Evaluation of Sustainable Interactions Between Customer and Supplier: A Case Study in Machining

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Abstract
This article aims to evaluate the sustainable interaction of machining processes for a global manufacturer of cutting tools for metal-mechanical industry and its suppliers. The research is exploratory, qualitative approach, accomplished through a case study using the method GAIA. The results of applying this method show satisfactory results.

Keywords: Sustainability, Supply Chain, Machining.

Introduction
An industrial development brings capital, jobs and develops the technical knowledge of the region. Natural resources and environment of poor countries (forests, land, water, etc.) are essential to maintain the production of conventional goods and services. Therefore, measures for environmental protection and natural resources are necessary to achieve continued economic growth. Therefore, this article aims to identify the environmental performance of a company, a leading global manufacturer of cutting tools for metal-mechanical industry and their respective supply chain. Specifically, the evaluation of sustainable interactions between the studied company and its suppliers.

At first, the interest of research into sustainability fell into financial impacts caused by specific environmental behaviors, such as pollution control, recycling and reverses logistics. Few studies have addressed the impact of sustainable supply chain with focus on protecting global environmental and social capital. Noteworthy was the absence of studies on the potential for developing competitive advantage understood as the basis for a sustainable supply chain. The word sustainability is used frequently in many different combinations: sustainable development, sustainable growth, sustainable community, sustainable industry, sustainable economy, sustainable agriculture, etc.. But what they really mean?

Sustainability comes from the Latin "Sustentare" which means to sustain, sustain, endure, keep in good repair, maintain, resist. Thus, development is all that can be supported, maintained.

According to the concepts of sustainability of this movement, innovations must generate economic results, social and environmental impacts at the same time, which is not easy to do,

give the uncertainties that innovations bring, especially when they are radical or with a high degree novelty in the state of the art.

The economic effects are relatively easy to predict, because there is a plethora of instruments developed for this, and innovative companies know how to use them. The social and environmental effects are more difficult to assess in advance, because they involve many more variables, uncertainties and interactions. So, what else we see is the continuation of conventional wisdom accompanied by a discourse that incorporates the theme of sustainable development that is just in good intention, when there is a means of appropriating an idea that is gaining importance for the population and opinion leaders. Sustainable development requires the combination of technical and social changes, since these are closely related (SICHE, AGOSTINHO, ORTEGA, ROMEIRO, 2007).

According to F. PUSAVEC ET AL, 2010 for production technologies, ways to improve the sustainability performance are:

- Reduce energy consumption machining processes;
- Minimize the waste (generate less waste and increase recycling or waste);
- Use resources efficiently;
- Use of recycled materials or reuse of parts of machine tools;
- Improving the management of metalworking fluids, cuttings, lubricating oils and hydraulic oils (improving the environment and safety performance of health);
- Adopt methods of evaluating the life cycle.

A key element of sustainability is the prudent use of natural resources. This means that the use of nonrenewable resources, efficiency and develop alternatives to replace them in the future as the use of renewable resources so as not to compromise the resources or cause pollution.

Methodology

The twentieth century brought a series of events and changes in various segments of society, which boosted the competitiveness of markets, globalization, fierce competition and also the scarcity of natural resources. Advances in manufacturing technology and information, the globalization of markets, deregulation and a greater awareness of ethical and environmental business, among other phenomena that sort of forced organizations adapt to a new competitive reality. Considering these aspects, people have become concerned with environmental issues, which had never before been noticed, since natural resources were abundant and free.

"In light of the requirements of society made by organizations in a position more appropriate and responsible action to minimize the difference between the economic and social as well as ecological concerns, which have gained significant, and compared their survival to quality of life of populations, has required companies to reposition themselves in their interaction with the environment. "Organizations are seeking ways to adapt to this reality, using assessment instruments for environmental performance"(ANDRADE, TACHIZAWA AND CARVALHO (2000, p. 6)).

Due to the need to adapt organizations to sustainability, was selected an industry benchmark for measuring environmental performance. It was used in this article, the method GAIA - Management Aspects of Environmental Impacts - idealized by Lerípio (2001), due to its ease of implementation and compliance with the proposed theme.

We applied this method in a leading global manufacturer of cutting tools for metal-mechanical industry. The research is characterized as exploratory, qualitative approach, accomplished through a case study. Data were collected through visiting with monitoring and verification of their production process, search and document analysis, and questionnaire relating to aspects of the GAIA method.

Method GAIA

Method GAIA - Managing Environmental Aspects and Impacts, according Lerípio (2001), is a set of instruments and management tools with a focus on environmental performance applicable to the production processes of an organization and in achieving full sustainability. The focus of GAIA is on developing a critical consciousness in people that make up the organization with regard to the levels of wastage of raw materials and inputs in the production process as well as on the effects produced by the waste effluents and emissions by - both generated in the process - and that are harmful to the environment and people.

This method tries to integrate, through sequential standardized approaches to educating people and improving processes, using such principles to their theoretical and conceptual. The principles of GAIA are identical to the basic assumptions of management recognized by ISO 14001: continuous improvement, pollution prevention and legal compliance. Thus, the basic principles of GAIA are defined by the following expression: "To provide organizations with legal compliance, continual improvement and prevention of pollution from activities focused on environmental performance and sustainability, taking as fundamental elements of the organization process and people through their relationships with the environment "(LERÍPIO, 2001, p. 66). The GAIA method consists of three phases, in which are subdivided into some activities, as shown in Figure 1. This article will focus on phase "awareness", where one can detect the level of sustainability of the company studied.

Stage	Objective	Activities	Outcomes
Awareness	Ambiental and Providing the accession of senior management commitment to continuous improvement of environmental performance	Evaluation of Sustainability of business	Current level of knowledge of the environmental performance of the organization for senior management
		Strategic Environmental	Current performance comparison with that submitted by defensive folosofias, reactive, and regardless of innovative management
		Commitment from senior management	Definition of mission, vision, policy and organizational objectives
		Awareness Program for Stakeholders	Awareness of employees, suppliers, community board environmental customers

Figure 1 – Phases and activities of GAIA (Lerípio, 2001, p. 68).

In the first phase, "Phase of Awareness", the activity of assessing the sustainability of the business is done by filling out a checklist, presented in Figure 2, which should be filled by senior management, managers and company employees. The responses on the checklist of sustainability of the organization are classified in three colors according to their significance in relation to the sustainability of the organization. The answer that represent good practice developed is classified as green, the response to represent a problem or an "opportunity for improvement" is classified as red, and when the question does not apply to the reality of the organization, it will be classified as yellow. The 79 questions are equally weighted, as the following formula:

$$\text{Environmental Performance} = \frac{\text{Number of Green Squares}}{\text{Number of Squares - Number of Yellow Squares}} \quad (1)$$

Depending on the identification of the level of sustainability of the business, the organization is to establish some important relationships, which is made in the strategic environmental analysis. This analysis can be done from the criterion of compliance with applicable environmental legislation. This activity helps top management to "see" in a systemic and Multicriteria real situation of the organization or unit under review. If that idea is understood, the involvement of senior management will be achieved, enabling the effective beginning of the process of change in the organization.

Case study in a company

The company studied is a leading global manufacturer of cutting tools for metal-mechanical industry, with over 25,000 products. In 60 countries around the world, thousands of experts working full steam to provide solutions to our customers.

The company has studied various processes in its production, one of them stood out to represent and measure the sustainable interaction, which would be subdivided into two stages: CNC Lathe - To handle w / clip - Dia. 50 x 40 mm length and Milling CNC - Machining conf. Design D2. Where have two types of disposal:

- Splinter- who is the surplus steel removed during the machining;
- Cutting-fluid - which is used to lower the temperature of the friction created a tool that removes material, the liquid is changed, that is from time to time all the fluid is removed from the tank of the machine (which must be discarded) secondly, there is a need for replacement, because it loses the properties and cause odor, and even cause allergies to the operator.

One of the most used in manufacturing in general is machining. The use of cutting fluids in this process is common, due to the improvement in tribological conditions. The use of cutting fluid improves tool life, minimizes heat generation during the process, assists in the removal of chips and generally improves the efficiency of the production system, according to ALVES, OLIVEIRA, 2007. After processing, it has a product that demonstrates the required characteristics in terms of quality, economic efficiency and recyclability. Still, there are the residual materials and emissions, which are unwanted parts. This process was discussed in this article to assess the interaction of the company's sustainability.

CHECKLIST OF SUSTAINABILITY OF THE ORGANIZATION				
CRITERION 1 - SUPPLIERS	**YES**	**NO**	**NA**	**COMMENTS**
1. The raw materials used are from renewable resources?				
2. The suppliers are monopolists in the market?				
3. The suppliers have processes impacting the environment and humans?				
4. For the extraction / transport / processing / distribution of raw material is needed big power consumption?				
5. The organization's main suppliers are certified by ISO 14001 environmental standards?				
6. The main suppliers are certified by the organization's health and safety standards BS 8800 or OHSAS 18001?				
CRITERION 2 - THE PRODUCTION PROCESS				
a) ECO-EFFICIENCY OF THE PRODUCTION PROCESS	**YES**	**NO**	**NA**	**COMMENTS**
7. The production processes are polluting or potentially polluting?				
8. Occurs the generation of hazardous waste during the processing of the product?				
9. The production process is responsible for a high consumption of energy?				
10. The conversion rate of raw materials into products is greater than or equal to the industry average?				
11. The ratio of effluent generated per unit of output is equal to or greater than the industry average in cubic meters of water per unit produced?				
12. The ratio of solid waste generated per unit of output is equal to or greater than the industry average in kilograms of solid waste generated per unit of product produced?				
13. The ratio of air emissions generated per unit of output is equal to or greater than the industry average product produced in meters? cubicos (ou quilogramas) de emissões atmosféricas por unidade de produto produzido? cubic (or kilograms) of air emissions per unit of product produced?				
14. The ratio of energy used per unit of output is equal to or greater than the industry average in Gigajoules per lot (or unit) of product produced?				
15. The organization fully meets the standards relating to health and safety of employees, internal and external				
b) LEVEL OF TECHNOLOGY IN THE PROCESS	**YES**	**NO**	**NA**	**COMMENTS**
16. The products produced have low added value?				
17. The technology offers viable only for large-scale operation?				
18. The technology features high degree of complexity?				
19. The technology features a high level of automation (a low density of demand capital and labor)?				
20. The technology requires the use of inputs and raw materials hazardous?				
21. The technology requires the use of nonrenewable resources?				
22. The technology is indigenous (able to be developed, maintained and perfected their own funds)?				
23. The technology represents a dependency of the organization in relation to any supplier or partner?				
c) ASPECTS AND ENVIRONMENTAL IMPACTS OF PROCESS	**YES**	**NO**	**NA**	**COMMENTS**
24. The water source used is a Community?				
25. There is a high water consumption in the production process?				
26. There is a high total water consumption in the organization?				
27. Is there any type of water reuse in the process?				
28. Hazardous waste are generated during the process?				
29. The legal standards regarding wastewater are fully met?				
30. Hazardous solid waste are generated (Class 1) during the production process?				
31. The legal standards relating to solid waste are fully met?				
32. 32. Is there some kind of reuse of solid waste in the process?				
33. Is there any waste generated subject to recovery in other processes?				
34. The energy matrix comes from renewable sources?				
35. The productive activity is high consumer of energy?				
36. Occurs the generation of toxic or hazardous air emissions?				
37. The legal standards relating to air emissions are fully met?				
38. Is there some kind of reuse of energy in the process?				
39. Greenhouse gases are used in the production process?				
40. Ozone gas is used in the production process?				
41. Elements are used which cause acidification in the production process?				
42. Volatile organic compounds are used in the production process?				
d) MANAGEMENT INDICATORS	**YES**	**NO**	**NA**	**COMMENTS**
43. The organization is subject to intense supervision by the municipal environmental agencies, state and federal?				
44. The organization is a defendant in any lawsuit relating to environmental pollution, environmental accidents and / or severance pay?				
45. Already there were complaints about aspects and impacts of the production process from the neighboring community?				
46. If so, have taken corrective actions and / or preventive measures to solve the problem?				
47. Accidents or environmental incidents have occurred in the past?				
48. If so, accidents or incidents were resolved according to the expectations of stakeholders?				
49. Accidents or incidents were documented and recorded in the appropriate way?				
50. Systematic investments are made in environmental protection?				
51. The efficiency of utilization of inputs and raw materials is less than the industry average?				
52. The monthly quantity of raw materials and energy used per unit of product is growing?				
e) HUMAN RESOURCES IN THE ORGANIZATION	**YES**	**NO**	**NA**	**COMMENTS**
53. Top management is committed to effectively shows the environmental management?				
54. The management team that has really committed to environmental stewardship?				
55. The manpower employed is highly specialized?				
56. Employees are directed to technological innovations?				
57. Creativity is one of the strengths of the organization and its employees?				
58. There is a policy of valuing intellectual capital?				
59. The organization offers profit sharing or other forms of motivation for employees?				
60. The newly developed products have long development cycles?				
f) AVAILABILITY OF CAPITAL	**YES**	**NO**	**NA**	**COMMENTS**
61. There is capital available for investment in environmental management?				
62. There are legal restrictions on registration or the granting of loans for investment in environmental management?				
63. The organization presents operating profit in line waste management?				
CRITERION 3 - USE OF PRODUCT / SERVICE	**YES**	**NO**	**NA**	**COMMENTS**
64. The traditional consumer product has a high level of awareness and enlightenment environment?				
65. The product is hazardous or requires attention and care on your part?				
66. The use of the product causes an impact or potential risk to the environment and humans?				
67. The product is located in a bull market competition?				
68. The product has substitutes in the market or in development?				
69. The product is intensive (the first article of necessity)?				
70. The product features high durability?				
71. The product is easy to repair for extending the shelf life?				
72. The product has a minimum of packaging?				
CRITERION 4 - PRODUCT USED AFTER	**YES**	**NO**	**NA**	**COMMENTS**
73. The product, after its use, can be reused or refurbished?				
74. The product, after use, can be disassembled for recycling and / or reuse?				
75. The product, after its use, can be recycled in whole or in part?				
76. The product, after its use is fairly simple to biodegradation and decomposition?				
77. The post-consumer product presents danger?				
78. The post-consumer product requires additional care to protect the environment?				
79. The post-consumed product generates jobs and income in society?				

Figure 2 – Checklist of sustainability of the organization (Lerípio, 2001, p. 70-72).

From the result of calculating the environmental performance, detects the sustainability of the business, as ranked in Figure 3.

RESULT	SUSTAINABILITY
LESS THAN 30%	CRITICAL - RED
BETWEEN 30 AND	BAD - ORANGE
BETWEEN 50 AND	RIGHT - YELLOW
BETWEEN 70 AND	GOOD - BLUE
OVER 90%	EXCELLENT - GREEN

Figure 3 – Classification of business sustainability (Lerípio, 2001, p. 73).

Method application GAIA

Regarding the method of Environmental Impact Management, GAIA method, it is emphasized that some aspects were analyzed from the "awareness" shown in Figure 2.

The calculation of the environmental performance using the GAIA method, which includes the checklist used in the company studied, as Equation 2.

So, have the following calculations:

$$\text{Environmental Performance} = \frac{\text{Number of Green Squares} * 100}{\text{Number of Squares - Number of Yellow Squares}} = \frac{48 * 100}{79 - 4} = \frac{4800}{75} = 64\% \quad (2)$$

According to these data, it was found that the company has a considerable environmental performance appropriate, with reference to the grading scale for sustainability of the business method of GAIA, as Table 3.

Results

The result obtained by the company was satisfactory due to have reached 64% level of sustainability, considered by GAIA methodology as "adequate. " Responding correspondingly given that the studied company is certified ISO 14001 since 2003. In addition, there are Supplier Evaluation - where partner companies are evaluated before their environmental management, quality, and health and safety. Studied where the company requires its suppliers to have a satisfactory rating. This assessment is often performed and used in selecting suppliers.

It is clear that the methodology demonstrates the reality of the company with reference to sustainability, because the result is compared with the production process and also by the company to have ISO 14001 certification.

Opportunity for improvement

The production processes of the company and its suppliers are impacting the environment and humans, the extraction / transport / processing / distribution of raw material has great need of energy consumption, production processes are polluting or potentially polluting, occurs at hazardous waste generation during processing of the product. These characteristics make it difficult for the company has a high level of sustainability, given the complexity of their production processes. For that the company needs a consultancy and manpower highly qualified to provide for other ways to produce your product and capture inputs.

Conclusion

The environmental problem, which has grown considerably each year, increases the problems of disposal and stricter legislation requiring more industries to delve into issues of environmental compatibility of their products. With growing legislative and civil charges on the relationship and industry environment, firms are not allowed to continue with the old technologies, or just to treat or recycle wastes and emissions generated, you should try to reduce or eliminate the them.

The results of applying this method show satisfactory results of the features observed, although the company provides opportunities for improvement in its production process. It follows the end of the study that the organization has gained a lot on the theme "Sustainability", seeking ways to develop a sustainable supply chain. In addition, the company is keen to demonstrate their environmental responsibility which transfers to your suppliers, as the establishment code of conduct and evaluation of partners.

However, it is known that companies in general are far from obtaining excellent results in their production processes in relation to sustainability, as existing methodologies have not brought significant financial benefits to justify such a change in their processes.

References

Alves, S M; Oliveira, J F. (2007). Adequação ambiental dos processos usinagem utilizando Produção mais Limpa como estratégia de gestão ambiental. Prod. [online]. vol.17, n.1, pp. 129-138.

Andrade,; Tachizawa, T; Carvalho, A. (2002) Gestão ambiental: enfoque estratégico aplicado ao desenvolvimento sustentável. 2ed, São Paulo, SP, Mackron Books.

Barbieri, JC.; Gouveia Vansconcelos, I F; Andreassi, T; Vasconcelos, F C. (2010) Inovação e Sustentabilidade: Novos Modelos e Proposições. RAE. Vol. 50. nº2. p.146-154.

Brito, Re P; Berardi, P C. (2010) Vantagem Competitiva na Gestão Sustentável da Cadeia de Suprimentos: Um Metaestudo. RAE. Vol. 50. Nº2.

Diniz, ,A. E. et al.,. (2006) Tecnologia da Usinagem dos Materiais. Art Liber Editora, São Paulo.

Lerípio, A.(2001) GAIA - Um método de gerenciamento de aspectos e impactos ambientais. Tese (Doutorado em Engenharia de Produção) – Programa de Pós-Graduação em Engenharia da Produção, Universidade Federal de Santa Catarina, Florianópolis.

Pusavec, F; Frajnik, P; Kopac, J. (2010). Transitioning to sustainable production – Part I: application on machining technologies. Journal of Cleaner Production 18 , 174–184.

Siche, R; Agostinho, F; Ortega, E; Romeiro, A. (2007) Índices versus Indicadores: Precisões Conceituais na Discussão da Sustentabilidade de Países. Ambiente & Sociedade. V. X, n.2. p. 137-148.

Sousa, M A B; Santos, F F; Lerípio, A A. (2007) Gerenciamento de Aspectos e Impactos Ambientais em uma empresa fabricante de tubos, tubetes e conicais. Revista Produção (on line) Vol. 6, nº 1.

Souza, M F; Moori, R G.; Marcondes, R C. (2005). Sincronismo entre Clientes e Fornecedores. RAE. Vol. 45. Nº4.

Stamm, H R. (2003). Método para Avaliação de Impacto Ambiental (AIA) em Projetos de Grande Porte: Estudo de Caso de uma Usina Termelétrica. Teste de Doutorado em Engenharia de Produção. Universidade Federal de Santa Catarina.