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Assessment of the Public Administration Tools for the improvement of the Eco-efficiency of Small and Medium Sized Enterprises.

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ABSTACT

Small and Medium Sized Enterprises (SME) face barriers to the implementation and development of eco-efficiency that could be overcome taking advantage of the adequate stimuli and incentives. A previous research and a thorough literature analysis show Public Administration (PA) is a key stakeholder. PA could use better its tools to stimulate SME to improve their ecoefficiency. Among these tools it can be named well known "command and control" tools like legislation or taxes, but also price policies, green procurement, ecological education, eco-innovation support and others.

This paper reviews these tools and how they contribute to overcome barriers to ecoefficiency by offering external and internal incentives for SME. The analysis is focused on the case of Venezuelan public administration and SME but it can be generalized to other case studies. In addition, a panel of experts validates the results and assesses the public administration tools by means of the policy Delphi method. The assessment is based on criteria like: market influence, capability of the public administration for controlling results, tool costs, impact on public administration image, timespan to get results, etc. The assessment, therefore, allows ranking and understanding the tools according to their effectiveness and efficiency to support SME to improve their ecoefficiency.

Due to the specific characteristics of the case study: SME of Venezuela, the method shows the best mix of public administration tools includes mainly "command and control" tools. Also the mix includes certain "new-approach" tools like advertising about responsible consumption and eco-efficient products, or education/training in environmental responsibility. The method also allows understanding better how the tools will help accomplishing the objectives for ecoefficiency of the public administration. Therefore, this research provides a method for raising information to be used when planning the actions to improve eco-efficiency of the SME.

Keywords: Eco-efficiency, Environmental public policy, SME,

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1. INTRODUCTION

Eco-efficiency is a key strategy for companies to decrease the environmental burden of the life cycle of their products. The World Business Council for Sustainable Development (WBCSD) introduced: "Eco-efficiency is achieved by the delivery of competitively priced goods and services that satisfy human needs and bring quality of life, while progressively reducing ecological impacts and resource intensity throughout the life-cycle to a level at least in line with the earth's estimated carrying capacity" (UNEP, 1998).

Various authors find eco-efficiency can help the sustainable development of any kind of business activity (Vernon et al., 2003) (Safari, 2005) (Howgrade-Graham, 2007) (van Berkel, 2007) (EUAPME, 2007) (Woolman & Veshagh, 2007). Moreover, other researches demonstrate eco-efficiency is particularly useful for Small and Medium Sized Enterprises (SME) in developing countries (Ciccozzi et al., 2003) (Byung-Wook et al., 2006) (Sangwon et al., 2008).

SME represents 99% of the business in Europe (EC, 2009), producing 70% of the industrial contamination (EC, 2007). In Venezuela, 90,7% of business are SME, and produce services or tangible products (INE, 2006). There are no reliable data for industrial contamination but related studies (Otero, 2002; Mercado & Testa 2001; Mendoza & Villegas 2004; Díaz et al, 2006) show that Venezuelan SME together account for most of the environmental impacts of the productive sector. Besides, these studies assert SME have been losing economical competitiveness and environmental quality over the last two decades. As a whole, production is less sustainable and investment in R&D has been consistently decreasing. Therefore, the improvement of the eco-efficiency of SME would contribute decreasing the environmental burden of the business sector overall. Finally, due to its close relationship to inhabitants, eco-efficiency of SME could play a significant role in the environmental education of Venezuelans.

Actually, eco-efficiency is not a new concept in Venezuela, it has been claimed and it has been tried to apply since some decades ago. However, it has not had the expected progress. This is due to the combination of various barriers against its development, the lack of real incentives for its implementation, and because the few incentives are unknown or missed (van Hemel & Cramer, 2002) (FONDOIN, 2005) (UEAPME, 2007).

In a previous research with 54 Venezuelan SME, authors show companies seldom got incentives from stakeholders to improve their eco-efficiency (Fernández-Viñé et al., 2010). Therefore, authors also considered a stakeholders analysis was necessary to determine which are more influencing for SME of Venezuela. As it was expected, in Venezuela the most influential stakeholders are the different institutions of the public administration (PA).

Many authors agree to relate the generally insufficient development of eco-efficiency among SME in Europe and Latin America and the insufficient actions of, particularly, the PA to support its development (UEAPME, 2007) (Tukker et al., 2001) (Otero, 2002) (Mendoza & Villegas, 2004) (Pimenova & van der Vorst, 2004) (Acquatella & Bárcena, 2005). According to these authors, PA is one of the most interested in the promotion of eco-efficiency among SME as it would contribute to the improvement of their competitiveness, the health of the users and environment, the decrease of PA's environmental expenditure and the environmental education of society as whole.

Finally, according to (Moors et al., 2005) (Zeng et al., 2011) or (Murillo-Luna et al., 2011) public administration has currently a sufficient catalogue of tools to overcome the barriers and to incentivize eco-efficiency among SME. The challenge should not be so much creating a new way of promoting eco-efficiency as arranging and applying the existing tools with the

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most effective mix. About this last important issue no scientific literature has been found and this is the objective of this research.

Tools for promoting ecoefficiency are interrelated and dependent on each other. That has to be considered when planning their implementation. Relationships may be, among others:

- Design, type of tool: Repressive tools like taxes or limit legislation. Incentives like subsidies or green procurement. Educational tools like research, ecoefficiency promotion, environmental education, etc.
- Objectives: Tools may be focused on similar barriers (lack of knowledge, lack of infrastructures, excess of offer, etc.) and/or similar Incentives (economic, image, consciousness, etc.).
- Resources: Tools may benefit from sharing resources like trained staff, distribution channels, technical resources, etc.
- Information: Tools may generate/share information about statistics, theoretical concepts, ecoefficiency methods, potential partners, etc.

Logically, the way to make them more effective is to combine them. In fact, all recent publications about tools for ecoefficiency (be them for public and/or private actors), recommend combining the various strategies and their tools, for example (Tukker, 2001) (van Berkel, 2007) (UEAPME, 2007) (Murillo-Luna et al., 2011). By contrast, early publications on ecoefficiency tools generally focused on just one or another tool, likely because still few tools were proposed or proven, apart from command and control legislation.

Therefore, the study of the tools must be comprehensive to benefit from synergies, not to unbalance any final tools mix proposed, etc. With this approach there are various publications already referred in this paper. However authors believe a comparative analysis is lacking. By analysis it is meant a division of the decision problem, i.e. defining the overall ecoefficiency aim, its consequent partial objectives (all them transformed into evaluation criteria) and the decision alternatives (the tools). This analysis should not lose sight of the whole, but will provide valuable information for decision makers, in this case study: the public administration.

Indeed, the analysis provides insight to prioritize alternatives based on the characteristics of each case study, for instance:

- Resources available. All desired tools may not be implemented at a time due to insufficient resources.
- Ecoefficiency development: Important barriers identified, Incentives determined to have more potential, tools already implemented and their results, etc.
- The importance of the role of public administration.
- Others.

Therefore, this research provides a method to obtain relevant information to be used when planning the actions to improve eco-efficiency of the SME. As actions are based on tools, the plan can be understood as plan for implementing the tools. Therefore, the results of this research will help designing the set of actions (and corresponding tools), arranging them in time, allocating the necessary resources for each action, establishing mechanisms of monitoring and management of the plan, etc. However, the research does not propose how to actually design and execute a plan for ecoefficiency. This is the aim of the ongoing research expected to give results still in a few months.

2. MATERIALS AND METHODS.

As it can be seen in fig. 1, the research followed a stepwise method. The method was designed to be applicable to different case studies and situations. As mentioned above, a previous research by the same authors (Fernández-Viñé et al., 2010) showed the current status of eco-efficiency in Venezuelan SME and identified the main barriers and incentives for its promotion. In the method this previous stage it is shown by a dotted line.

Fig 1. Research procedure and proposed method for assessing public administration tools for eco-efficiency.

The first step is a specific analysis of the barriers and incentives for the case study. Although there is ample literature on the subject not many specific studies are published, and authors could find none addressed to Venezuela. Thus, an extensive literature research leaded to a comparison of six studies analysing barriers and stimuli to ecoefficiency in companies. Studies were selected among the few ones found because they used a similar set of barriers and stimuli. Also, according to (Tukker et al., 2001) (EEA, 2007) (Hoevenagel et al., 2007) (Fernández-Viñé et al., 2010), the studies allowed to compare the situation of a country developed in the public support to eco-efficiency (The Netherlands), a country of intermediate development in public support to ecoefficiency (Spain) and Venezuela with almost no eco-efficiency promotion, public or private. The first Dutch study involved 77 manufacturing companies (van Hemel & Cramer, 2002) and the second one is carried out by a panel of senior experts from various ministries for the Dutch Ministry of Environment (Ministerie van Vrom, 2004). The first Spanish study involved 154 SME of the Valencian region in Spain (Gómez-Navarro, 2004). The second study involved 240 Spanish firms, 91% of which were SME (Murillo-Luna et al. 2011). The first Venezuelan study was carried out by FONDOIN and studied SME by a survey to 73 representatives of the government, industry, academy and environmental NGO (FONDOIN, 2005). Finally, the second Venezuelan study was carried out by the authors and involved 54 SME of the central region of Venezuela and a panel of six experts on the relationship industry-environment (Fernández-Viñé et al., 2010). As discussed later results for Venezuelan studies vary from other studies and the research helps understanding better the current lack of ecoefficiency in Venezuelan SME.

Following, a stakeholders' analysis was carried out using the method presented by Freeman (1984). Starting from the stakeholders' lists proposed by Heidrich et al. (2009) and Murillo-Luna et al. (2008), Stakeholders' Analysis (Freeman, 1984) was applied mapping their power and interest towards the support to eco-efficiency. As it was expected, public administration (PA) is the most influential stakeholder by far. Venezuelan PA accounts for as much as 50% of the Venezuelan market, either directly or through the public companies: PDVSA, ALCASA, VENALUM, CADAFE, etc.

After this analysis, authors searched for public administration tools and strategies through a literature survey while. In parallel, panel of experts from Venezuela was arranged. The selected experts have the following profile:

1) senior scientist of Venezuela and university professor devoted to environmental science,
2) consultant and expert in eco-efficiency and clean production with extensive experience in the oil industry in Venezuela,
3) environmental expert, president of the local NGO VITALIS and president/member of several national and international environmental agencies,

4) expert from PA, former senior official in the Ministry of Environment in Venezuela,

5) president of INFOEM, an organization dedicated to providing advice to SME of Venezuela in terms of quality and productivity,

6) member of the "National Academy of Engineering" of Venezuela and "Habitat", has been Minister of the Environment and Minister of the Public Works, and has been chairman of various organizations devoted to global environmental programmes.

Authors analyzed the available methods for working with experts, for example those published by (Powell & Single, 1996) (MET B-W, 2004) (Okoli & Pawlowski, 2004) (Landaeta, 2006) (McMillan & Marshall, 2006) (Gamarra, 2009). According to the characteristics of this study, the time availability of the experts and the features of the methods, the Delphi method was first selected. Delphi method is a methodical, transparent and well known method suitable for research with subjective information, different approaches and complex concepts (McMillan & Marshall, 2006). But later, policy Delphi was finally preferred because it presents the advantages of Delphi: avoid undue influence in face to face debates, give time for appropriate reflection, allow debate with pros and cons, etc. but overcomes the necessity of taking decisions (Loe, 1995). That is to say, as the objective of the research was facilitating the decision but not actually taking it, therefore consensus was not so important and, actually, the disagreement is a useful input for the ones in public administration taking the decisions.

As Franklin & Hart (2007) explain, similar to Delphi, the policy Delphi includes: a sample of topic-specific experts, polling of expert opinion through the administration of sequential questionnaires, and summarized data from each questionnaire reported back for feedback and comments by the panel. One of the main weaknesses of the policy Delphi method, also similar to Delphi, is the importance of the questionnaires because they must truly reflect the key elements of the research topic. Another problem may derive from the importance of arranging a panel of experts not too homogeneous or like-minded (Landaeta 2006). Finally, experts must be truly committed with the investigation in order to answer questions after sufficient reflection and information contrast. Nevertheless, due to their advantages, the use of Delphi and policy Delphi methods for investigation has increased in the last 30 years, and are now widely used in scientific research (Franklin & Hart, 2007).

Three consultations were made, each one with two policy Delphi rounds. First consultation was devoted to validating the results of the barriers/incentives analysis and the list of public administration tools for ecoefficiency support. The second consultation was devoted to relate the tools with the barriers and incentives. It was discussed, for each tool, which barriers helped to overcome and which incentives helped to support. The third consultation aimed at establishing and ranking the criteria to assess the tools and then assessing the tools according to the criteria.

After processing the results of each round the degree of agreement among experts was established by calculating the standard deviation, the median and the interquartile range of responses (Landaeta, 2006) (Gamarra, 2009). Stability was reached in the second round in the three consultations. This means the relative interquartile ratio was sufficiently low (typically lower than one for a lickert-type scale from 1 to 9). Consensus, measured by the standard deviation was almost always reached. For the questions that did not get to a consensus (see table 3 for example), judgements did not differ much and conclusions could be obtained. Anyway, as explained earlier, policy Delphi does not need reaching a consensus as it is not intended to take decisions. In fact, identifying the discrepancies once the answers stabilized is another interesting result of the method.

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3. Results.

3.1. Barriers and incentives to eco-efficiency.

Table 1 shows the results of the comparative analysis of the above mentioned six studies, incentives have been separated into internal and external incentives. About barriers, on the one hand, the European countries agreed in finding the "Lack of sensitive and competent staff" and the "Lack of information about the environmental regulation" as barriers to eco-efficiency. On the other hand, the Venezuelan companies and their stakeholders coincide in establishing "No relationship is found between innovation and environment" and "Inefficient control mechanisms of the PA for the environmental regulation" as barriers to eco-efficiency. Moreover, and somehow surprisingly, none of the Venezuelan studies show "Lack of information about the environmental regulation" as a barrier. Finally, all studies mention with different emphasis "Market is not ready for ecoefficient products and services" as a barrier. About the causes for the deficient market, Europeans mention the lack of infrastructure (for example for recycling) and the lack of alternative technology, while the Venezuelans blame the lack of environmental awareness of buyers and end users

About the internal incentives for eco-efficiency, the first finding is all researches prioritize similar internal incentives, although they differ in the importance they give to them. Thus, and logically, all studies emphasize "costs reduction" as the main incentive. Then European studies propose "Opportunities for innovation" as the second more important incentive for eco-efficiency while Venezuelan studies indicate "Efficient use of resources".

Finally, asked about external incentives, almost all results coincide that "Improving competitiveness" would be a main incentive, showing that currently eco-efficiency is not yet a concern related to competitiveness. Europeans also mention "Customer requirements" and "Compliance with legislation" as important incentives. Venezuelan studies do not give much importance to those incentives but to an "Increased support and advice from the PA".

Table 1.

Main barriers and incentives for Eco-efficiency found in the comparison.

BARRIERS	The care for environment is not considered as a quality criterion	(Fernández-Viñé et al., 2010)
	No relationship is found between innovation and environment	(FONDOIN, 2005) (Fernández-Viñé et al., 2010) (Murillo-Luna et al. 2011)
	Lack of sensitive and competent staff	(Ministerie van Vrom, 2004) (Gómez-Navarro, 2004) (Fernández-Viñé et al., 2010) (Murillo-Luna et al. 2011)
	PA has inefficient control mechanisms	(Gómez-Navarro, 2004) (FONDOIN, 2005) (Fernández-Viñé et al., 2010) (Murillo-Luna et al. 2011)
	There is little market for green products	(Ministerie van Vrom, 2004) (Fernández-Viñé et al., 2010) (Murillo-Luna et al. 2011)
	Stakeholders do not demand eco-efficiency	(Ministerie van Vrom, 2004) (Fernández-Viñé et al., 2010)
	Environment is not considered as a responsibility of SME	(van Hemel & Cramer, 2002) (Fernández-Viñé et al., 2010)
	Lack of information about environmental regulation	(Ministerie van Vrom, 2004) (Gómez-Navarro, 2004) (Murillo-Luna et al. 2011)
INTERNAL	Cost reduction	(van Hemel & Cramer, 2002) (Ministerie van

INCENTIVES		Vrom, 2004) (Gómez-Navarro, 2004) (FONDOIN, 2005) (Fernández-Viñé et al., 2010) (Murillo-Luna et al. 2011)
	Efficient use of scarce or sensitive resources	(FONDOIN, 2005) (Fernández-Viñé et al., 2010)
	Opportunities for innovation	(van Hemel & Cramer, 2002) (Gómez-Navarro, 2004)
	Market Opportunities	(van Hemel & Cramer, 2002)
	Improved company environmental sensitivity	(van Hemel & Cramer, 2002) (FONDOIN, 2005)
	Improved product quality	(Ministerie van Vrom, 2004)
EXTERNAL INCENTIVES	Customer requirements	(van Hemel & Cramer, 2002) (Gómez-Navarro, 2004) (Murillo-Luna et al. 2011)
	Compliance with legislation	(van Hemel & Cramer, 2002) (Ministerie van Vrom, 2004) (Gómez-Navarro, 2004)
	Improving competitiveness	(Ministerie van Vrom, 2004) (Gómez-Navarro, 2004)(FONDOIN, 2005) (Fernández-Viñé et al., 2010) (Murillo-Luna et al. 2011)
	Increased support and advice from the PA	(FONDOIN, 2005) (Fernández-Viñé et al., 2010)

Experts were asked by policy Delphy about these results and they showed almost a consensus agreeing with the identified Venezuelan barriers and incentives for eco-efficiency. During the consultation, among other findings, experts aggregated two more conclusions on the situation in Venezuela. First, in Venezuela the SME entrepreneurs have no clear cost structure and some raw materials and energy rates are very cheap, therefore they are unaware of the costs of their energy and materials and show little interest in saving them. Second, in Venezuela there is neither infrastructure nor standards to guide material recovery and waste recycling, and the limited effort made is informal and unstructured.

3.2. Public administration tools for eco-efficiency support

Table 2 lists and explain PA tools for promoting eco-efficiency, selected for the particular case of Venezuela. Note that tools are ordered from less interventionist in market (more liberal type) to more interventionist (less liberal type). The selection is based on the scientific literature (Tukker et al., 2001) (Fullerton, 2001) (Mendoza & Villegas, 2004) (Otero, 2002) (Pimenova & van der Vorst, 2004) (Acquatella & Bárcena, 2005) (Requate, 2005) (UEAPME, 2007) and the suggestions of the above mentioned 6 experts. A first list with 23 tools was further abbreviated and refined to get the final list of 16 tools suitable and available for Venezuelan public administration.

First policy Delphy consultation was also used to modify and validate the list and, again, consensus was obtained about the tools. The only noticeable discussion and disagreement arose about the name of the tools and whether a particular set of tools should be analyzed together or separately; that was the case of "environmental declarations" and "environmental legislation".

Table 2.

Public Administration Tools for Eco-efficiency promotion among SME

Spaces protection legislation	Set of laws and regulations which ensure the preservation of the protected areas of the nation, or the endangered species and the habitat on which they depend
Species protection	

legislation	
Environmental Declarations type I	Environmental Product Declarations type I, II and III are labels and logos to report certain positive environmental attributes of a product or service. Type I is a multiattribute label developed by a third party; type II is a single-attribute label developed by the producer; type III is an eco-label whose awarding is based on a full life cycle assessment.
Environmental Declarations type II	
Environmental Declarations type III	
Education in environment	Actions aimed at generating and disseminating knowledge and technologies for eco-efficiency, carried out in academia or in companies with public funding.
Research in environment	
Voluntary agreements	Commitments or agreements established between firms or industries, sometimes involving the PA. These actors are committed to voluntary compliance with environmental quality objectives
Product panels	
Advertising of responsible consumption	Advertising sponsored by the State to educate the public promoting more eco-efficient habits and recommending the use of products and services with less environmental impact.
Advertising of eco-efficient products	
Green procurement policy	PA policies and procedures for purchasing products and services that minimize environmental impacts.
Subsidies	Financial assistance offered to companies by the State, directly or through organizations, to achieve certain environmental goals.
Taxes	Fiscal instruments that allow the direct incorporation of the costs of environmental damages to the cost of goods and services.
Limit legislation	Regulation that set standards of environmental quality and set limit values of concentration of physical, chemical and biological agents in air, water or soil. This set also comprises Norms driven by public institutions both compulsory and recommended.
Best Available Techniques (BAT) legislation	Note: BAT are primarily aimed at medium to large companies, but they affect also to the SME in each sector as they also are suppliers, buyers, users, etc.

3.3. Potential of the public administration tools to reduce barriers and increase incentives for eco-efficiency

Each tool of the PA, by its nature, affects certain barriers and incentives, hence a well-structured environmental policy should consider a well-planned combination of these tools. Table 3 shows the results of the second consultation to the panel of experts of the policy Delphy. Table 3 show relationships among the different tools of the PA and the barriers they help to overcome or the stimuli to eco-efficiency of SME they help to promote.

Table 3.

Influence of the tools of the PA on barriers and stimuli. Note (*) means the majority agreed with the relationship but there was not a consensus.

PUBLIC ADMINISTRATION TOOLS / BARRIERS AND DRIVING FORCES	Protection of Areas and Species	Environmental Declarations type I, II and III	Training and research in environment:	Voluntary agreements and product panels	Advertising of responsible consumption & eco-efficient products	Green procurement policy	Taxes	Subsidies	Limit legislation and legislation of BAT
The care for environment is not considered as a quality criterion		X		X*	X	X			
No relationship is found between innovation and environment		X*	X	X				X	
Lack of sensitive and competent staff			X	X	X				
PA has inefficient control mechanisms	X*					X	X		X
There is little market for green products		X			X	X			
Stakeholders do not demand eco-efficiency				X	X				
Environment is not considered as a responsibility of SME	X*	X*	X	X	X				X
Lack of information about environmental regulation		X	X			X	X	X	X
Cost reduction				X	X		X*	X	
Efficient use of scarce or sensitive resources			X*	X			X	X	X
Opportunities for innovation			X					X	
Market Opportunities		X		X	X	X	X	X	X*
Improved company environmental sensitivity			X		X			X*	
Improved product quality			X						X
Customer requirements	X	X	X		X	X*			
Compliance with legislation	X			X			X	X	X
Improving competitiveness		X*	X		X	X		X*	
Increased support and advice from the PA				X		X*	X		X*

3.4. Characterization of the tools of the PA for the development of a plan for eco-efficiency promotion among SME.

As mentioned before, the research carried out allows concluding the insufficient support of the PA to the eco-efficiency should not be attributed to the lack of tools because there are enough. Rather, it should be attributed to the lack of planning and the lack of a coordinated and integrated implementation of all tools. A method is required to establish an action plan to take advantage of the effectiveness of the tools of the PA. For this method, tools of the PA for eco-efficiency should be assessed from a variety of criteria.

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The final steps of the panel of experts, and its main aim, was to assess the actions of the Administration for promoting the eco-efficiency of Venezuelan SME. This characterization has also been made using the policy Delphy method. It was implemented in two rounds of consultation and the degree of stability and agreement was verified like in the previous Policy Delphy rounds.

With the support of the six experts, 10 criteria for evaluation of the tools have been selected. These criteria were formulated based in studies like (Tukker et al., 2001) (Otero, 2002) (Mendoza & Villegas, 2004) (Pimenova & van der Vorst, 2004) (Acquatella & Bárcena, 2005) (UEAPME, 2007). A first list of 23 criteria was defined and then reinterpreted, simplified and clarified after the consultation with the Venezuelan experts. The criteria allow establishing the suitability of the tools for the development of eco-efficiency among SME of Venezuela. The criteria chosen and validated with experts are the following:

1. Costs of implementing the tool,
2. Capacity of the PA to monitor compliance with the tool,
3. Effectiveness (efficacy) to improve eco-efficiency
4. Visibility of the tool, contribution to improve the image of the PA
5. Efficiency of the tool,
6. Legal feasibility of the tool,
7. Time the tool takes to be implemented,
8. State of development of the tool, maturity and reliability
9. Capacity of the PA to disseminate and implement the tool
10. Dependence of the results with the continuity of the tool, eco-efficiency results reverse when the tool stops being applied (which is not desired).

Once the list of criteria was agreed, experts were asked about the importance of each criterion. For this, every criterion was assigned a number from a Likert-type scale from 1 to 9. Likert-type scales are one f the most widely used approach to scaling responses in survey research. In this scale, the higher the assigned number the more important is the criterion. After the six judgments for each criterion were obtained, the final value for the importance (or weight) of the criterion is calculated by the geometric mean of the values, according to the proposal of Saaty (2001). The values of the weights of the criteria are shown in columns in table 4, just below the criteria.

Afterwards, each tool was assessed in relation to these criteria. The results of this assessment are shown in table 4. In the matrix, the value of the "aij" cell corresponds to the assessment of the tool "i" for the criterion "j". Again, a Likert-type scale of 1 to 5 is applied, and the greater the value of the cell "aij" the better assessment the tool "i" gets about the criterion "j". It must be noticed, furthermore, that the most suitable tools will be those that maximize all the criteria except the "C1 Cost", the "C7 Time it takes to implement the tool" and the "C10 dependence of the results with the continuity of the tool". For these criteria the greater the value the worse valued is the tool for that criterion, i.e., all criteria are to be maximized except for the three above mentioned.

Table 4 is also built by calculating the geometric mean of the answers from the experts in each cell. Finally to aggregate all the judgments for each tool the weighted sum is calculated multiplying the values of the row times the weights of the criteria, according to equation (1). The weighted sum must take into account the criteria "C1 Cost", "C7 Time it takes to implement the tool" and "C10 Dependence of the results with the continuity of the tool" are criteria to be minimized. In the weighted sum these are terms subtracting while the others add. In table 4 the result of equation (1) is shown in the last column.

$$Tool(i)\ assessment = \sum_{j=10}^{j=1} \pm a_{ij} \cdot w_j \qquad (1)$$

Another option for criteria like 1, 7 and 10 is recoding them so that they are to be maximized, i.e. the higher the value the better the assessment. However, according to authors like Antoine et al. (1997) or Mareschal & Brans (1988), subtracting the values of the criteria in formula (1) allows keeping the criteria as they were determined by the experts, and minimizes the risk of changing the meaning or the weight of the criteria by recoding (for example, criterion "C1 Cost of implementing the tool" is somehow difficult to recode to be maximized without significantly changing it).

Table 4.

Matrix analysis of the tools of the PA

ASSESSMENT CRITERIA (in order of importance) / PUBLIC ADMINISTRATION TOOLS (in order of importance)	Efficacy, effectiveness	Legal feasibility	Capacity to monitor compliance	Efficiency	Cost of implementation	State of development	Capacity to disseminate and implement	Time it takes to implement	Dependence of results with the continuity of the tool	Improvement of public administration image	FINAL RESULT
CRITERIA WEIGHT (wj)	**8,63**	**8,63**	**7,61**	**7,61**	**7,50**	**7,50**	**7,30**	**7,10**	**6,80**	**6,25**	
Taxes	3,70	3,49	3,98	3,96	3,05	4,11	3,42	2,85	3,28	3,14	**132,40**
Protection of Areas	3,77	4,42	3,32	3,91	3,36	4,26	3,66	3,60	4,29	4,06	**130,01**
Protection of Species	3,77	4,42	3,11	3,73	3,24	4,42	3,53	3,91	4,42	3,91	**124,02**
Advertising of eco-efficient products	2,99	4,22	3,80	2,85	3,60	3,42	3,36	3,14	3,14	4,26	**119,07**
Advertising of responsible consumption	3,36	4,22	3,80	2,99	3,91	3,05	3,53	3,14	3,36	4,26	**117,82**
Subsidies	3,56	3,53	3,36	3,96	3,98	3,70	2,94	2,57	3,16	3,36	**117,43**
Education in environment:	3,98	4,59	3,26	3,66	3,49	3,84	2,83	3,77	3,38	2,18	**113,82**
Limit legislation	3,30	3,43	2,71	3,53	2,29	3,66	2,90	2,80	3,16	2,70	**112,47**
Research in environment	3,60	5,00	2,80	3,77	4,82	4,47	3,14	3,91	3,11	1,98	**107,98**
Legislation of BAT	3,36	3,20	2,62	3,70	2,24	3,36	2,71	2,99	3,01	2,40	**106,15**
Green procurement policy	3,36	3,43	3,32	3,77	3,63	2,40	3,09	3,24	2,77	3,09	**103,37**
Voluntary agreements	3,80	3,87	1,85	4,06	3,05	3,36	2,62	3,77	2,85	2,33	**101,04**
Product panels	3,66	3,60	2,14	4,11	3,03	2,80	2,14	3,09	2,57	2,24	**98,72**
Environmental Declarations type I	3,32	3,44	2,22	3,52	3,25	3,39	2,35	3,29	3,06	3,10	**95,55**
Environmental Declarations type II	2,05	3,17	1,64	2,05	2,46	3,39	2,17	2,40	2,46	2,35	**76,89**
Environmental Declarations type III	2,70	3,64	1,72	2,93	3,73	2,49	1,89	3,78	3,25	2,93	**64,08**

This evaluation allows sorting the tools according to their suitability, the greater is the value of the weighted sum the more appropriate is the tool. As a result, the order of suitability and potential of the tools to improve the eco-efficiency of SME in Venezuela is:

1. Taxes

2. Protection of Areas and Species

3. Advertising of responsible consumption & eco-efficient products

4. Subsidies

5. Education in environment:

6. Limit legislation

7. Research in environment

8. Legislation of BAT

9. Green procurement policy

10. Voluntary agreements

11. Product panels

12. Environmental Declarations type I, II and III

4. Discussion of results and conclusions

This paper presents an analysis of the barriers and stimuli that SME of Venezuela face to implement eco-efficiency. Also how public administration tools can help to overcome barriers and develop stimuli. The research has focused on manufacturing SME of the central region of Venezuela, but could be reproduced for any region. From the comparative analysis of six studies in The Netherlands, Spain and Venezuela we have found there are more coincidences than differences among the barriers and stimuli SME face, although differences are significant. Thus, all studies coincide in showing SME do not believe to have significant environmental impacts and believe the protection the environment to be more an extra cost than an opportunity to improve their products and services. This is mainly because market does not seem to demand eco-efficient products and services. However, Europeans attribute their barriers more to the lack of infrastructure and technology while Venezuelan more to the lack of sensitivity of buyers and end users.

Likewise, internal stimuli that would move SME towards eco-efficiency are very similar, regardless of the degree of eco-efficiency promotion in the studied region. These stimuli are decreasing costs and improving the quality of products. This coincidence could be due to the fact SME worldwide have similar characteristics as they are subject to the same limitations of human and material resources and the same limitations of training of its staff.

However, there are differences in external stimuli. European studies agree on underlining the legislation and the customers' requirements as the more important external stimuli, while in Venezuela these two stimuli are seldom mentioned. In fact, PA has very few effective mechanisms for monitoring environmental legislation compliance in Venezuela. Also, given the low environmental awareness of the Venezuelan consumer, the environmental market is practically non-existent. Finally, what the Venezuelan studies propose as external incentive is the design and development of an office of the PA for advice and support to SME and, secondarily, alliances between market stakeholders: consumer associations, producer associations, media, funders, legislators, tax collectors, etc. and better access to funding.

Public administration has been identified as one of the stakeholders with greater interest and capacity to promote eco-efficiency among SME. Besides, there has been identified numerous tools of the PA that would help SME overcoming the barriers to eco-efficiency of SME and would enhance internal and external stimuli. These tools include repressive measures like legislation and taxes. Incentive measures like subsidies, voluntary agreements and green procurement. Educational measures like environmental declarations, advertising, education

and research. And, finally, protectionist measures aimed at protecting spaces and species of exceptional environmental value.

The studied authors agree that the share of responsibility that touches the PA in the poor development of the eco-efficiency of SME is due to PA has not properly implemented the available tools. In order to help planning implementing strategies for ecoefficiency, the identified tools have been analyzed in relation to the barriers and incentives previously determined. Table 3 shows tools that are more oriented to overcome barriers are those that affect more directly the activity of the company, such as "environmental declarations", "voluntary agreements and product panels" and "green procurement", while tools that are more focused on producing stimuli are those directed to encourage and discourage businesses practices such as "taxes", "subsidies" and "legislation" (although also "education and training").

A panel of six experts in industry, eco-efficiency, public administration and environment have suggested criteria in order to assess the appropriateness of the tools that PA can use to stimulate eco-efficiency of SME. The policy Delphi method has been used. As shown in table 4 the most important criteria according to experts are: "Efficacy" and "Legal feasibility", followed by "Efficiency" and "Capacity to monitor compliance". However, all criteria obtained a similar weight and "Improvement of the PA image" was valued not far from the most important criteria.

The final assessment of every tool is shown in the last column of table 4. In this case results are clearly different with the maximum scores more than doubling the minimum scores. Hence, it is easier to classify the tools according to their potential for eco-efficiency. The tools that receive the highest values in the assessments of the experts are those which experts believe to be more effective and the PA has greater capacity to implement. This is the case of tools like "taxes", "the protection of important environmental areas", "the protection of endangered species", "advertising ecological products and responsible consumption", "subsidies" and "environmental education". Note that not necessarily the tools more related to barriers and incentives in table 3 are the most suitable for experts, although there is a certain correlation.

On the other hand, the tools that occupy the last places in the order of suitability are those for which there is no experience in Venezuela. That means experts believe PA does not trust much the tools yet. That is to say, PA expects companies to trouble with the new norms, or trying to take advantage of the incentives, while end users and buyers will not understand the measures much. This is the case of the voluntary agreements, product panels and the environmental declarations type I, II and III.

It is interesting to note that these results differ noticeably with the suggestions of the analyzed works referred in section 3.2. Particularly, authors addressing European public administrations tend to recommend tools like "education and training", "environmental declarations" or "product panels" that have been assessed as not appropriate for Venezuela.

This assessment also allows obtaining partial results. For instance, according to cells of table 4, the less expensive tools would be "limit and BAT legislation" and "environmental declarations type II". The more effective would be "Education in environment", "voluntary agreements" and "Protection of areas and species", while the more efficient would be "voluntary agreements" and "product panels" followed by "taxes" and "subsidies". But "voluntary agreements" and "product panels" score poorly in criteria related to the improvement of the PA image and the capacity of the PA to implement and control the tool.

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According to the difficulties for implementation and to the time needed, the preferred tools would be "taxes" and "subsidies", followed by "advertising of responsible consumption and ecological products". In relation to the immediate pay-back of implementing the tools "advertising of responsible consumption and ecological products" is the one that better improves PA image. Finally, it is important to note that all tools have a high legal feasibility.

The analysis of this research and its results facilitates designing different plans in support of eco-efficiency depending on the desired approach. Different combinations of tools can be selected depending on whether the focus is more on the economy of resources, the management of deadlines, the optimization of returns to the PA, the effectiveness and reliability of the tools, etc.

Currently, research with the panel of experts is devoted to determine which may be the approach that would be more suitable for the complex PA of Venezuela in order to promote eco-efficiency. By PA of Venezuela authors mean from FONDOIN to the Ministry of Industry, public companies, city councils, public services, etc. The aim is to design a methodological proposal to implement the tools that fulfills the strategic objectives of the public administration regarding eco-efficiency according to the obtained characterization of the tools of PA in Venezuela.

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INVOLVED AGENTS

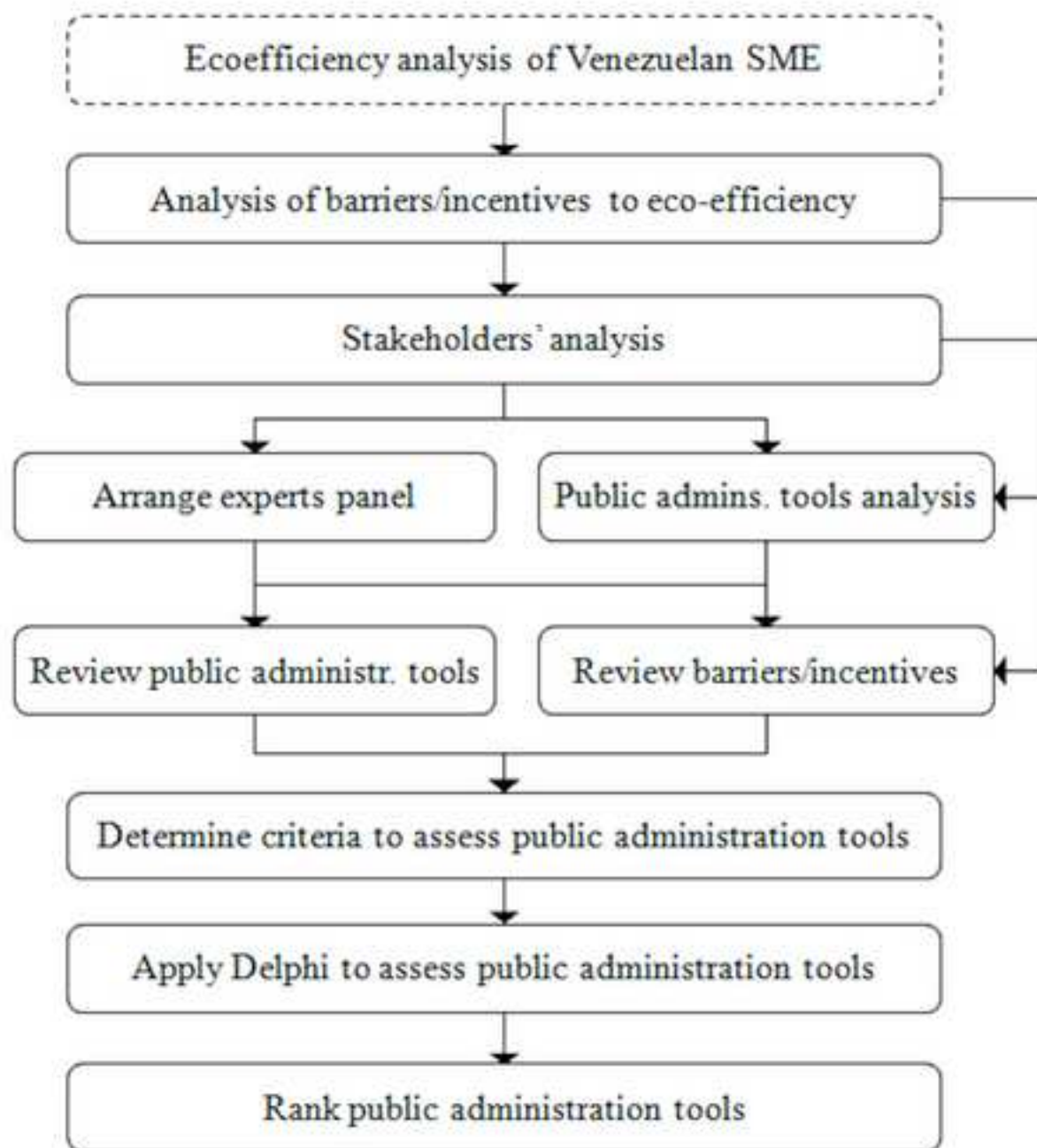| Authors and SMEs' managers | Ecoefficiency analysis of Venezuelan SME |
Authors	Analysis of barriers/incentives to eco-efficiency
Authors	Stakeholders' analysis
Authors	Arrange experts panel / Public admins. tools analysis
Experts	Review public administr. tools / Review barriers/incentives
Experts	Determine criteria to assess public administration tools
Experts	Apply Delphi to assess public administration tools
Authors and experts	Rank public administration tools

Table 1

BARRIERS	The care for environment is not considered as a quality criterion	(Fernández-Viñé et al., 2010)
	No relationship is found between innovation and environment	(FONDOIN, 2005) (Fernández-Viñé et al., 2010) (Murillo-Luna et al. 2011)
	Lack of sensitive and competent staff	(Ministerie van Vrom, 2004) (Gómez-Navarro, 2004) (Fernández-Viñé et al., 2010) (Murillo-Luna et al. 2011)
	PA has inefficient control mechanisms	(Gómez-Navarro, 2004) (FONDOIN, 2005) (Fernández-Viñé et al., 2010) (Murillo-Luna et al. 2011)
	There is little market for green products	(Ministerie van Vrom, 2004) (Fernández-Viñé et al., 2010) (Murillo-Luna et al. 2011)
	Stakeholders do not demand eco-efficiency	(Ministerie van Vrom, 2004) (Fernández-Viñé et al., 2010)
	Environment is not considered as a responsibility of SME	(van Hemel & Cramer, 2002) (Fernández-Viñé et al., 2010)
	Lack of information about environmental regulation	(Ministerie van Vrom, 2004) (Gómez-Navarro, 2004) (Murillo-Luna et al. 2011)
INTERNAL INCENTIVES	Cost reduction	(van Hemel & Cramer, 2002) (Ministerie van Vrom, 2004) (Gómez-Navarro, 2004) (FONDOIN, 2005) (Fernández-Viñé et al., 2010) (Murillo-Luna et al. 2011)
	Efficient use of scarce or sensitive resources	(FONDOIN, 2005) (Fernández-Viñé et al., 2010)
	Opportunities for innovation	(van Hemel & Cramer, 2002) (Gómez-Navarro, 2004)
	Market Opportunities	(van Hemel & Cramer, 2002)
	Improved company environmental sensitivity	(van Hemel & Cramer, 2002) (FONDOIN, 2005)
	Improved product quality	(Ministerie van Vrom, 2004)
EXTERNAL INCENTIVES	Customer requirements	(van Hemel & Cramer, 2002) (Gómez-Navarro, 2004) (Murillo-Luna et al. 2011)
	Compliance with legislation	(van Hemel & Cramer, 2002) (Ministerie van Vrom, 2004) (Gómez-Navarro, 2004)
	Improving competitiveness	(Ministerie van Vrom, 2004) (Gómez-Navarro, 2004)(FONDOIN, 2005) (Fernández-Viñé et al., 2010) (Murillo-Luna et al. 2011)
	Increased support and advice from the PA	(FONDOIN, 2005) (Fernández-Viñé et al., 2010)

Table 2

Spaces protection legislation Species protection legislation	Set of laws and regulations which ensure the preservation of the protected areas of the nation, or the endangered species and the habitat on which they depend
Environmental Declarations type I Environmental Declarations type II Environmental Declarations type III	Environmental Product Declarations type I, II and III are labels and logos to report certain positive environmental attributes of a product or service. Type I is a multiattribute label developed by a third party; type II is a single-attribute label developed by the producer; type III is an eco-label whose awarding is based on a full life cycle assessment.
Education in environment Research in environment	Actions aimed at generating and disseminating knowledge and technologies for eco-efficiency, carried out in academia or in companies with public funding.
Voluntary agreements Product panels	Commitments or agreements established between firms or industries, sometimes involving the PA. These actors are committed to voluntary compliance with environmental quality objectives
Advertising of responsible consumption Advertising of eco-efficient products	Advertising sponsored by the State to educate the public promoting more eco-efficient habits and recommending the use of products and services with less environmental impact.
Green procurement policy	PA policies and procedures for purchasing products and services that minimize environmental impacts.
Subsidies	Financial assistance offered to companies by the State, directly or through organizations, to achieve certain environmental goals.
Taxes	Fiscal instruments that allow the direct incorporation of the costs of environmental damages to the cost of goods and services.
Limit legislation Best Available Techniques (BAT) legislation	Regulation that set standards of environmental quality and set limit values of concentration of physical, chemical and biological agents in air, water or soil. This set also comprises Norms driven by public institutions both compulsory and recommended. Note: BAT are primarily aimed at medium to large companies, but they affect also to the SME in each sector as they also are suppliers, buyers, users, etc.

Table 3

PUBLIC ADMINISTRATION TOOLS / BARRIERS AND DRIVING FORCES	Protection of Areas and Species	Environmental Declarations type I, II and III	Training and research in environment:	Voluntary agreements and product panels	Advertising of responsible consumption & eco-efficient products	Green procurement policy	Taxes	Subsidies	Limit legislation and legislation of BAT
The care for environment is not considered as a quality criterion		X		X*	X	X			
No relationship is found between innovation and environment		X*	X	X				X	
Lack of sensitive and competent staff			X	X	X				
PA has inefficient control mechanisms	X*					X	X		X
There is little market for green products		X			X	X			
Stakeholders do not demand eco-efficiency				X	X				
Environment is not considered as a responsibility of SME	X*	X*	X	X	X				X
Lack of information about environmental regulation		X	X			X	X	X	X
Cost reduction				X	X		X*	X	
Efficient use of scarce or sensitive resources			X*	X			X	X	X
Opportunities for innovation			X					X	
Market Opportunities		X		X	X	X	X	X	X*
Improved company environmental sensitivity			X		X			X*	
Improved product quality			X						X
Customer requirements	X	X	X		X	X*			
Compliance with legislation	X			X			X	X	X
Improving competitiveness		X*	X		X	X		X*	
Increased support and advice from the PA				X		X*	X		X*

Table 4

ASSESSMENT CRITERIA (in order of importance) / PUBLIC ADMINISTRATION TOOLS (in order of importance)	Efficacy, effectiveness	Legal feasibility	Capacity to monitor compliance	Efficiency	Cost of implementation	State of development	Capacity to disseminate and implement	Time it takes to implement	Dependence of results with the continuity of the tool	Improvement of public administration image	FINAL RESULT
CRITERIA WEIGHT (wj)	**8,63**	**8,63**	**7,61**	**7,61**	**7,50**	**7,50**	**7,30**	**7,10**	**6,80**	**6,25**	
Taxes	3,70	3,49	3,98	3,96	3,05	4,11	3,42	2,85	3,28	3,14	**132,40**
Protection of Areas	3,77	4,42	3,32	3,91	3,36	4,26	3,66	3,60	4,29	4,06	**130,01**
Protection of Species	3,77	4,42	3,11	3,73	3,24	4,42	3,53	3,91	4,42	3,91	**124,02**
Advertising of eco-efficient products	2,99	4,22	3,80	2,85	3,60	3,42	3,36	3,14	3,14	4,26	**119,07**
Advertising of responsible consumption	3,36	4,22	3,80	2,99	3,91	3,05	3,53	3,14	3,36	4,26	**117,82**
Subsidies	3,56	3,53	3,36	3,96	3,98	3,70	2,94	2,57	3,16	3,36	**117,43**
Education in environment:	3,98	4,59	3,26	3,66	3,49	3,84	2,83	3,77	3,38	2,18	**113,82**
Limit legislation	3,30	3,43	2,71	3,53	2,29	3,66	2,90	2,80	3,16	2,70	**112,47**
Research in environment	3,60	5,00	2,80	3,77	4,82	4,47	3,14	3,91	3,11	1,98	**107,98**
Legislation of BAT	3,36	3,20	2,62	3,70	2,24	3,36	2,71	2,99	3,01	2,40	**106,15**
Green procurement policy	3,36	3,43	3,32	3,77	3,63	2,40	3,09	3,24	2,77	3,09	**103,37**
Voluntary agreements	3,80	3,87	1,85	4,06	3,05	3,36	2,62	3,77	2,85	2,33	**101,04**
Product panels	3,66	3,60	2,14	4,11	3,03	2,80	2,14	3,09	2,57	2,24	**98,72**
Environmental Declarations type I	3,32	3,44	2,22	3,52	3,25	3,39	2,35	3,29	3,06	3,10	**95,55**
Environmental Declarations type II	2,05	3,17	1,64	2,05	2,46	3,39	2,17	2,40	2,46	2,35	**76,89**
Environmental Declarations type III	2,70	3,64	1,72	2,93	3,73	2,49	1,89	3,78	3,25	2,93	**64,08**