufactures and recyclers. Our model also reveals that considering geographical proximity when selecting a service provider limits the ability of manufacturers to find recovery opportunities. We found that firms that rate geographical proximity as important when selecting service providers have an

approximate five-fold lower probability to opt for recovery (the coefficient is significant at 99% and the odds ratio is 0.19). Our results do not provide a univocal confirmation regarding the role of coercive pressure on the recovery performance of public institutions. Although the general variable on the influence of regulations and the political framework is not significant, the focus on the impact of different forms of regulation provides a valuable contribution. The traditional approach of C&C - based on bans and sanctions - has a really strong effect on recovery performance. The probability of firms perceiving traditional regulations as very stringent have a recovery performance up to 18 times higher than the probability of attaining a low level of waste recovery.

As expected, public incentives were not perceived as being significant. We found that this approach is still not structured in a way that business can clearly understand how public incentives positively influence management decisions. Public authorities probably still underestimate its potential and mainly focus on a consolidated paradigm based on requirements, inspections and penalties.

A firm's size does not appear to be an important factor in explaining the investigated relations. The high use of local facilities for waste recovery has a negative influence on a firm's performance. This last case confirms that the proximity of plants for waste recovery is not a relevant factor in persuading a firm to increase its recovery performance. Finally, in order to check the robustness of our empirical model (model 1), we performed a different regression (model 2) by changing the form of the dependent variable from categorical to binary (Table 4). Although the level of significance of the estimated effects slightly decreases in some cases, the results highlight the reliability of the previous considerations on the factors influencing the performance of recovery at the firm level.

#### 5. Discussions

We explored several drivers influencing the decision of manufacturing firms to recover industrial waste in open loop supply chains. We investigated internal criteria in the selection of suppliers and external factors, the role of policies and environmental policy instruments, which could potentially influence a recovery decision by collecting data from manufacturing firms located in one of the most industrialized regions of Italy.

By applying a rigorous statistical method, our results provide a valuable contribution to the literature by highlighting factors that characterize relations with service providers and that influence managerial decision to send their waste to recovery facilities. In line with Franke et al. (2005), and in contrast with Quélin and Duhamel (2003), intangible assets (e.g. reputation of supplier/service provider) seem to be relevant in waste management decisions.

	Dependent variable	Model 1		Model 2	
Variable typology		Coefficient	Standard error	Coefficient	Standard error
	-	(Odds ratio)		(Odds ratio)	
		-1.289**	2.04	-1.184*	1.75
	Specificity of technical requirements	(0.275)	-2.04	(0.305)	-1./5
		-0.817	0.01	-0.869	0.07
	Service quality standards	(0.441)	-0.91	(0.419)	-0.96
		0.630	0.1(1	0.375	0.04
	I reatment Price	-1.879	0.161	-1.455	0.84
	Flouible veletionship	-0.900	1.22	0.802	1.15
	Flexible relationship	(0.406)	-1.33	(0.448)	-1.15
	D	1.340**	2.17	1.084*	1 77
	Reputation	-3.820	2.17	-2.956	1.//
		-1.642***	2.70	-1.367**	2.09
	Geographical proximity	(0.193)	-2.70	(0.254)	-2.08
	Ducton	2.523**	2.52	2.652**	2.22
	Blokei	-12.476	2.32	-14.189	2.33
	Regulations and political framework	-1.089	-1.24	-0.279	0.31
		(0.336)		(0.756)	-0.31
Doliou pressures	Command and Control regulations	2.942**	2.47	2.685**	2.09
I oney pressures		-18.964		-14.661	
	Incentives	-0.631	-0.76	0.056	0.07
		(0.532)		-1.057	
	Number of employees           Availability of local recovery facilities	-1.314	-1.47	-1.202	0.247
Control variables		(0.268)		(0.300)	
Control variables		-2.542**	-2.00	-2.230*	-1.77
		(0.078)		(0.107)	
	Constant			22.770**	1 00
				-7.755	1.77
	LRchi2		***		**
	Pseudo R2	0.335 0.350		.350	

<b>Fable 4.</b> Estimation results of p	performance equations
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\*, \*\*, and \*\*\* indicate the significance at the 10%, 5%, and 1% levels, respectively

This suggests that firm often considers waste management not only as a source of costs to be minimized, but also as critical in the management of corporate image. Our analysis underlined also that strictly interconnected with the corporate image there is the technical complexity of the sector and of the strict framework of requirements set out by the law. Such aspect it is also related with the possible risks for the reputation in a field of activities affected by a high level of illegal practices.

The fact that a waste recovery service provider do not affects a firm's decision to focus its waste on recovery operations in term's of flexibility; service quality and price could be seen still connected with the importance of the reputation of the service providers in the field of operations.

Differently, relations with brokers are crucial in the decision as to whether to send industrial waste to a recovery facility. Firstly, the crucial role of a broker in establishing the relationship with recyclers, influencing a firm's choice of recovery alternative, could be seen related to the non-significance of other aspects related to service quality standards, treatment price and flexible relationship. Indeed, from the one hand, the employment of a broker could drive firms in identifying the best market opportunities related to their waste also in relation with treatment price. On the other hand, the employment of a broker could help in dealing with conditions of sudden changes in offer. The great importance of a broker, reflects the difficulties of producers in internalizing the competences required in order to gain a competitive advantage from creating partnerships throughout the life-cycle of materials. Brokers are also relevant for implementing waste exchange programs which promote the use of waste from one firm as a raw material for another. Strong economic and regulatory instruments can contribute to make this option viable by ensuring government involvement with firms, assessing alternative waste management options and developing quality standards for recovered materials. The implementation of such networks - unstructured forms of industrial symbiosis between waste producers and service providers - could create a competitive edge for both typologies of firms and also result in an environmental benefit.

From the other hand, the relevance of the role of brokers justify the fact that evaluations regarding service quality standards, treatment price and flexible relationship are usually within a broker's mandate; and recovery activities are also strongly regulated from a technical point of view by EU and national laws. Such regulations may even define the detailed requirements that must be complied with when reprocessing waste into products, materials or substances. This also explains why the specificity of the technical requirements of the recovery facility does not have a positive influence on decision to opt for recovery.

Another important result to discuss concerns the fact that geographical proximity when selecting a service provider limits the ability of manufacturers to find recovery opportunities. Indeed, the model shows that firms rating geographical proximity as important when selecting service providers have lower probability to opt for recovery. This could be explained by the fact that the complexity of the sector in terms of public planning and administrative rules and the economic and financial crisis that discourage investments, along with issues related to social acceptability, make a widespread diffusion of waste treatment plants difficult at a territorial level (Rahardyan et al., 2004). Accordingly, the focus on reduced transportation costs while choosing a service provider seems to reduce the recovery performance of a company since the geographical area where a company is located does not always provide a wide and differentiated supply of environmental services.

We found a clear influence of enforced legislation and regulations on environmental practices. In line with previous research (Delmas, 2002), public authorities may exert coercive pressure and push companies to adopt environmental initiatives. In terms of which form of regulation has a higher effect on managerial decisions, in contrast with a large body of research (Ederington and Minier, 2003; López-Gamero et al., 2009), our study clearly shows that direct regulation has a strong and significant effect on a firm's decision to improve its environmental performance. A possible reason might be related to the waste charges and the national waste tax that effectively stimulate enterprises to upgrade to waste recovery instead of disposal. In fact, that during the past years the C&C charges and taxes increased and firms actively sought new ways for increasing the recovery of their companies' wastes to not incur in such charges and taxes.

From a political perspective, considering that the direct regulation has a strong and significant effect on a firm's decision, government contribution could take the form of an integrated set of policy instruments influence markets towards a stronger that collaboration between companies and recovery services. While policies at the European level should set stronger recovery target, those at national level could work towards strong economic and regulatory instruments to secure those targets (e.g. taxes and bans), leaving enough flexibility at regional level (e.g. through market-based instruments) to find the best economic and environmental responses with stakeholders such as firms and recovery facilities. Indeed, in a country like Italy, the mere extensive application of economic and regulatory instruments such taxes and bans only might harm the competitiveness of branches of industry, using high amounts of materials. For this reason, the more fundamental changes, for example in the structure of taxation, should be implemented. Indeed, if designed

through a balanced policy mix regulation can discourage polluting activities and also create positive effects on competitive performance (Iraldo et al., 2009; Testa et al., 2014).

Finally, we should mention some limitations of this study. Although issues related to the lack of generalizability and nonresponse bias have been addressed, the study relies on a small sample size. The study also relies on self-reported data: which is quite common in measuring environmental performance (Iraldo et al., 2009), however the use of quantitative data would have undoubtedly been preferable. Future research could integrate data collected by a survey with data from the European Pollutant Release and Transfer Register (E-PRTR) to obtain kev environmental data on recovery performance. The focus on a specific area must be taken into account in case of generalization. Measuring the managers' perception of the environmental impact of the policy framework and regulations on the effect of environmental regulations on managerial decisions is quite common (Lanoie et al., 2012). However, further measures could be used to increase the robustness of the results, such as compliance costs, the number of new regulations taking effect, discrepancy between non-constrained emissions and actual emissions, and the number of inspections.

#### 6. Conclusions

The theoretical implications on the determinants behind the selection of service providers within the theoretical framework of the relational view theory (Dyer and Singh, 1998) underline three main contributions, those in turn are:

• the positive and significant influence of reputation on the selection of service suppliers shows that social control is a key in enforcing agreements in the field of environmental services;

• brokers seem to play a significant role in establishing an effective governance of the waste management system. This means that self-enforcing safeguards between waste producers and brokers produce lower transaction costs;

• geographical proximity has a negative influence. In fact, the economics of waste management seem more dependent on the ability to establish relationships that result in a sustained competitive advantage (i.e. ability to manage the possible lack of partners) than on the reduction in travel costs (i.e. geographical proximity).

The practical implications in this study are clear. Firstly, an important managerial implication stemming from our research is that approaches and tools supporting consolidated relations between firms, brokers and waste management facilities should be developed, and local networks, where feasible, should be stimulated. The creation of networks could in turn considerably stimulate and prompt the commitment of firms towards the environment by (i) increasing their knowledge and awareness on the opportunities deriving from waste recovery and also (ii) by providing specialised support for innovative solutions in the recovery sector. Furthermore, from a business perspective, both economic and environmental issues clearly highlight the need to develop local networks for reuse, recycling and recovery that can also lead to a competitive advantage.

Secondly, our results highlight that policy makers should improve the design of market-based instruments (such as incentives) to overcome the uncertainty affecting waste management relations supporting managers in their decisions, improving resource efficiency among firms and fostering recovery practices. These voluntary instruments should be used also to contribute to increase information availability, facilitation and assistance. market-based instruments may help Indeed, businesses to perceive economic advantages in environmental outperformance even in cases where the social and economic contexts do not favour going beyond compliance. This could help achieving remarkable achievements also in the circular economy. This means that circular economy policies and instruments need to be innovative, and incorporate knowledge derived from actual situations, in their development.

Future research could shed light on the dynamics that make the factors investigated relevant for the creation of a symbiotic network based on waste recovery. It may be that industrial waste recovery decisions are influenced by the different managerial attitudes of project managers, supervisors, planners company executives. Also, a deeper and understanding of the impacts of procurement and contractual systems on industrial waste recovery decisions is essential. From a regulatory perspective, future research could investigate why the current system of incentives seems to be ineffective to stimulate firms to recover their waste and how marketbased instruments could be designed to improve this performance. Finally, the opportunities and threats to networks of recovery local facilities and methodologies should be investigated in order to assess the adequacy of the policy mix in waste management at different government levels.

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