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THE OPERATIONS STRATEGY AND THE ENVIRONMENTAL DIMENSION: a case study in the Brazilian automotive industry

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ABSTRACT

The operations strategy has usually considered the competitive priorities, cost, quality, delivery and flexibility. The performance of these four dimensions was enough until now to assure the firm's competitiveness and maintain its survival.

The environmental dimension is, currently, enhancing globally its strategic importance as a competitive priority for the firms, especially with the growing society demands in order to obtain sustainability and so increasing the pressure on the firms, asking for its responsible participation in the reduction of environmental and social impacts.

Facing these changing scenario, the objective of this research is to evaluate how the firms consider in its operations strategy the environmental dimension. This research was carried out in the automotive industry using a multiple case study in three passenger cars and commercial vehicles assemblers from the ABC paulista region.

The research data analysis lead to the conclusion that the researched companies, concerning its present and future market demands attendance, also considered in its operation strategy the environmental competitive priority, beyond the "traditional" quality, delivery, flexibility and cost competitive priorities, defining actions, targets, objectives and a proactive management model in terms to maximize the positive impacts of the environmental dimension on the operations competitive performance.

Key words: Operation Strategy. Competitive Priorities. Environmental Dimension.

1 INTRODUCTION

In corporate management, it is the business or corporate strategy that specifies, involving all aspects of the company's long term management, including the operation function (BARNES, 2002), how the company intends to achieve, maintain and enhance competitive advantage (WHEELWRIGHT, 1984). It is part of the corporate strategy of companies environmentally committed the environmental policy that defines the general principles regarding the corporate environmental performance (BARBIERI, 2007).

In this sense, the company's operations area has a relevant impact on competitiveness (SLACK, LEWIS, 2001; SKINNER, 1969; WHEELWRIGHT, 1984) once it is the element of liaison of the market needs detailed in the business strategies by means of its policies with the operations resources (SLACK, LEWIS, 2001). According to Jimenez and Lorente (2001) to achieve such competitive advantage in a sustainable way, the operations strategy must consider the environmental dimension as an additional dimension to the already traditional cost, quality, delivery and service dimensions.

Regardless of the relevance of the product on the company's environmental impact, this study only considers the process environmental impact, for it being directly related to the operations strategy and, in this case, it becomes relevant to understand how the environmentally committed companies consider the performance of the environmental dimension as a competitive priority in its operations strategy (ANGELL, KLASSEN, 1999).

1.1 Research relevance and justification

The society's general concern with sustainable development enhances the importance of the environmental dimension in the management of companies, both in the economic and institutional image aspects, and, therefore, it must be considered in the contents of the strategy of companies that seek competitive leadership (EPELBAUM, 2004; JIMÉNEZ, LORENTE, 2001).

Based in this changing scenario, where the environmental dimension assumes a growing importance to the stakeholders and focusing the operations strategy which known literature treats almost exclusively the dimensions or competitive priorities quality, delivery, flexibility and cost the question became relevant and justify the research that aim at understanding how assembling companies of the automotive industry, which present the best environmental practices, treat the question of operations strategy and environmental dimension.

Focusing on the operations strategy and the environmental dimension, the research question can be formulated as follows:

"How the assembling companies of the automotive industry located in Sao Paulo's ABC region incorporate the environmental dimension into their operations strategy?"

1.2 Research objective

The objective of the research is to assess how the assembling companies of the automotive industry treat the environmental dimension in their operations strategy, considering it as one of their competitive priorities.

Departing from the research question, it is intended to deepen the knowledge on the definition processes of strategy and the environmental impacts that occur in companies committed with the environmental prevention and provide empirical references to the advance of knowledge on the environmental dimension and operations management. Therefore, it was performed a multiple case study with three automotive industry companies of Sao Paulo's ABC region where the preoccupation with the environment is part of the formulation of corporate or business strategy of these companies, evidenced by means of their best environmental practices and norm NBR ISO 14001 certification.

1.3 Work structure

The study has been structured in six sections; the first section, Introduction, which shows

current challenges that the practice of the corporate management faces and based on this scenario it defines the objective of the research and justifies its relevance. The second section deals with the theory of the operations strategy under the point of view of several authors, discussing the competitive advantage and presenting the vision of the authors in the formulation and contents of operations strategy and also the considerations on the operations strategy and its impact to the research work.

The environmental dimension is discussed in the third section, starting with the evolution of the environmental question, highlighting the increase that this subject has to the companies and ending the section with the detailing of the environmental performance and its key indicators. The fourth section presents the research method, the conceptual model of the research, the set of indicators used in the data analysis and also the definition of the companies that participated to the multiple case study and the tools for data collection.

The results of the research with the data of the companies that participated to the multiple case studies are presented in the fifth section where an analysis and interpretation of data is made by means of the analytical technique of explanation construction (YIN, 2001). In the last section, the sixth section, are presented the remarks of the work, the general implications and recommendations for future studies.

2 OPERATIONS STRATEGY

The strategy may be defined as being the combination of various decisions and actions of an organization that has long term impact (BARNES, 2002). To build competitive advantage, a strategy must present a set of plans and policies with which the company shall seek to obtain advantages upon its competition (SKINNER, 1969). These plans and policies present different characteristics in the most different hierarchical levels of an organization.

According to Wheelwright (1984) there are three levels of strategy in a corporation: the corporate strategy, the business strategy and the functional strategy.

The corporate strategy specifies two areas of interest, the definition of the business that the company intends to develop and the obtaining of corporate resources necessary for that (SLACK, LEWIS, 2001).

The business strategy of the various units of the company is unfolded from the corporate strategy, defining the mission and objectives and also how the company intends to compete in its markets (SKINNER, 1969). It specifies the scope of each business in such a way to link the business strategy to the corporate strategy (WHEELRIGHT, 1984).

The functional strategy is the unfolding of the business strategy and defines how the function, whether sales and marketing, operations, research and development, finance or quality, is going to support the competitive advantage desired (business strategy) and how it will supplement other functional strategies (WHEELWRIGHT, 1984).

In order for the strategies in the three levels to fulfill their definition to establish competitive advantages to the company they must be vertically aligned among the strategic levels and horizontally among the functional strategies (DA SILVA, 2008).

2.1 Operations strategy and its concept

Skinner (1969) defines the operations strategy as the operations policies derived from the corporate or business strategy that defines the amplitude of the operations process, the scale of the operations process, the election of the operations process and the equipment, the plant location, the determination of the critical control elements, the control systems and the management organization.

The main function of an operation strategy is to develop a set of operation capabilities that will enable the business to meet its current and future strategy (WHEELWRIGHT, 1984).

Additionally, the operations strategy has the function to conciliate the market requirements and the capabilities of the resources of the organization, as presented in Figure 1, and it is the decision standard that defines the long term capabilities for any type of operation and its contribution to the business strategy (SLACK, LEWIS, 2001; DA SILVA, 2008).

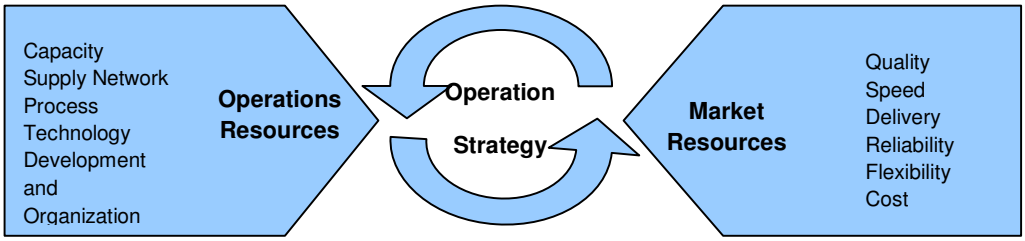

Figure 1 – Operations strategy reconciles the market requirements to the operation capabilities
Source: Slack and Lewis, 2001

2.2 The operations strategy and the competitive advantage

The sustainable competitive advantage mentioned by Slack (2005) is affected by the operations strategy by means of the company's capability to meet market demands, making use of its capabilities and competences (VOSS, 1995). Among the various focuses of contribution to competitiveness there are the competitive priorities that present four competitive dimensions, that are, according to Wheelwright (1984): Product Prices; Superior Quality; Delivery; Product and Volume Flexibility, which are prioritized in a different way by different companies, depending on market conditions.

Slack, Lewis (2001), referring to the market perspective of operations strategy, define four performance objectives more commonly used as being the aspects of performance of the operations area that meet the market requirements of any type of operations. These performance objectives, also contemplating the competitive priorities of Wheelwright, are: Cost, Quality, Delivery and Flexibility.

Enhancing the focus of Slack (2002), of how the operations strategy impacts the competitiveness, and considering the environmental dimension also as a performance objective that generically means the management of natural resources uses, the prevention of pollution, the

application of clean process and legal compliance, the operations strategy can provide sustainable competitive advantage, improving, in addition to costs, the company's image (ANGELL, KLASSEN, 1999).

2.3 Evolution of the operations strategy

The evolution of the operations strategy occurs in a competitive environment where the demand of consumers is more and more complex, more dynamic and more difficult to meet (LOWSON, 2003). According to Lowson (2002), the evolution of the operations strategy was stimulated by a large number of influences that may be summarized in the two most important ones: Demand Trends and Competitive Priorities.

2.3.1 Demand Trends

The evolution of the consumer demands occurs in the sense of higher variety and customization of product and service and this reflects in the organization as complexity and dynamism, establishing trade-offs between low cost and flexibility. The objective of mass customization is to supply varied and customized products with the same low cost of the mass produced standardized products. This trend acknowledges the growing need of individual, customized and personalized goods and services (LOWSON, 2002).

2.3.2 Competitive Priorities

The operations strategy clearly reflects both influences, the demand trend as a reaction of the company to the market and the competitive priorities as a proactive response. Therefore, for being a proactive company, the competitive priorities are a key element of the operations strategy that defines which functions the company's operations area must execute proactively well, that is, how the activities of the operations area must be defined based on capabilities to effectively support the company to compete with its business strategy (DA SILVA, 2008).

The competitive priorities of operations must form a consistent set of priorities that will define the actions to be performed by the operations function of a company (ALVES FILHO, *et*

at., 1995). The most used and mentioned competitive priorities were defined by Skinner (1969), Wheelwright (1984), Slack, Lewis (2001), Slack (2002) as being: Cost, Quality, Delivery and Flexibility.

2.4 Considerations on the operations strategy

In the sense of evolution and adequacy of the operations strategy, Hayes and Pisano (1996) state that in the competitive environment of continuous change, the operations strategy is no longer formed only by short term trade-offs between competitive priorities like cost, quality, delivery and flexibility. The long term success requires that the company differentiates itself in relation to its competitors offering something unique and valuable to its consumer like a fast special service, high reliability, low costs or innovative products. Considering current perspective, it could be included as a differentiating aspect also the institutional image based on the social-environmental responsibility.

In conclusion, with this review on the operations strategy theory, it can be noted that Wheelwright (1984), twenty seven years ago, stated that the concept of competitive priorities needed to be enhanced and enriched, once the companies could compete in other ways in addition to only through the price of their products. If a wider scope of competitive priorities was considered like, for example, quality, delivery reliability and flexibility, today already integrated to the theoretical and practical scope, the role of operations strategy as basis for competitive advantage would be significantly enhanced.

Likewise, Voss (2005), in reviewing the paradigms of operations strategy, also mentions that, with the evolution of the services provision in the last sixteen years, the expansion occurred with the services provision business should be considered and the strategic election of operations should be enhanced to manufacturing and services, as it in fact occurred in case of some authors as it can be seen in Chart 2, that presents the competitive priorities adopted and mentioned by

several authors who contributed to the development and evolution of the operations strategy, confirming that the concept of competitive priorities is likely to be enhanced.

Authors	Competitive Priorities								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
01. Skinner, 1969	X	X		X			X	X	
02. Wheelwright, 1984	X			X		X	X		
03. Alves Filho et al., 1995	X					X	X	X	
04. Voss, 1995, 2005	X			X	X	X	X		
05. Jimenez, Lorente, 2001	X	X		X	X	X	X	X	X
06. Slack, Lewis, 2001	X		X	X		X	X		
07. Slack, 2002	X	X		X		X	X		
08. Lowson, 2003	X		X	X		X	X		
09. Carvalho, 2005	X				X	X	X		
10. Da Silva, 2008	X				X	X	X		
11. Gavronski, 2009	X				X	X	X		
	(1) – Quality			(2) – Time			(3) – Speed		
	(4) – Reliability			(5) – Delivery			(6) – Flexibility		
	(7) – Cost			(8) – Service			(9) – Environment		

Chart 1 – Competitive priorities and authors
Source – Author

From the above it can be concluded that the traditional competitive priorities and those most considered in the operations strategy are: quality, delivery, flexibility and cost, but that there is room for others, justified by service and environmental priorities.

Considering this fact and assessing the evolution of business to date, it can be recognized, as Da Silva (2008) and Gavronski (2009) did, that some lines of research of operations strategy are not finished yet, as it is the case of competitive priorities whereby some recent works (JIMÉNEZ and LORENTE, 2001; EPELBAUM, 2004; BORGES, 2007, DA SILVA, 2008,

HRDLICKA, 2009 and GAVRONSLI, 2009) verify that the environmental questions may be a source of competitive advantages to the companies.

3 ENVIRONMENTAL DIMENSION

The accelerated development of the economy has led to a continuous growth of production and consumption, which can lead to irreversible scarcity of natural resources like potable water, breathable air, arable soil, mineral resources and regulated climate which has taken, in the attempt to minimize this negative impact, to the definition and continuous improvement of environmental laws and norms that started to regulate the obtaining and use of raw materials, energy, industrial processes and final disposal of waste in general and, thus, interfering more and more strikingly in the management of companies in general.

3.1 Environmental dimension and the company

In the corporate environment and mainly in the industrial environment, the environmental dimension is comprised by the direct environmental impact caused by the product and by the productive process and, considering the impact of the value chain, also by the indirect environmental impact caused by the chain of suppliers and distributors (SANCHES, 2000).

The environmental impact caused by the product is due to the volume and type of raw materials and energy used; the impact caused by the usage of product during its useful life, as energy consumption, fuel consumption and air emissions; and its final disposal.

The environmental impact caused by the productive process is due to the consumption of raw materials, water and energy; waste generation; air, water and soil pollution; the final disposal of waste, mainly the hazardous waste (EPELBAUM, 2004).

The indirect environmental impact from suppliers and distributors is defined as such by the fact of the productive processes and products not being directly linked to the productive process of the client company, but, rather, indirectly linked by means of the value chain. That

makes the environmental impacts of suppliers and distributors contribute in part to the impact of the environmental dimension of the client company (SANCHES, 2000).

The major impact to the environment, if from the product or from the process, varies depending on the type of product, the process and the industry, making it difficult to assess in a general and non specific way what contributes the most to the company's environmental impact.

Since the present study focus on the operations strategy, it will be considered in this work, regardless of the importance of its contribution to the company's direct environmental impact, only the impacts from the manufacturing processes of operations, once the environmental dimension of the product is the most impacted by the strategy of Research & Development (EPELBAUM, 2004).

Considering the environmental dimension based on this industrial sustainability scenario and focusing on the impacts of the manufacturing and operations processes, the companies that, according to Sanches (2000), seek to maintain themselves competitive and adjust to this new context of sustainable business perceive that the environmental questions require new postures in the way to operate business and also in the organizations.

Such adjustment implies in continuous changes that may have a large financial impact, especially if imposed by means of the environmental legislation or resulting from a bad institutional image resulting from conflicts with the community or from environmental disasters. In order to deal with this reality, there are companies that are adopting a proactive posture related to the environment and incorporating the environmental policies into the company's policies, strategies and targets.

The proactive posture related to the environment requires, in addition to policies and targets, new values that incorporate the environmental dimension into the organization. By implanting such innovations in the processes, in the strategies and in the organization, the company develops a capability to anticipate to external demands, from the government, from the

market and from the society, no longer needs to expect that these demands become pressures for the adoption of more sustainable environmental practices.

In this context, it is mentioned the global excellence that assesses the company not only by its productive and economic performance but also by its environmental performance and the environmental excellence is being considered with a growing importance to the company's success.

3.2 Environmental Performance

In order to assess the relevance of the environmental dimension to the success of a given company, the environmental dimension has its impact measured through indicators or environmental performance of the operations area. In this sense, Jimenez and Lorente (2001) highlight that there is a great variety of criteria and indicators that can be used to assess the company's environmental performance. Each company must chose the assess system most adequate to its particular needs. The indicators of environmental performance have the function to demonstrate the organizational practices for minimizing the impacts to the environment resulting from the company's activities. According to Campos and Melo (2008), these indicators consider the consumption of natural resources in monetary amounts and in absolute quantity values, also considering initiatives of environmental management, the significant impacts and the minimizing actions.

To facilitate and standardize the duty of the companies in the definition of the environmental performance indicators, norm ISO 14031:2004 appears as a conceptual reference for the election of environmental performance indicators (DEMAJOROVIC, 2003; DOS SANTOS, 2007; CAMPOS, MELO, 2008; HRDLICKA, 2009). Despite that environmental impacts vary according to the type of company, there is a set of common indicators for an analysis of the operations environmental performance.

Therefore, the environmental performance indicators to be used in this study had as basis the operational performance indicators, requirement 4.3.1 of norm ISO 14031:2004, once these indicators focus on the operation processes that are of interest for the proposed study.

These indicators are: use of materials, raw materials, hazardous materials and water consumption, energy consumption, waste generation, general emissions and support service to operations that, according to Massi et al (2010) are also considered best environmental practices.

4 RESEARCH METHOD

Every scientific research needs to define its study objective and, based on it, determine the investigation process, delimiting the universe to be studied and the method to be used (VENTURA, 2000). There is a diversity of methods that are determined by type of object to be researched and by the class of questions to discover (GIL, 1999).

Since the objectives of a research determine the strategy, the type and method of the research to be applied, and having the objective of this research been defined as being to understand how the companies consider the environmental dimension in the operations strategy, it was elected the performance of a multiple case study, descriptive and exploratory, because it is intended to clarify, understand how concepts of operations strategy are applied in the corporate practice (GIL, 1999).

The main criticism made to this study strategy is the possible narrow basis that it can provide to the result generalization achieved, but it must also consider that the case studies are generalizable to theoretical propositions (analytical generalization) even if not to populations or universes (statistical generalization) (YIN, 2001).

4.1 Research conceptual model

Defining as research assumption the conceptual model of Figure 2 that represents the

operations strategy (EO) considering the environmental dimension (DA) as a possible competitive priority (PC), we have the following:

The society environmental demands, the legislation and the market comprise current external impacts that can vary along time and that press and influence the internal environmental demand (DA) of the company that must be considered by the competitive or business strategy (EN) to, from there, set the environmental policy (PMA) taking into consideration the company's internal and external situation in the sense of achieving a sustainable competitive advantage.

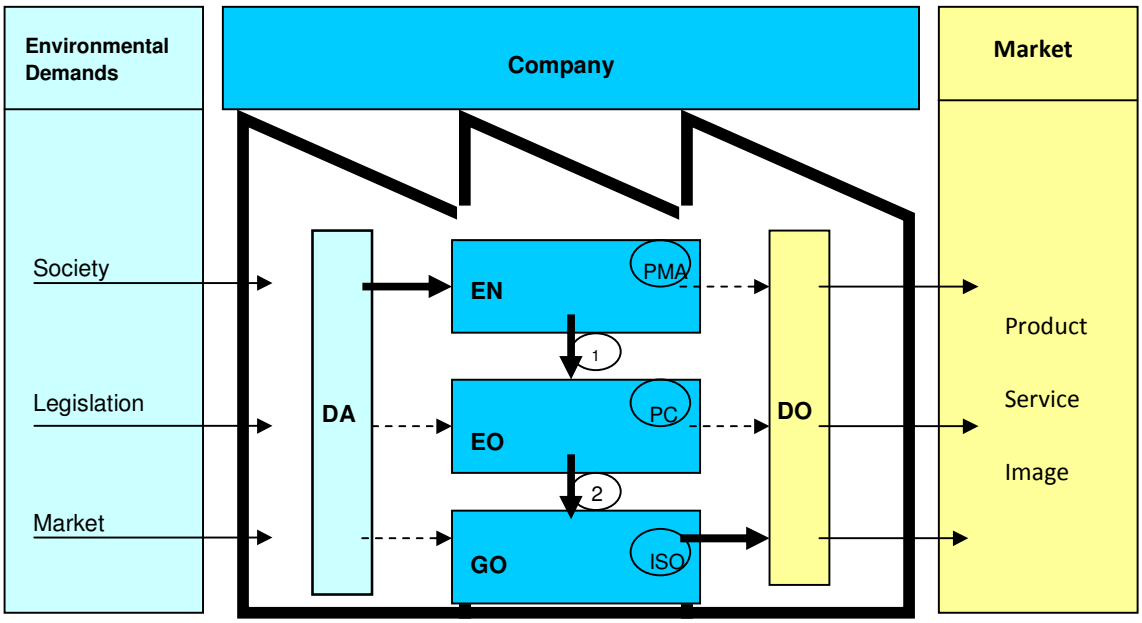

Figure 2 – Research conceptual model
Source: Author

The environmental demands of the society, the legislation and the market comprise current external impacts that can vary along time and that press and influence the internal environmental demand (DA) of the company that must be considered by the competitive or business strategy (EN) to, from there, set the environmental policy (PMA) taking into consideration the company's internal and external situation in the sense of achieving a sustainable competitive advantage.

The operations strategy (EO), considering or not the environmental policy (PMA) deployed (1) from the business strategy, represents the company's strategic option. This strategic option deployed (2) to the operating level, affects positively or negatively the operations competitive performance (DO) by means of the operations management (GO) that incorporates the environmental management and the environmental management system (ISO) and affects mainly the competitive priority cost and also the company's image. That can signify an improvement opportunity of the operations competitive performance (DO) to meet market requirements, in the sense of supply products and services, cheaper, better and with lower environmental impact and with an improved image by environmentally fit manufacture.

The research conceptual model also defines a set of indicators and practices that characterize the handling of the environmental dimension as a capability of the manufacturing process, measured by sets of environmental performance indicators (JIMÉNEZ, LORENTE, 2001; ANGELL KLASSEN 1999). They are: consumption of natural resources and energy, meeting legal and normative compliance, prevention of environmental impacts and pollution and meeting of society's demands.

Now, the operations strategy performance can be measured by the performance of the strategic practices (LOWSON, 2002); lean production; strategic outsourcing; build to order/build to stock and suppliers network management by means of performance indicators of the competitive priorities: Quality; Delivery; Flexibility; Cost and by the image performance, that at the end measure the operations competitive performance (WHEELWRIGHT, 1984; VOSS, 1995; SLACK, LEWIS, 2001; JIMÉNEZ, LORENTE, 2001; EPELBAUM, 2004; DA SILVA, 2008; HRDLICKA, 2009).

In the case of this study it was surveyed the environmental performance indicator cost and image performance, that are the aspects of operations that suffer the influence by the way that the environmental dimension is considered by the operations strategy (JIMÉNEZ, LORENTE, 2001;

DA SILVA, 2008).

The image performance, according to Thomas and Brito (2010) can be measured by ten categories of attributes, out of which, for this study, it was only used the environmental responsibility indicator, which is the attribute that suffers the influence from the environmental dimension, focus of this research.

4.2 Cases selection

In order to analyze the subject of the problem, that consists in understanding how the companies consider the environmental dimension in the operations strategy, and how this can impact the competitive performance of operations, companies were researched where the environmental dimension is managed, with support from a certified environmental management system (ISO 14001) and this confirmed by best environmental practices. This is because it is assumed that a company with a certified environmental management system that presents best environmental practices has higher probability to consider in its operations strategy the environmental dimension than a company without an environmental management system and with or without best environmental practices. In this sense, the analysis of Brazilian companies in a research carried out by the specialized magazine *Analise Ambiental*, showed that the industrial sector presented the largest number of best environmental practices with certification of an environmental system by norm ISO 14001. In this sector, it was surveyed companies of the automotive industry that better met the assumptions of the study, being, therefore, the sector chosen.

In the election of three companies of the automotive industry for the multiple case study, it was elected three car assemblers of the ABC region of Sao Paulo, being an assembler of North-American (A) origin, one of European (E) origin and one of Asian (J) region, thus representing the main cultures of the automotive industry, the European, the American and the Asian, which

enables wider coverage in the verification of the subject of the study, once in a multiple case study the election of the cases follows the logics of replication, and not sampling (YIN, 2001).

4.3 Data collection

The sources of evidences used for this study were three: documentation survey, questionnaire and interviews.

A survey of the documentation on the companies obtained in company's websites, internal and external publications, specialized reports and magazines to compose its history, considering their line of products, technical specifications, market size, organization and hierarchical structure that served as basic context to the analysis of the cases.

A questionnaire with twenty one questions on the environmental performance, operations strategy and competitive priorities of the companies, which was previously sent to the companies, via internet, with the purpose to obtain information on how each environmental aspect is impacted by the operations strategies practiced and how the environmental performance resulting therefore impacts the competitive performance. This is to support the interviews and also for obtaining comparable data of the theme under study of the three companies.

There were seventeen face to face interviews, directed and semi-structured, recorded with an average duration of one hour, with the key managers of the area of operations, environment, quality, production, logistics, infrastructure and industrial planning from the three companies studied, configuring a sample by convenience and not probabilistic.

The means of collection was an interview script with eleven questions that was used as reference to obtain information on how the incorporation of the environmental dimension in the operations strategy occurs and how the environmental dimension impacts the operation competitive performance and the filling up by all interviewees of a chart of interrelations of the environmental dimension (Chart 8) and additional questions that were used when the development of the interview so allowed it.

The realization of the data collection occurred in the period from January to April, 2011 and Chart 2 presents a summary of the data collection by company.

Company	Collection Means			Date
	Documents	Questionnaire	Interview	
E	Institutional and environmental reports of company E; ANFAVEA Annual report and sector guide	Answered by executive of the Environmental area	Interview made with executives of the areas: Production, Quality, Planning, Logistics, Infrastructure and Environmental	JAN/ 11
A	Institutional and environmental reports of company A; ANFAVEA Annual report and sector guide	Answered by executive of the Environmental area	Interview made with executives of the areas: Production, Quality, Planning/ Infrastructure, Logistics and Environmental	APR/ 11
J	Institutional and environmental reports of company J; ANFAVEA Annual report and sector guide	Answered by executive of the Environmental area	Interview made with executives of the areas: Production, Quality, Planning, Logistics, Infrastructure and Environmental	FEB/ 11

Chart 2 – Summary of data collection
Source: Author

4.4 Data treatment and analysis

The data analysis consisted of examining, categorizing, tabling and recombining the evidences having in view the initial propositions of the conceptual model of the study (YIN, 2001). The data analysis used the analytical technique of construction of explanation of the cases, using the set of data of the three companies as proposed in the study conceptual model (figure 2), obtaining how the operations strategy of each company treats the questions related to the impacts of the environmental dimension, the operations strategies practiced and the competitive performance indicators of operations.

The analysis and interpretation of data was performed in two blocks: in the first block, based on data mainly from the survey of documents and questionnaires, the analysis following the conceptual model of the research (figure 2), where the external environmental demands, the composition of the environmental dimension, the environmental policy, the competitive priorities

and operations performance were treated. In the second block, with the results from the questionnaires and interviews with the executives of the three companies studied, the analysis with focus on the objective, to understand how the operations strategy of the companies treat the environmental dimension, considering it or not one of their competitive priorities and assess the possible impact in the competitive performance of the operations strategy.

5 RESEARCH RESULTS AND DATA ANALISIS AND ITERPRETATION

The result of the survey of documentation of each one of the three companies comprised by the operations strategies practiced and the composition of the environmental dimension, their management and their indicators, that together with the data from the questionnaire and the interviews formed the basis for the analysis and interpretation of data that, as defined, occurred in two blocks: analysis according to the conceptual model and analysis of the objective itself.

5.1 Data analysis and interpretation according to the research conceptual model

In the research conceptual model, six elements of analysis were considered, as follows: external environmental demands, environmental dimension, environmental policy, competitive priorities, operations performance and market requirements.

The external environmental demands are a composition of the society demands, legislation demands and market demands. The society's demands, according to the literature, are more and more focusing on sustainability, which concern is the consumption of natural resources, mainly non renewable, and also with the generation of pollution, mainly with the emission of greenhouse gases.

The companies of the study, regardless of their cultural origin, internalized the same contents like external environmental demand, interpreting that society is concerned with the consumption of natural resources and with the pollution generation. Such empirical interpretation

of the companies coincides in great deal with the theoretical vision of the literature as mentioned in section 3.1 and represented in Chart 3.

External Demands	Companies			Literature
	E	A	J	
Society	Resources Consumption Pollution Generation	Resources Consumption Pollution Generation	Resources Consumption Pollution Generation	Sustainability
Legislation	Legal Compliance	Legal Compliance	Legal Compliance	Legal Compliance
Market	Low Environmental Impact	Low Environmental Impact	Low Environmental Impact	Low Environmental Impact

Chart 3 – External environmental demands

The demands of the legislation, both in the vision of literature and in the interpretation of the companies, are related to legal compliance, that in the case of the three companies equally configures in meeting the environmental licensing, regulating norms and environmental laws.

The environmental demands of the market, presented by literature, refer to the preoccupation of the clients with the low environmental impact of products and processes of the companies. The three companies of the study, by their turn, internalized the environmental demands of the market

as being the generation of the lowest environmental impact possible.

It can be concluded, based on the data of Chart 3, that in case of the environmental demands, both the academy and practice of the three companies confirm the conceptual model of the research proposed of external demands of society, legislation and market, and it can be said that the companies of the study, regardless of their cultural origin, internalized the environmental demands in the same way and with the same contents. With due care, maybe it can be said that sustainability, legal compliance and low environmental impact are current environmental demands to the automotive industry, once the three companies surveyed understood the environmental demands of the market empirically the same way.

The composition of the environmental dimension of the companies, other aspect of the first block of analysis, is formed by the set of impacts that the operation processes of these companies can cause to the environment, taking into consideration the society environmental demands, the legislation and the market. This means that, in case of the society's demand for sustainability, the company's environmental demand, considering the consumption of natural resources and the pollution generation as elements of environmental sustainability, has as aspects of the environmental dimension composition, the natural resources and energy consumption and the environmental impacts prevention. In case of the legislation demand, there is the legal compliance and in case of the market demand there is once again the prevention of the environmental impacts.

In Chart 4 is presented the composition set of the environmental demand of the companies surveyed and also the literature. It can be perceived also in this case a strong alignment among the companies studied and the literature, making it appear a possible standard for the automotive sector.

Companies	**Composition of the environmental dimension**
E	Consumption of natural resources; Meeting of legal and normative compliance; Prevention of environmental impact; Meeting of society's demand
A	Consumption of natural resources; Meeting of legal and normative compliance; Prevention of environmental impact;
J	Consumption of natural resources; Meeting of legal and normative compliance; Prevention of environmental impact; Meeting of society's demand
Literature	Consumption of natural resources; Meeting of legal and normative compliance; Prevention of environmental impact; Meeting of society's demand

Chart 4 – Composition of environmental dimension

Other element considered in the research conceptual model is the environmental policy that must be defined by the corporate or business strategy considering the composition of the environmental dimension. The environmental policy, according to Chart 5, unfolded to the functional strategies, as the operations strategy, defines the company's strategic options to consider the environmental dimension and perform them by the management of operations.

Companies	Environmental policy
E	Meeting of future demands and continuous improvement, product development and planning of environmentally responsible processes, legal compliance, services and information to clients with focus on the environmental preservation, transparent information to stakeholders.
A	Business decisions consider the environment, legal compliance, products, environmentally fit processes and services planned, objectives to minimize impacts to the environment, environmental protection is responsibility of all employees in the execution of their activities.
J	Legal compliance, stakeholders serviced, prevention of environmental impacts, continuously improved environmental performance, continuous training of employees.

Chart 5 – Summarized environmental policies of the companies of the study

The summarized companies environmental policies present basic common elements, despite the varied formulations, sometimes detailed and sometimes lean. These common elements are: legal compliance, prevention of environmental impacts, meeting of society's demand.

These elements coincide with the composition of the environmental dimension with exception to the aspect of reduction of consumption of natural resources and energy, which might, in function of the sustainability, is an unfolding of the element meeting the society's demand. Anyhow, it can be perceived here also an alignment among the three companies.

The competitive priorities, one element more of the first block of analysis according to the conceptual model, are a key element of the operations strategy that defines which function the operations area of a company must execute proactively well.

The theory seen in section 2.3 defines the competitive priorities of the operations strategy as being: Quality, Delivery, Flexibility and Cost.

Now, the competitive priorities of the companies studied are reunited in Chart 6 where, in addition to the priorities considered in the theory, the companies also defined the priorities: environment and labor safety.

Companies	Competitive Priorities
E	Quality, Delivery, Flexibility, Cost, Environment, Labor Safety.
A	Quality, Delivery, Flexibility, Cost, Environment, Labor Safety.
J	Quality, Delivery, Flexibility, Cost, Environment.

Chart 6 – Competitive Priorities

From there it can be concluded that the empirical competitive priorities identified and considered by the companies of the study coincide, in its great majority, to the competitive priorities mentioned by the theory, but in addition to the four "traditional" competitive priorities, the three companies also consider the environmental priority and, going beyond, company E and company A also consider the priority labor safety.

Other important conclusion of the present study is that the great majority of the authors of the theory of operations strategy, as already mentioned, do not mention the environmental dimension, as if it was not relevant as those considered quality, delivery, flexibility and cost. In the same way, the authors of the theory of environmental management do not mention also the operations strategy explicitly, but they do mention the environmental strategy, that if is not vertically aligned with the business strategy and horizontally with other functional strategies, and mainly with the operations strategy, will not be able to leverage excellence in the performance of the operations possible and necessary to the always desired competitive advantage.

The operations performance is the summation of the performance of its competitive priorities in meeting market requirements. Of the competitive priorities, quality, delivery, flexibility and cost, the competitive priority cost is the most influenced by the environmental dimension, mainly by its components, reduction of consumption of natural resources and prevention of environmental impacts. The performance of the competitive priority cost means the manufacture of product at the lower possible cost and costs generally result from expenditures with: personnel, installations, technology, raw material, consumption materials, natural resources and with treatment and disposal of waste and effluents.

Therefore, the environmental dimension can strategically and positively contribute to the operations performance, mainly improving the performance of the competitive priority cost, with the reduction of expenditures with the consumption of natural resources water and energy and with the reduction of the volume disposed of waste and effluents, reducing their generation, that is, improving its performance.

The environmental performance of the companies of the study is measured by the environmental performance indicators, selected in function of their relevance as environmental impacts of the manufacturing processes of these companies and based on norm ISO 14031, requirement 4.3.1 – environmental aspects, that are: water consumption, energy consumption, waste generation and level of recycling that is the percent ratio between the waste recycled to waste generated.

The accumulated average performance of the specific reduction per vehicle produced of water consumption, energy consumption and waste generation of the three companies in the last three years was: 15%, 10%, 20% and 92% of recycling, respectively. That means a real expenditure reduction with resources consumption and waste disposal in the manufacturing process of the companies of the study, providing lower costs or higher margins.

Other aspect positively affected by the environmental performance was the company's

institutional image, which performance was improved in one of its indicators, environmental responsibility that, by means of an environmentally adequate manufacture, meets the growing demands of society by a consistent contribution of the industry to sustainability, mainly to the environmental sustainability component.

The winning orders requirements of the automotive market for products and services, of the three companies studied, were defined as being: low relative price, quality and, in some cases, delivery term and volume. As least important requirement, the market seeks the environmental adequacy of products, services and processes.

To finalize this first block of analysis based on the conceptual model (Figure 2) and on the research data, the Figure 3 presents in a summarized and consolidated way the study results.

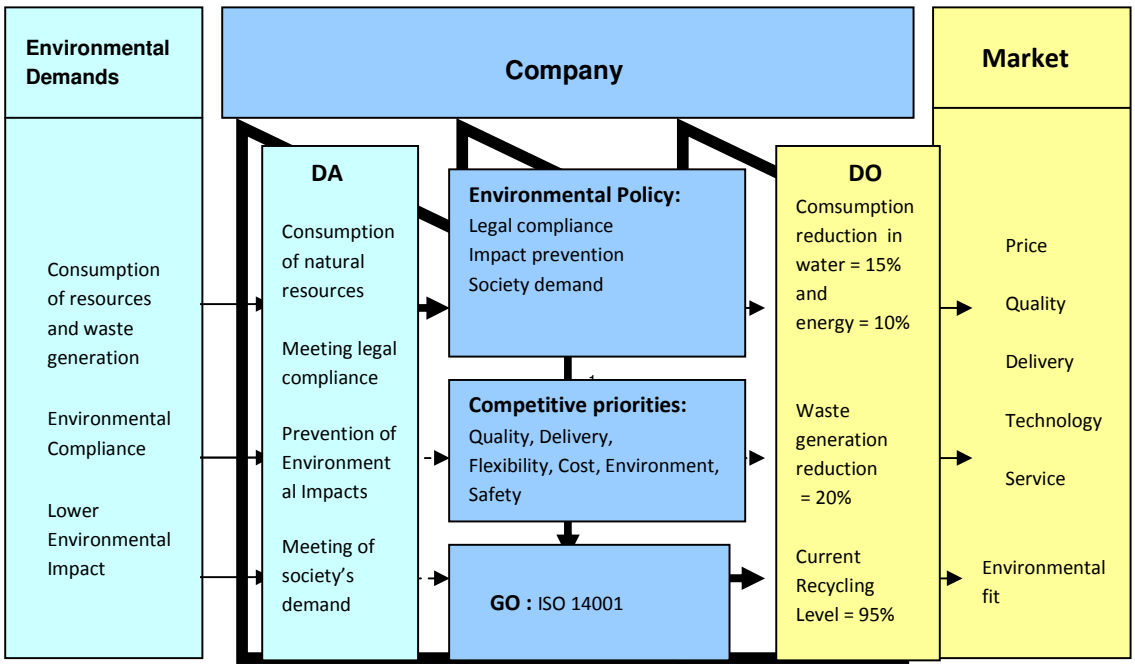

Figure 3 – Research conceptual model with consolidated data of the companies surveyed

These results shows the current external environmental demands (Chart 3), the composition of the environmental demand DA (Chart 4), the business strategy EN environmental policy PMA (Chart 5), the operations strategy EO competitive priorities PC (Chart 6), the operations

management GO, with the support from ISO 14001 management system, the operations competitive performance DO, showing a average reduction in the water consumption, energy and in the waste generation per vehicle produced in the last three years and the level of recycling, that positively impacted reducing the cost of operations and improving its performance and, finally, the market requirement of each company researched.

The operations strategies of all companies of the research are deployed from the business strategy and, in the case of companies A and J, are also formalized in writing, which does not occur in company E. In the companies A and J, the operations strategies are formulated and deployed top-down, not allowing the operations strategy to influence the business strategy in the sense bottom-up, which occurs with Company E.

The examples of operations strategy obtained from the theory and used to compose the research conceptual model, coincided to the operations strategies practiced by the researched companies, as detailed in Chart 7.

Companies	Operations Strategies	Written	Influence the business strategy
E	Lean production Strategic outsourcing Build to order Built to stock Supply chain management	No	Yes
A	Lean manufacturing Modular assembly Supply chain management	Yes	No
J	Lean Production Supply chain management	Yes	No

Chart 7 – Operations strategies practiced by the companies

5.2 Research objective analysis

With the data collected with the semi-structured face to face interviews it can be expressed how the companies treat the questions related to the operations strategies,

environmental dimension, operations competitive performance and environmental performance.

As the consolidated result of the interviews of the seventeen executives of the three companies on the inter-relations of the environmental dimension and its twelve attributes, presented in Chart 8, where each interviewee assigned one point to a strong or medium inter-relation and zero points to a weak inter-relation between the environmental dimension and the operations strategies, the competitive priorities and the company's image, allowing a maximum aggregate of 204 points (12 attributes times 17 interviewees), it was verified that the environmental dimension received a higher impact, that is, it has a stronger inter-relation, with the operations strategies, lean production (192 points) and outsourcing or de-verticalizing (110 points).

Environmental Dimension		**Operation Strategies**			**Competitive Priorities**			**Others**	**∑ Score**
		Lean Production	Outsourcing	Supplier Network	Costs	Quality	Delivery	Image	
Consumption reduction of natural resources	Water	17	14	6	17	3	3	15	**75**
	Energy	17	14	7	17	4	4	16	**79**
Legal and normative compliance	Licenses	14	7	9	13	7	13	16	**79**
	Norms	14	7	10	11	13	12	17	**84**
Impacts Prevention	Reduction Waste generation	17	11	8	17	7	3	17	**80**
	Cleaner Production	17	7	4	14	13	6	17	**81**
	Environmental Mgmt System	16	5	10	11	6	6	17	**71**
	Environmental Performance Index	16	9	5	14	6	4	16	**70**
	Selective waste collection	17	8	6	16	4	3	17	**71**
Society Demands	Sustainability	17	9	11	13	8	9	17	**84**
	Impact Prevention	15	10	8	13	8	6	17	**74**
	Legal Compliance	15	9	12	13	7	11	17	**84**
∑ Score		**192**	**110**	**99**	**169**	**86**	**80**	**199**	

Chart 8 - Environmental dimension inter-relations

What can also be verified, under the interviewees point of view, is that the factor of the environmental dimension, consumption of natural resources, water and energy (45 points on average) is affected with an intensity higher than other factors, that are affected with an equal intensify by the operations strategies.

Based on the assessment data of the inter-relation by the interviewees, the performance of the environmental dimension, resulting from targets and actions defined by the operations strategies, affects more intensely the competitive priority cost (169 points) and the image of the companies (199 points).

This result confirms the assumption of the research conceptual model that defined the performance of the competitive priority cost and image as the most affected by the way how the operations strategy considers the environmental dimension.

Analyzing the inter-relation result of the four environmental dimension factors with the competitive priorities it is verified that the factor legal and normative compliance has higher influence on the performance of the competitive priorities (34 points on average) followed by the factor society's demands (29 points on average), natural resources consumption (24 points on average) and finally the factor impacts prevention (21 points).

Other verification is that all twelve attributes or performance indicators of the environmental dimension strongly influence the company's image performance, reaching 97% of the possible points and exceeding the also strong influence in the performance of the competitive priority cost, with 83% of the possible points.

The great majority of the interviews ascertained that the decision of the companies to incorporate the environmental dimension as competitive priority in the operations strategies was taken because in some cases it was intended to improve the cost situation, efficiency, sustainability and image, in other cases ensure the legal compliance and the company survival the and also by incorporation tradition or simply by corporate decision. The causes, in any way, more

frequent of the environmental dimension incorporation as competitive priority in the operations strategies were the cost reduction, the image, the sustainability and legal compliance.

The operation competitive performance is affected by the environmental dimension as competitive priority, mainly by cost performance, image and legal compliance. It was also mentioned, in one case, an initial negative impact in the operation competitive performance cost in function of the investments in new clean technologies that temporarily increased the operational cost.

According to all interviewees there was a the production systems adequacy in the sense of improving the environmental indicators performance like energy conservation replacing previous equipment by equipment with more energetic efficiency, adequacy of packaging in the sense of reuse, replacing one way cardboard and wooden packaging by high durable returnable plastic packaging, waste management, reducing the hazardousness and increasing the reuse and recycling with the implementation of recyclable waste centrals, the elimination of machinery and equipment oil leakages, elimination of freezing CFC gas in refrigerating equipment and investments environmentally more adequate like water-based paints and others.

The planning rework of the productive process that could have been avoided by the fact that the operations strategy incorporate the environmental dimension as competitive priority were exclusively by means of investment and acquisition of new equipment more environmentally adequate avoiding later reworks to meet the environmental targets or legislation as occurred in previous planning.

In the question of identification of market demand, in addition to the legal compliance demanded by government agencies, there was a balance between the responses yes and no. For the cases with responses “yes”, there was demand from the dealers and clients. For the cases of responses “no”, there was the explanation that the clients still only see price, but even so the companies take proactive actions in dealing with the environmental dimension, because they

understand that the vision of the clients can change rapidly, which in reality is already occurring, and a requirement today still not so important can assume the performance objective relevance of a winning order.

What changed in the competitive performance with the incorporation of the environmental dimension as a operations strategy competitive priority, was a lower operating cost due to the reduction of the environmental cost in function of the average improvement of 15% in the indicators of environmental performance and a better company image for the fact of use a manufacturing process environmentally more adequate with a lower natural resources consumption and lower pollution generation.

From that it can be inferred that the environmental dimension, when considered as operations competitive priority, can contribute to the operating cost reduction, allowing the companies the practice of lower prices or higher margins and also to improve the image of the company that can provide a better clients loyalty increasing sales, which was confirmed by the executives interviewed. It becomes evidenced, the companies are proactively adjusting their capacities and competences to be able to meet market demands in development and thus ensure the sustainable competitive advantage.

It is confirmed by the fact of the three companies consider the environmental dimension in their business strategies, formulating an environmental policy based on external demands of the company that, deployment in functional strategies, is made by means of environmental management models with the support of a management system in compliance with norm ISO 14001.

The environmental policy is deployed and considered in the operations strategy as competitive priority by means of the targets definition and objectives or environmental improvements in the processes.

The relation of the operations strategies with the environmental management is aligned by the fact of the operations strategy incorporate the environmental dimension as competitive priority and define targets of environmental performance improvement to be made by the environmental management models defined by the companies as cleaner production and eco-efficiency.

The interviews also demonstrate a general knowledge and awareness of all researched functional areas executives on the strategic importance of the environmental dimension to the company and how it contributes to the consolidation of a sustainable competitive advantage.

6 REMARKS

Concluding the analysis and interpretation of data of the multiple case study three assembling companies, it was verified that there is a great alignment, almost a standard or best practice, among the companies, regarding the operations strategies, to the environmental demands, to the factors, attributes and performance indicators of the environmental dimensions and to the competitive priorities.

This alignment can be the result mainly from the equal strategic perception of market demands, legislation and society by part of these companies that operate in the same market of the mobility industry and also for the use of technologies and standardized management tools and defined as best practices like, for example, lean production, cleaner production, eco-efficiency and norms of series ISO 14000, as proven by the data surveyed in the study.

It was not verified in almost the totality of the aspects examined any specific and highlighted influence of the different cultural origin of the companies, with that, demonstrating a high level of globalization and market unique vision of a sector on industry that appears to improve continuously and globally its best practices. The companies cultural origin influence appears only express itself punctually in the fact of the differentiated definition of the number of

inter-relations of the environmental dimension with the operations strategies, with the competitive priorities and with the image of the companies, where company A defines a higher number of inter-relations, company E defines an intermediate number of inter-relations and company J defines a lower number, meaning a differentiated degree of the importance given by the companies to the influence of the environmental dimension in the operations competitive performance.

The verification and conclusion of highest relevance to the present study is the fact of the three companies consider the environmental dimension in their operations strategy and, as a result, define the environment as one of the competitive priorities, defining targets and actions to improve their environmental performance indicators that directly impact in the operations performance. It is worth highlighting here that two companies of the case study considered, in addition to the environment, also labor safety as competitive priority, maybe anticipating a future trend influenced by the definition of sustainability and social responsibility. This way, it can be inferred that the companies of the study are considering in their business strategy, as a vision of opportunity, the interdependence of the productive, environmental and social systems.

What unfolds to the operations strategy in the sense of seek solutions for the questions of sources of energy, economy of resources and use of materials, replacement of inputs, reduction of environmental impacts along the value chain and also productive systems socially more fair, where labor safety and occupational health are seen as a strategic aspect that contributes to the operations competitive performance.

The inclusion of the environment as one of the competitive priorities of the companies means enhancing the vision scope of the main authors that contributed to the operations strategy theory development seen in this work, that only consider the competitive priorities: quality, delivery, flexibility and cost.

The precarious alignment between the operations strategy theory and environmental management, as opposed to what is got in the case of alignment between the operations strategy theory and quality management can make it difficult to the expert and academic the holistic understanding of the operations competitive performance.

Considering the restrictions made to the method of case study, it would be interesting in future studies, to expand this research inserting other companies of the automotive industry value chain and maybe even repeat it in other productive sectors in the sense to verify the validity of the theoretical assumption of the conceptual model of this study in other corporate context.

Additionally, a question to be better explored in future studies is how much the companies with social-environmental practices consider labor safety as competitive priority of the operations strategy.

REFERENCES

ALVES FILHO, A., G.; PIRES, S., R., I; VANLLE, R., M.. *Sobre prioridades competitivas da Produção: compatibilidades e sequências de implementação.* Gestão& Produção v.l.2, n. 2, 1995.

ANGELL, L. C.; KLASSEN, R. D. *Integrating environmental issues into main stream: an agenda for research in operation management.* Journal of Operation Management, v.17, 1999.

ASSOCIAÇÃO BRASILEIRA DE NORMAS TÉCNICAS. *NBR ISO 14031: indicadores de desempenho ambiental operacional.* Rio de Janeiro, 2004.

BARBIERI, J. C. *Gestão Ambiental Empresarial: conceitos, modelos e instrumentos*. São Paulo, Saraiva, 2007.

BARNES, D. *Research methods for the empirical investigation of the process of formation of operations strategy.* International Journal of Operations & Production Management, v., n. 8, 2001.

BORGES, F. H. *O meio ambiente e a organização: um estudo de caso baseado no posicionamento de uma empresa frente a uma nova perspectiva ambiental* – Dissertação (Mestrado) - Escola de Engenharia São Carlos – USP, 2007.

CAMPOS, L. M. S., MELO, D. A. *Indicadores de desempenho dos sistemas de gestão: uma pesquisa teórica.* Produção, v.18, n.3, 2008.

DA SILVA, E. M. *O relacionamento entre estratégia de manufatura, práticas de produção e desempenho operacional e de negócio: uma survey em firmas do setor moveleiro.* Tese (Doutorado) – Escola de Engenharia São Carlos USP, 2008.

DEMAJOROVIC, J. *Sociedade de risco e responsabilidade socioambiental: perspectivas para a educação corporativa.* São Paulo, SENAC, 2003.

DOS SANTOS, M., K. *Ecoeficiência e avaliações de sistemas integrados de gestão***.** Dissertação (Mestrado) – Escola de Engenharia da Universidade do Rio Grande do Sul, 2007.

EPELBAUM, M. *A influência da Gestão Ambiental na Competitividade e no Sucesso Empresarial. Dissertação* (Mestrado) – Escola Politécnica da USP, 2004.

GAVRONSKI, I. *Estratégia de Operações Sustentáveis: Produção, suprimentos, logística e engenharia alinhados com a sustentabilidade corporativa.* Tese (Doutorado) – Universidade Federal do Rio Grande do Sul, 2009.

GIL, A. C. *Métodos e técnicas de pesquisa social.* São Paulo, Atlas, 1999.

HAYES, R. H.; PISANO, G. P**.** *Manufacturing Strategy: at the intersection of two paradigm shifts*. Production and Operations Management. v.5, n.1, 1996.

HAYES, R. H.; WHEELWRIGHT, S. C. *Restoring our Competitive Edge: competing through manufacturing.* Wiley, New York, 1984.

HRDLICKA, H. *As boas práticas de gestão ambiental e a influência no desempenho exportador: um estudo sobre as grandes empresas exportadoras brasileiras.* Dissertação (Mestrado) – Faculdade de Economia, Administração e Contabilidade da USP, 2009.

JIMÉNEZ, J. B.; LORENTE, J. J. C. *Environmental performance as an operations objective.* International Journal of Operations & Production Management, v. 21, n 12, 2001.

MASSI, K. G., PEREZ, A. C., ALMEIDA, F. F., SMID, L. N., SOUTO, L. A., DÁRIO, V. P. G**.** *As micro e pequenas empresas e as boas práticas ambientais.* Revista cientifica Hermes, v 3, 2010.

LOWSON, R. H. *The nature of an operation strategy: combining strategic decisions from the resource-based and market-driven viewpoint.* Management Decision 41/6, 2003.

_____, *Operations strategy: genealogy, classification and anatomy.* International Journal of Operations & Production Management, v.25, n.12, 2005.

SANCHES, C. S. *Gestão Ambiental Proativa***.** Revista de Administração de Empresas,

EAESP FGV, v.40, n.1, 2000.

SLACK, N.; LEWIS, M. *Operations Strategy.* New Jersey, Prentice-Hall, 2001.

SLACK, N. *Vantagem competitiva em manufatura***.** São Paulo, Atlas 2ª. Edição, 2002.

_____, *Operation strategy: will it ever realize it's potential*. Gestão e Produção, v.12, n.3, 2005.

SKINNER, W. *Manufacturing – missing link in corporate strategy.* Harvard Business Review, May-June 1969.

THOMAS, J.C.; BRITO, E.P.Z. *Reputação corporativa: constructos formativos e implicações para a gestão.* RAC, v.14, n.2, art. 3, 2010.

VENTURA, M. M. *O estudo de caso como modalidade de pesquisa.* Rev. SOCERJ. v.20, n 5, 2007.

VOSS, C. A**.** *Alternative paradigms for manufacturing strategy***.** International Journal of

Operations & Production Management, v.15, n. 4, 1995.

_____, *Paradigms for manufacturing strategy.* International Journal of Operations & Production Management, v.25, n.12, 2005.

WHEELWRIGHT, S. C. *Manufacturing strategy: defining the missing link*. Strategy Management Journal, v.5, 1984.

YIN, R. K. *Estudo de Caso: planejamento e métodos.* Porto Alegre, Bookman, 2001.