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Preventive Command and Control Regulation: A Case Analysis

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Abstract: The aim of the current study is to evaluate new preventive command-and-control environmental regulation's competitive effects on automobile manufacturers and their suppliers. The methodology that we have used is a case analysis, and its main aim is to study an unfamiliar situation. Therefore, we have chosen cases from each of the groups: two suppliers and one manufacturer. The new regulation obliges automobile companies to deeply modify their process technologies and their relationships with their suppliers (toughening requirements and strengthening long-term relationships) and to require their workers to train in environmental matters. Complying with regulation by suppliers will be possible if product and process designs are modified. However, only organisational actions, which include workers' training in environmental and quality matters and activities to recover value in factories, are capable to achieve it. In any case, these factories have already been affected by trade-offs between environmental and other more classic manufacturing objectives, especially quality.

Keywords: environmental management; manufacturing strategy; manufacturer-supplier relationships; quality management

1. Introduction

Especially in the first periods of environmental development in a region or a country, the role played by Public Administrations is key (Brío *et al.*, 2002) [1]. Later, governments develop other kinds of tools, which demand companies to internalise those costs derived from environmental damage which they had caused earlier. Environmental instruments with this aim are called economic instruments. Some examples are environmental taxes, tradable emission rights or financial aids (OECD, 1991; Ledyard and Szakaly-Moore, 1994) [2,3]. There are other kinds of tools which help companies to improve their image by supporting their reputation on environmental management (Cascio *et al.*, 1996) [4]: certifications and eco-labels. This kind of regulation is known as preventive environmental regulation, because it leads companies to avoid pollution. However, previous laws, the so-called command-and-control regulation or traditional command-and-control regulation, can be defined as the direct regulation in an industry or activity which states what is permitted and what is illegal (McManus, 2009) [5]. It imposes limits only to the permitted level of pollution.

In fact, the first tool used by Pubic Administrations in any country is this command-and-control regulation (Jennings and Zandbergen, 1995; O'Connor, 1998; Hillary and Thorsen, 1999) [6–8]. In order to comply with this kind of regulation, companies must develop new technologies to avoid polluting. As a result, papers on the environmental activity in companies have usually been focused

exclusively on technological issues, whereas organisational aspects are often ignored: actions to reduce CO_2 emissions (Medina and Tarlock, 2010) [9], an industry's dynamics (BenDor, 2012) [10] or even issues linked to social problems, such as dependence by older adults (Nakanishi and Black, 2015) [11], among others.

Recently, the European Union has elaborated a new kind of command-and-control regulation, the so-called preventive command-and-control environmental regulation described in this paper. It establishes preventive objectives when a new design is established to reduce and to eliminate the use of dangerous substances in manufacturing, to facilitate reutilization, recycling and revaluing and to reduce environmental pollution. This new initiative, which requires technological and organisational solutions, is used to comply with preventive regulation. They are also linked in order to guarantee the success of companies' environmental strategies. Nevertheless, this preventive command-and-control environmental regulation shows what is permitted and what is illegal too, so, in this sense, it is similar to command-and-control regulation.

With the ratification of the Kyoto Protocol by Russia, industrialised countries that signed the Protocol accounted for 55% of all CO_2 emissions, which came into effect in 2004. In the European Union more than anywhere else, even prior to the Protocol, a process began to develop new regulation to ensure compliance with what would eventually become the targets set by the Protocol: for example, Directive 2000/53/CE on Management of Vehicles at the End of their Useful Life. As a consequence, said regulation shows effective guidelines for the correct environmental management of vehicles at the end of their useful life, but also preventive measurements which should be taken into consideration at any automobile's design and manufacturing and when suppliers produce new components.

Environmental regulation always induces changes at the business level. Nevertheless, the most traditional approaches for environmental regulation modifies a company's business strategy only slightly. However, regulation of the type of Directive 2000/53/CE relating to vehicles at the end of their useful life, forces not only a group of companies, but also all participants in the value chain of every industrial sector, to alter their "way of doing things". This especially affects the manufacturing area, where environmental issues exercise greater influence. Literature has independently studied the most relevant effects of preventive regulation and command-and-control regulation. Nevertheless, preventive command-and-control environmental regulation had not been studied yet. In fact, Directive 2000/53/CE is the first preventive command-and-control environmental regulation, so its effects have not been studied yet. As a result, this has become a remarkable topic. Consequently, we will focus on this gap. That is to say, we will study how the new preventive command-and-control regulation is able to influence and to modify a business' strategy, and, especially, its manufacturing strategy. It is a very new environmental regulation, whose influence on business strategy, as well as on manufacturing strategy, and the relationship between regulation and strategy, may lead to important effects on organisational performance.

In addition, this paper analyses the role of the supply chain within this new regulatory framework. The literature has shown the role of any supply chain in managing environmental issues. Akyuz and Erkan (2010) [12] reveal that the supply chain is still a fruitful research area. Moreover, further research is necessary. More recently, Vanichchinchai and Igel (2011) [13] suggest that, in future, research ino the automotive assemblers and downstream business partners could be studied together with the upstream suppliers in order to investigate the relationship along the whole supply chain. Huscroft *et al.* (2013) [14] have addressed that environmental issues are key to study reverse logistics successfully. Some alternative papers had focused their study on the automotive industry (Hsu, Tan and Laossirihongthong, 2014) [15]. However, research has not analysed the green supply chain specifically within the automotive industry so far.

The aim of the present paper is to undertake a case analysis on the reaction of an industrial sector, the automotive sector, to comply with this new preventive command-and-control environmental regulation. We analysed the role of companies scrapping vehicle companies in a previous paper (Brío *et al.* 2006) [16]. In this research, we study the consequences of preventive command-and-control

environmental regulation for component suppliers and automotive manufacturers, as well as the relationships between them.

The structure of this paper will be broken down as follows. The theoretical approach will first be shown, followed by the methodology according to which this study has been carried out. Finally, the conclusions and implications of this paper will be set out.

2. Theoretical Approach

The environmental Directive 2000/53/CE studied in this paper establishes measures to prevent waste generated by vehicles, to regulate its collection and decontamination at the end of their useful life, in addition to other treatments, with the aim of improving the environmental management's efficacy during the vehicle life cycle (DOCE, 2000) [17]. According to our definition, it is a command-and-control environmental law in its preventive version.

The aim of the directive studied in this paper is to establish measures to prevent waste generated by vehicles, to regulate its collection and decontamination at the end of their useful life, in addition to other treatment, with the goal of improving the effectiveness of environmental management during the vehicle life cycle. In this way, this directive establishes preventive measures, from the start of the vehicle's design stage, to reduce and to eliminate the use of dangerous substances in its manufacturing and to facilitate reutilisation, recycling and valorisation of its components and to reduce the environmental pollution produced by vehicles. That is to say, this directive is preventive command-and-control environmental regulation, although in a preventive manner.

The central figure in this regulation is the user, who becomes obligated to hand over the vehicle at the end of its useful life—either directly or via a system for its delivery—to an authorised treatment centre charged with the removal of contaminants. In order to facilitate the user's compliance with this duty and to apply the principle of the manufacturer's responsibility, the latter must be responsible for the vehicles which it has produced or sold, guaranteeing the suitability of the reception facilities.

The abovementioned directive establishes preventive measures which various elements in a vehicle have to comply with, so that the use of dangerous substances is reduced to a minimum. To this effect, the use of lead, mercury, cadmium and hexavalent chrome is prohibited in vehicle materials and components, with some exceptions and conditions.

(a) Designing and manufacturing vehicles and the elements composing them in such a way as to facilitate their dismantling, decontamination, reutilisation of parts and the valorisation of the vehicles at the end of their useful life and to encourage the use of new models for recycling materials and components.

(b) Using codification standards which allow workers and managers to identify those components suitable for reutilisation or valorisation.

(c) Providing people who work with vehicles at the end of their useful life with the correct information for their dismantling, which allows the identification of the different components and the location of dangerous substances.

(d) Informing consumers about environmental management criteria used both at the stages of vehicle design and manufacturing, as well those used to ensure their correct environmental treatment at the end of their useful life.

The newness of the compulsory introduction of preventive approaches in environmental management brings with it implications of great significance to the companies. In fact, Porter and Van der Linde (1995) [18] have observed that the more complex the environmental approaches are, the less autonomous the environmental actions become. Consequently, environmental issues are linked more closely to other functional areas, especially to manufacturing department (Oglethorpe and Heron, 2010) [19].

As preventive regulation, Directive 2000/53/CE induces a change in the way of dealing with business strategy as a whole, as we have already observed. This is particularly relevant in the manufacturing area, the department most affected by environmental regulation.

The lack of preventive environmental laws has led to only a few studies about its effects on business competitiveness and, as a result, about the aspects that could foster its compliance. In any case, the new European directive which we have analysed in this paper has triggered the beginning of a new era when research about preventive command-and-control environmental regulation has become a priority. Firstly, Aggeri (1999) [20] has studied cooperative movements in the automotive industry, although these papers have been used to study only manufacturers. Other studies have analysed environmental issues in automotive industry (Das *et al.*, 1995; Bellmann and Khare, 1999, 2000; Mildenberger and Khare, 2000) [21–24], but they have not studied the implications derived from companies' environmental actions, especially on decisions isolated from manufacturing strategy. On the other hand, these papers are descriptive and are not focused on the analysis of the implications derived from new command-and-control environmental laws, but with a preventive bias. Nevertheless, they are an exceptional theoretical support to approach the current paper. In fact, Mildenberger and Khare (2000) [24] have analysed environmental issues in the automotive industry, focusing on the German case. Likewise, Bellmann and Khare (1999) [22] have discussed the potential implications derived from environmental regulation on the automotive industry and, lately, to analyse its economic implications (Bellmann and Khare, 2000) [23].

Therefore, one of the main obstacles in carrying out this paper is the lack of specific literature. However, we have found another kind of literature which could be the support our study of the issue which we are working on. Once we have achieved this point, we have to consider, on the one hand, institutional approaches and strategic literature, which, together with contributions stemming from economic theory, have produced several win-win results for the analysis of environmental issues. On the other hand, and related to the influence of manufacturing strategy development to ease the compliance with the new regulation, we have used the literature focused on the study of manufacturing strategy, and especially those papers which have made an effort to try to integrate environmental issues.

In fact, Barbera and McConnell (1990) [25] had defended the differences between several kinds of effects derived from environmental regulation on business productivity. The first one is the so-called direct effect (the cost which companies have to deal with to comply with environmental regulation). The second effect, addressed by Barbera and McConnell (1990) [25], is the so-called indirect effect, which is linked to the influence the change could have on the productive factors to manufacture goods. That is, environmental regulation can improve productivity using manufacturing processes, which use less inputs and take advantage of productive processes which consume a smaller amount of inputs or using waste, either by selling it as derived products or reducing operative costs as a consequence of a more efficient use of materials and energy (Porter and van der Linde, 1995; Shen, 1995) [18,26]. In short, the literature recognizes that environmental regulation can improve or damage business competitiveness from the beginning.

From an institutional point of view, Hoffman and Ventresca (1999) [27] support their analysis on three issues linked to institutions (regulative, normative and cognitive) and take into account the implications derived from this argument. Hoffman *et al.*'s (1999) conclusions match with the Porter hypothesis in the sense that environmental protection allows win-win alternatives for companies [28]. Hoffman (1999) [29] tries to check his theories empirically by applying this analysis to the chemical industry in the United States, a very similar paper to Hoffman's (2005) [30].

Within the same debate, the strategic literature has analysed environmental regulation's influence on business competitiveness (Shrivastava, 1995) [31]. Although there are no conclusive results, some authors have explained the differences perceived between companies with a different kind of relationship between environmental performance and business performance supporting their arguments on the resource-based view (Russo and Fouts, 1997) [32]. According to Porter Hypothesis,

Marcus and Geffen (1988) [33] have analysed, focusing their reasoning on pollution prevention for electricity generation, how the system characteristics together manage the paths which imply the acquisation of new competencies and a change in the interaction with other groups and stakeholders in the company. A comprehensive view of these papers allows us to guess whether the same regulation is able to foster such different effects on several companies or not.

In general, environmental approaches allow us to divide companies into two groups: those with command-and-control approaches and those with preventive approaches. Those companies, where the main method is to use specialized equipment to fight against pollution, may suffer from too many costs. Simultaneously, it is unproductive, because it is not able to generate value (Andersson and Wolff, 1996) [34]. The philosophy on which this approach is supported is that the only force to manage an environmental policy is to minimize tangible costs derived from pollution. That is to say, any company beyond compliance would not accept benefits derived from internalising those costs (Russo and Fouts, 1997) [32]. On the other hand, the so-called Porter hypothesis maintains that strict and preventive environmental regulation triggers the discovery and introduction of cleaner technologies and environmental improvements, an innovative effect which leads to more efficient manufacturing, processes and products (Porter and van der Linde, 1995) [18]. From this point of view, the more additional improvements a kind of environmental regulation fosters, the more said regulation can contribute to balance earlier costs derived from regulation, avoiding fines, among other sanctions (Greeno and Robinson, 1992; Shrivastava, 1995a; Hart, 1997) [35–37].

Additional contributions have found out several aspects which could influence the relationship between compliance with environmental regulation and business competitiveness. Dean and Brown (1995) [38] address the fact that environmental regulation can create entry obstacles because of the increase of new investment or the change of the minimum efficient scale as a consequence of entering new environmental technologies. On the other hand, they suggest that environmental regulation could decrease some entry barriers, because incumbents companies simultaneously choose environmental technologies and manufacturing technologies, avoiding, in this way, potential conflicts.

Supporting the conclusions derived from our review of the literature, we have not been able to obtain conclusive results, perhaps because not every kind of environmental regulation affects business competitiveness in the same way. We should consider the specificities linked to this new kind of environmental regulation, the so-called preventive command-and-control environmental regulation, which has not been studied yet, because it fosters companies to adopt preventive actions, that is, those that interact with product and process designs. In fact, they may ease (or make more difficult) the implementation of preventive environmental practices. That is, the specific influence of a rule on business competitiveness could depend on its intrinsic characteristics. The newness derived from the directive which we have analysed in this paper fosters the most important implications from a qualitative point of view. Moreover, Porter and Van der Linde (1995) [18] found that the more complex environmental approaches become, the less autonomous environmental actions are and the more linked to other functional areas in the company they are, especially to manufacturing department.

The new preventive approaches lead to a change in the way of dealing with manufacturing management, so that eco-manufacturing management was born in Angell and Klassen's (1999) terms and in Newman and Hanna's (1996) words [39,40]. It is defined as the integration between environmental principles in decision making, which affects the transformation of resources into useful goods (Gupta and Sharma, 1996) [41]. Nevertheless, the method of adopting integrated decisions into manufacturing strategy in a company is a key issue, because Newman and Hanna (1996) [42] have shown how developing a manufacturing strategy is an uncrossable constraint to improving a company environmentally (Ioppolo *et al.*, 2012; Ioppolo *et al.*, 2014) [43,44].

However, including environmental issues into production function is not an easy task. Moreover, preventive environmental protection may change the hierarchy of manufacturing objectives in a company and the way that companies make several manufacturing decisions. This kind of literature has studied the main implications derived from implementing preventive environmental actions, although

voluntarily, never with a mandatory character. However, it is very helpful to know those implications and constraints derived from its implantation. Florida (1996) [45] shows the results of a survey carried out in the United States in industrial companies, whose aim was to explain the relationship between advanced manufacturing systems and innovative approaches for environmentally-conscious manufacturing. Klassen and Whybark (1999) [46] found that improving environmental performance is possible only after implementing preventive technologies in a company's environmental technology portfolio. Sarkis (1995) [47] shows a strategic framework to manage environmentally-responsible programs and projects in industrial companies. Later, Sarkis (2001) [48] analyses the role of manufacturing into corporate sustainability, dealing with problems derived from manufacturing function specifically.

In general, this kind of literature should be classified as prescriptive and supported on anecdotic evidence, although some aspects defining environmentally responsible manufacturing can be perceived. For example, Richards (1994) [49], Sarkis (1995) [47], Zhang *et al.* (1997) [50], Gungor and Gupta (1999) [51], Nagel and Meyer (1999) [42] and Melnyk *et al.* (2003) [52] emphasise the importance of value recovery activities, whereas Sarkis (2001) [48] includes aspects related to decisions to implement a manufacturing strategy. Go *et al.* (2011) [53] have studied said effects on end-of-life vehicles in the automotive industry. Other authors have studied environmentally responsible approaches for responsible manufacturing from an ecological view (Florida, 1996; Zhang *et al.*, 1997) [45,50], including job safety (Zhang *et al.*, 1997) [50].

However, two papers must be addressed (Newman and Hanna, 1996; Angell and Klassen, 1999) [39,40], although, in general, only a few papers can be said to have focussed their main aim on checking empirically how the level of development in manufacturing decisions improves environmental development. In fact, some of them have partially been analysed (Florida, 1996) [54], although without taking into account their links to a manufacturing strategy.

On the other hand, we should consider those empirical studies published which have analysed relationships between the supply chain and environmental actions. Handfield *et al.* (1997) [55], in a case analysis for the furniture industry, found the main influence areas on environmental performance in a company, after showing the weaknesses of the literature published until that moment. Young (2000) [56], in another case analysis, also shows the importance of supply function if the aim is to achieve an environmentally solid, profitable and efficient waste management, although the paper does not go beyond this.

Some of these studies even referred, completely or partially, to the automotive industry. For instance, the case analysis by Handfield *et al.* (2001) [57], whose main aim is to study the integration of environmental issues into product design, includes an automotive company. Hammond *et al.* (1998) [58] have carried out a study in the automotive industry which, among other conclusions, has shown specific issues. Nevertheless, instead of their findings, no paper has achieved relevant conclusions about how preventive environmental activities and manufacturing strategy are integrated together (Brío *et al.*, 2002) [59]. The reason for these results is that they are linked to actions assumed voluntarily by companies, not to the new regulation impact. In this paper, we are going to work withing this gap.

To sum up, preventive command-and-control environmental regulation may require a different way of management and, especially, a stronger integration of environmental issues into manufacturing strategy. However, it is a very new kind of regulation, and research about it is too scarce, so that many questions remain unanswered. Consequently, we have approached the following research questions to be answered after this case analysis:

(a) Does automotive suppliers and manufacturers' attitude towards a strict compliance with environmental regulation depend on their own environmental development?

(b) Do the stakeholders play a key role to foster companies towards more developed environmental approaches?

(c) Are there any relationships between complying with preventive command-and-control regulation in automotive regulation and integrating environmental issues into manufacturing strategy?

(d) Is there any relationship between the way companies in the automotive industry define their environmental objectives and their level of environmental development?

(e) What are the main changes that complying with new preventive command-of-control regulation requires?

(f) What kind of manufacturing decisions influence the compliance with the new preventive command-of-control regulation?

3. Methodology

The methodology which we have used is a case analysis because our aim is to study an unfamiliar situation (Voss *et al.* 2002) [60]: the implications of the new preventive command-and-control environmental regulation on the manufacturing activity in companies. Using this methodology is the most suitable option when the key questions are what (description), how and why (explanation) in the generation of a theory (Snow and Thomas 1994; Meredith 1998) [61,62]. As a result, this methodology is the best choice according to the main objective of this research.

A first key decision relating to case analysis is referring to how many and which cases to choose for the analysis. To solve this issue we have considered the previous literature. Eisenhardt (1989) [54] suggests that from 4 to 10 cases is an adequate number, although Dyer and Wilkins (1991) [63] maintain that two at maximum is sufficient. As part of this debate, Voss *et al.* (2002) [60] maintain that the optimum number of cases to analyse depends on the desired results.

The objective of this paper is to study the consequences of preventive command and control environmental regulation between component suppliers and automotive manufacturers and the relationships between them. Taking into account the suggestions from the previous literature and the specific characteristics of our study, which include two kinds of groups (component suppliers and automotive manufacturers), we have decided to analyse three companies: two suppliers (X and Y) and one automobile manufacturer (P).

At the same time, to avoid problems with external validity (a specific problem of any case analysis), we have carried out a detailed review of the literature, from which we have been able to extract the most relevant information. With a similar aim, we used the guidelines of the Spanish Association for the Environmental Treatment of End-of-Life Vehicles (SIGRAUTO), whose members are companies and institutions involved in the process of a right environmental management of vehicles at the end of their useful life. They gave us sufficient criteria to choose the most suitable cases and to define the measures related to the phenomenon to be studied (Yin 1984) [64]. The field work was carried out during the first half of 2011.

We designed a questionnaire according to our conclusions from the review of the literature and SIGRAUTO members' suggestions. After that, two researchers visited the companies analysed and interviewed a manager with responsibility for environmental issues in every case.

Nevertheless, to avoid the problem of internal validity which customarily affects any case analysis, we have used methodological triangulation, so that the information obtained from interviews could be complemented by observation and review of several documents. That is, triangulation or obtaining information from these companies leads us to use various sources, the following ones: their websites (when these were available), direct observation by the interviewer and the filling out of a questionnaire using literally the words by the person considered by the company to be most qualified to talk about environmental issues. We obtained qualitative and quantitative information. The process is similar to other analysis carried out in the automotive industry (Lu *et al.*, 2014) [65].

Since conclusions drawn from the literature and a preliminary inspection of the sector lead us to see envisage substantial differences regarding to the consequences of this new kind of regulation on the groups analysed (component suppliers and automobile manufacturers), we have opted for carrying out two different questionnaires. Both of them have, however, identical objectives and even

have identical questions and some of them are similar, although with a different focus depending on the position of each company in the supply chain. Our review of the literature was also used to choose the questions in the study, as well as the observations undertaken in the sector by the authors of the paper and SIGRAUTO's recommendations. We describe our three cases below.

Description of the Companies Analysed

X is a company founded in 1980 in Madrid. It manufactures electrical equipment for automobiles (horns and relays). The company is a division of a German multinational and leader in the manufacturing of lighting, electronic and electro-mechanical systems for the automobile industry. We visited its factory located in Madrid, with a workforce of 268 people. The company manufactures nine million horns and twenty-two million relays per year, with sales of approximately 36 million euros.

Y is a company which operates in the transmission product line as part of a multinational group which began operations in Paris in 1923 manufacturing brake linings and transmission systems. On 28 May 1980 the group's companies adopted the same name to operate as one brand. The group currently operates in 27 countries and has a workforce of 51,200 employees in 121 factories, 61 R&D facilities and 10 distribution centres. The group is structured according to product lines: transmissions, heating systems, air conditioning, lighting systems, electrical systems, windscreen wipers, security systems, fire detection systems, connection and electronic systems, drive shafts and engines and, finally, services. The case study was carried out in the transmission product line of the group's Spanish division, founded in 1968, where clutches and power steering systems are manufactured. Employees currently number approximately 300, including management, administrative and shop floor staff.

Between vehicle manufacturers only plant P was analysed. The reasons for this were various: (a) this type of plant is much less common in Spain than those belonging to other types; (b) not all vehicles must be considered, but rather only those affected by the directive, which fulfil certain characteristics; and (c) the company studied in this section was among that group of companies which have been the least challenged by the approval of the directive, as, in reality, their principal task is assembly, so that the environmental harm which they could potentially cause is less than in the other groups of companies included in our analysis, such as suppliers. This plant, with a workforce of over 3000, is part of a multinational group. P is composed of three companies. Two of them are commercial companies marketing two brands and with headquarters in Spain. The third is a manufacturing company with two factories in Spain, one founded in 1958, in which several models are manufactured. This plant works on drawing of metal parts, soldering, paint and assembly. In 2002, it produced 483,000 vehicles, of which 87% were exported. The workforce currently numbers 10,000 workers. The second manufacturing plant, where the analysis was undertaken, started operations in 1952. In 1970 was acquired by one multinational and in 1980 by another. Finally, due to a merger, in 2001 it became known as the company it is today. At this latter manufacturing plant, activities of assembly, bodywork and painting are carried out and several models are produced. Manufacturing amounts to 123,000 vehicles, of which 60% is exported. The plant has a production capacity of 38.17 vehicles per hour and works in three shifts. The company employs 3,143 people in its plant in Madrid, divided among, 2275 shop floor workers, 237 teams and 631 technical and administrative staff.

4. Case Analysis

Under this heading, the results shown above are analysed. Our results include several topics: regulation compliance and its relationships with environmental objectives and their involvement with their manufacturing strategy. After that, we differentiated between structural and infrastructural aspects linked to manufacturing strategy content.

Our first finding is related to their attitude to regulation. Given that both supplier plants are highly advanced in environmental compliance, they require the public administrations a strict control over the compliance by the others with the new regulation. However, this is not referred only to their direct competitors, but also to those companies selling substitute products. For example, one of the

suppliers (Y) affirms that "several vehicle recyclers sell material without any regulatory compliance". From the viewpoint of the automotive manufacturer, the companies which have traditionally worked with environmental issues are able to obtain a competitive advantage from their position in this area. That is the case with the automotive manufacturer which we have analysed. Over recent years they have invested heavily in Research and Development aimed at improving the environmental performance of its products (a particle filter for its diesel and HDI engines, which are more energy efficient and emit less CO_2). Y is not of the opinion that the new regulation will harm it, or at least, the impact will never amount to that produced by other, less environmentally developed companies. The companies we have analysed show a high level of environmental development and, as a result, one of their competitive advantages is supported on that environmental superiority, so that they demand a strict control by public authorities to comply with this kind of regulation. The literature has already evaluated which kind of regulation benefits/harms an industry's environmental leaders compared to its competitors (Nehrt 1998) [66], reaching conclusions very similar to those expressed above. That is to say, companies in the best position from an environmental viewpoint demand a stricter control of regulatory compliance on the part of the authorities, extending their coverage to companies which do not form part of their direct competition. In fact, although not referring to the automotive sector, other studies have shown how the degree of environmental development in companies affects the role required of the public authorities as regards environmental protection (Brío *et al.* 2002) [1]. López-Gamero, Molina-Azorín and Claver-Cortés (2010) [67] have studied the potential of environmental regulation to change environmental approaches in companies, although they have independently focused on command-and control *versus* another kind of regulation. However, no paper has studied preventive and command-and-control regulation. In this paper, we have found that relationship for the new kind of regulation in the automotive industry. As a result, we can conclude the first finding of our analysis:

Finding 1. The more environmentally developed suppliers and manufacturers in the automotive industry are, the more they demand a stricter compliance with regulation of Public Administrations because environmental development is a competitiveness factor in that context.

Not only environmental regulation is important for automobile industry, but also external pressure perceived by the companies influences, to a fair degree, the development of their environmental strategy. Some empirical studies (Kim and Lee, 2012) [68] had recognised significant relationships between stakeholder pressures and environmental logistics practices, although they were not focused on the automotive industry. The analysed automotive manufacturer has acknowledged that it cannot allow public repercussions over any environmental irregularity, while X recognises that it does not suffer from any strong external pressure in environmental terms, while at Y the situation is not as easy. Other studies (Vastag *et al.* 1996; Henriques and Sadorsky 1999) [69,70] have already analysed external influence on companies' environmental responses, but none of them has focused on the automotive industry. As a result, this study confirms what had been found out in other industries. That is, as well as new environmental regulation, pressures by external stakeholders influence environmental actions by companies in the automotive industry.

Finding 2. The more active stakeholders are in an industry, the more they lead companies to more developed environmental approaches.

How have these companies been able to comply with this new regulation? A key element is the degree of involvement of environmental objectives in the manufacturing strategy. This issue has already been discussed in the literature. Although Handfield *et al.* (1997) [55], also through case analyses, deny equal priority for the classic manufacturing objectives and those for the natural environment, Angell and Klassen (1999) [39] say that they should be given equal treatment. However, no paper had studied this phenomenon in the automotive industry or its role to comply with preventive command and control regulation (we have to remember this regulation newness). In our analysis, X is a plant which we can qualify as one that "goes beyond mere compliance" (according to words by the interviewed manager). Our own observation has confirmed this sentence: X not only complies with environmental

regulation, but also it has achieved ISO 14001 certification and evaluates all operating aspects which could cause impact. In this case, the environmental objective is important, although not to the same degree as those more classic (cost, quality, flexibility and delivery times). Supplier Y has made even greater progress: by making significant investments and progress in fulfilling the regulation's requirements. Without a doubt, at Y the natural environment protection is given a similar level of priority to the most classic manufacturing objectives. The analysed automotive manufacturer has a continuous process to introduce environmental product innovations. All the interviewed managers agree that complying with preventive command and control environmental regulation requires a strong integration of environmental objectives into their manufacturing strategies. Actually, companies in automotive supply chain carried out this process of integration before complying with the new kind of regulation. This may be the first factor that explains how preventive command and control regulation influences whether a company has a competitive advantage supported on its environmental situation or not.

Finding 3. Complying with preventive command-and-control regulation in the automotive industry implies to integrate environmental issues into manufacturing strategy.

Talking about environmental objectives is not a simple task because it is a multidimensional concept and, as a result, there are different kinds of environmental performance measurements and companies choose those that are better adapted to their characteristics. In fact, different environmental protection approaches result in diverse environmental performance measurement (Illinitch *et al.* 1998) [71]. Both X and Y have systems to measure their environmental activity. Those at X try to evaluate the level of compliance with regulation. Y, on the other hand, focuses more on the preventive aspects linked to environmental management. The analysed automotive manufacturer has systematic measurements about its environmental performance and is audited annually by an external body about said indicators. Previous research considers this situation as an environmental development indicator (Brío and Junquera 2003) [72]. That is, we have interviewed managers belonging to companies with a different level of environmental performance. Our automotive manufacturer shows the highest level, while X is the least developed company if we consider its environmental performance. In any case, the measurements used show us every company's environmental approach because of the close linking between environmental strategy and measurement system.

Finding 4. How companies in the automotive industry define their environmental objectives shows their level of environmental development.

The introduction of the most preventive environmental policies has substantially modified their manufacturing strategy. As a result, we have shown greater formalisation of some procedures, the modification in other cases and the generation of new procedures. Said issues have been seen by Kitazawa and Sarkis (2000) [73] in their case studies. However, it had not been analysed in the automotive industry. In our case analysis, X and Y show the new environmental requirements have led to an increased formalisation of procedures to begin the process of raising employees' awareness. X and Y had been certified with ISO 9001 earlier, as well as with QS 9000 and UDA6-1 and, as a result, some processes were modified and other ones were created. Likewise, the analysed automotive manufacturer points out the high level of process formalisation because of the new environmental requirements when the company was certified with ISO 14001.

Finding 5. Complying with new preventive command-and-control environmental regulation requires companies to increase their procedure formalisation.

In the short term, preventive command-and-control environmental regulation leads to important competitive effects in the short term derived from the adaptation of a company's activity to the new regulation. That is to say, it makes costs higher. The company must implement technical and organisational actions, whose combination is very useful for the development of its manufacturing strategy (Angell and Klassen 1999) [39]. In our cases, X and Y have carried out technical and organisational changes, by modifying design (in the case of the latter company in a more specific way), to avoid the use of lead in the clutches, as well as hexavalent chrome. Among organisational changes,

X uses the International Material Data System (IMDS) to inform manufacturers of the basic substances contained in all its products via the Internet and Y has implemented a process of quality control subsequent to the elimination of lead in its clutches. Likewise, both plants have taken the following measures: distribution of written documents, formalisation of processes to identify the regulatory requirements, extremely thorough internal environmental audits, planning of environmentally measurable objectives, programmes to achieve environmental objectives, periodic review of objectives to achieve continuous improvement, release of environmental reports, as well as the assignment and training of human resources in environmental matters. Preventive command-and-control environmental regulation also influences the application of environmental tools for Design for the Environment (DfE) at the analysed automotive manufacturer. Manufacturers are obliged to introduce innovations facilitating compliance with preventive regulation. The analysed automotive manufacturer expects, during the period 2010–2020, the first vehicles with a fuel cell. Our results strengthen Berry and Rondinelli's (1998) results, among other authors [74], who had spoken about its influence on design of preventive regulation, but had not examined its implications.

However, our study shows new changes in structural manufacturing decisions, which have affected technologies to improve and minimise any product's environmental impact. The analysed automotive manufacturer was committed, together with other European automobile manufacturers, to controlling greenhouse gases (140 grams of CO_2 in 2007). This challenge was and is a corporative priority and is being carried out through innovative technology in its diesel and petrol engines, a field in which the company is a benchmark, as its diesel HDi engines, their respective decontaminant systems and the direct petrol injection engines, designed and built by the corporation, associate environmental protection with manufacturing decisions.

Environmental consequences are more evident in infrastructural manufacturing decisions. Preventive regulation affects relationships with components suppliers. X and Y have toughened the relationship with their suppliers as a result of the stricter demands from their clients: ISO 14001, environmental criteria selection and the use of plastics. These results are in accordance with that suggested by the literature. Azzone and Noci (1998) [75,76], for example, have already demonstrated the importance of the relationship with suppliers for the environmental development of any company. Cramer and Schot (1993) [77] refer specifically to the requirements of ecological purchases. On the other hand, some papers had studied the role of logistics and supply chain process integration as a source of competitive advantage (Mellat-Parast and Spillan, 2014) [78], although the previous literature has not analysed what is specifically happening in the automotive industry. The analysed automotive manufacturer demonstrates that preventive command-and-control environmental regulation helps them strengthen their long-term relationship with them, as any legal non-compliance would lead to disastrous consequences for its public image as an innovator in environmentally-friendly products. Geffen and Rothenberg (2000) [79] show in case studies that, as a supplier learns more about the manufacturer's productive process, they discover the kind of environmental actions which are best adapted to the clients' needs.

The role of employees is a key element in compliance with preventive command-and-control environmental regulation. Workers' training, according to the literature (Gupta and Sharma 1996; Sarkis, 2001) [41,48], is a key element for the application of preventive command-and-control regulation. Likewise, this training is also the result of the implementation of environmental management systems and, especially, of ISO 14001 certification. The analysed automotive manufacturer has organised informal meetings for the implementation of environmental actions, as well as suggestion boxes, encouraging their use with the aim of engendering environmental improvements. All this has been made possible thanks to the decision of upper management to support environmental preservation. Confirming the results of our paper, Taylor and Welford (1993) [80] showed the importance of informal meetings about the natural environment at IBM (New York, NY, USA). Handfield *et al.* (2001) [57] address the importance of individual contributions to the success of environmental objectives. Additionally, in the case of suppliers, this training results from the implementation of

environmental management systems and especially of ISO 1400 certification, as those interviewed have emphasised. In fact, both X and Y have underlined the importance of training their workforce in its compliance. It is at Y, however, where training is planned in more detail: it is planned in modules according to the hierarchical level to which it is being given ('cascading' environmental training). That is, our results match with Antonioli, Mancinelli and Mazzanti's (2013) [81] ones in the sense that environmental innovation is an element of organisational change, especially for human resource management and they are necessary to deal with the new environmental regulation.

Quality control and, more specifically, certification (ISO 9000, but also other types) are very important in the three companies, but only X, however, acknowledges its advantages in the application of preventive command-and-control environmental approaches. This contradicts the previous literature, which believes in the advantages of applying knowledge in quality control for environmental development (Klassen and McLaughlin 1993) [82], especially as regards ISO 9000 (Beechner and Koch 1997) [83]. An explanation is perhaps that this knowledge is more helpful when a company's environmental objectives do not go beyond mere compliance with the regulation. Y is a company with more developed environmental approaches than X. Likewise, the analysed automotive manufacturer has a long tradition to invest heavily in R&D aimed at improving the environmental impact of its products.

On the other hand, our case analysis lets us find out some obstacles to comply successfully with this kind of regulation. We can see the importance of communication between suppliers and manufacturers to explain the difficulties to adapt to preventive command-and-control environmental regulation, as Geffen and Rothenberg (2000) [79] had addressed earlier. This idea was already suggested in the literature for manufacturing strategy in general (Fine 1998; Fawcett, Waller and Fawcett 2010) [84,85]. We have analysed the reasons which influence this lack of communication too: in automotive sector, as X and Y point out, the environmental requirements do not encourage closer ties with clients, because automobile manufacturers have great bargaining power. They only use any new requirements to call for stricter compliance from their suppliers. In any case, sometimes said inadequate communication leads to any efficiency problems.

That is to say, from the aforementioned, we can conclude that only a combination of technological and organisational measures (product design, process technology, closer client-manufacturer relationships, a strong quality management and employees' involvement, among others) enables compliance with preventive command-and-control environmental regulation successfully.

Finding 6. Complying with new preventive command-and-control regulation requires changes manufacturing strategy and its implementation, mainly product and process design, relationships supplier-manufacturer, the role of employees and quality control systems. However, a lack of close client-manufacturer relationships could hinder the compliance with preventive command-and-control regulation.

To sum up, the literature had shown that consequences of environmental regulation on economy and businesses are multiple and complex (Gurtoo and Anthony, 2007) [86]. We have added that complying with preventive command-and-control regulation means to transform business strategy and, as a result, functional strategies, but especially manufacturing strategy. That is, the companies with the aim of complying with said regulation have to modify the implantation of their manufacturing strategies.

5. Conclusions

With Russia's ratification of the Kyoto Protocol in November 2004, the industrialised countries which had signed the Treaty accounted for 55% of CO_2 emissions, set as the point at which obligatory compliance would enter into effect. However, prior to this, signatory countries, especially in the European Union, had already begun drawing up legislation to comply with the goals set by the Protocol. Such is the case of Directive 2000/53/CE on Vehicle Management at the End of their Useful Life. The aim of this paper is to evaluate, by means of case studies, the consequences of said Directive.

While it is true that actions required aimed at achieving compliance are the most difficult ones for companies to put into practice, only measures with a preventive nature will allow the achievement of a competitive advantage from the natural environment management. This problem is especially relevant in manufacturing processes (Sanchez-Rodrígues, Potter and Naim 2010) [87], those most affected by environment problems at the companies. For this reason, we have analysed the effects which the compliance with preventive regulation may exercise on the future of a company's manufacturing strategy, both in terms of its content and its process. As regards content, we have distinguished between the analysis of environmental protection as a production goal and the actions needed to develop its attainment. These latter may be of a structural type (installations, process technology, capacity and vertical integration) or infrastructural (new products, the role of employees, quality management, planning and control systems, relationships with clients and other members of the value chain, relationships with environmentally-aware stakeholders, systems to measure environmental performance and the environmental department's organisation). In this paper we have shown how this process is necessary in the automotive industry to comply with preventive command-and-control environmental regulation.

After an in-depth review of the literature, which studies the competitive effects stemming from environmental regulation and the effects linked to its influence on manufacturing strategy, we decided that the most suitable methodology was a case analysis. Given that our aim was to study regulation and its consequences evaluated by component suppliers and vehicle manufacturers, we chose subjects to study out of each group: two from the first and one from the second.

From the case studies and the review of the literature, we have been able to confirm that, in general, both groups represent two sides of the same coin. However, the heterogeneity of the companies forming each group in terms of their ability to respond to the environmental challenge depends on factors such as the environmental strategy, the degree to which this is integrated into manufacturing strategy and communication between the various levels of the supply chain. Compliance with this new type of regulation usually affects some manufacturing decisions, although not all, and in different ways and intensity depending on whether supplier or manufacturer.

Our results have important implications for research. It is the first paper which has studied how new preventive command-and-control environmental regulation influences business strategy in the automotive industry. On the other hand, our results are useful for managers because they show what conditions let companies adapt their environmental approaches to the new environmental approaches successfully.

Although this research has enabled us to make the progress shown previously, we cannot avoid its limitations: firstly, as regards external validation, which problem should be avoided with subsequent research, using surveys based on larger samples. As has been explained, this will be one of our objectives in future studies. A second limitation is based on the fact that the companies studied here are those that, out of a large number, were willing to cooperate (especially, among the parts suppliers). Therefore, the overview given here may show an optimistic bias, as it is reasonable to suppose that those not taking part felt to be at a disadvantage. On the other hand, some studies (Ramanathan *et al.*, 2010) [88] have suggested the significance of environmental regulation for the improvement of economic performance in several industrial sectors. As a result, future research should approach how these improvements can be achieved not only in the automotive industry, but in the other sectors.

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every section in the research and have carried out several contributions in all of them. Moreover, the different reviews have been done jointly.

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