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THE COST AND ENVIRONMENTAL IMPACT METHODOLOGY TO PRODUTS

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Abstract. Many environmental problems in the oil refining industry and other companies are related to purchasing choices. This department usually considers only cost and quality aspects but do not take into account environmental aspects. The purpose of this study is to develop a methodology to guide the purchases giving companies a suitable tool to evaluate products along its life cycle and helping them to find the most efficient option according to environmental aspects, but not forgetting financial interests. A case analysis was developed along this paper, using the cost and environmental impact methodology to a ¾" metal ball valve and a ¾" PVC ball valve. Both have similar function and representative application in the industries. The environmental analysis found by the inventory was compared with Eco-indicator 99 result, concluding that they are quantitative similar. Then, the inventory was homologated and became the data base to the cost index survey along the life cycle. The case analysis confirms the applicability of this methodology to the environmental impact reduction.

Keywords: Environmental Purchasing, Sustainable Development, Life Cycle Analysis

1. INTRODUCTION

Many of the environmental questions as the pollution of water and air, the greenhouse effect and acid rain are related to pollutants emissions of the companies from diverse activities. The environmental problems generated by the company are not centered in a single process developed for them. They are distributed in some points in the interior of the productive and administrative processes of these companies. One of these points was identified by Goldemberg and Nascimento (2004) that is the use of low environmental quality products. These authors cite that the origin of this problem is located in the purchase procedures of the companies. According to them the government purchases reach billions of dollars per year, distributed in approximately 40,000 items. How to identify, then, the environmental quality of the products or services? It is possible to opt to a dismissible cup or glass cup, an incandescent or fluorescent light bulb, only using the simple information? It is not possible, is necessary more information to determine which product is better. In order to solve this problem is necessary to use a methodology that considers the environmental aspects of the products without leaving the economic aspects transforming them into objective and comparable information.

2. REDUCTION OF ENVIRONMENTAL IMPACTS BY MEANS OF THE SUSTAINABLE CONSUMPTION

According to Zacchi and Bellen (2005), the concept of the sustainable development was spread out with bigger popular expression through the document Our Common Future written in 1987 and also known as Brundtland Report. According to them the document began the idea of an economic and industrial development. This concept is complemented by the definition the sustainable development is the use of the natural resources to satisfy the necessities of the moment without compromising the future necessities. The basic elements of the sustainable development are described for Kinlaw (1997) as being the equality among people, the responsible administration for everything that are produced or used, limits of human intervention in ecosystems, the damage of ecosystems and the harmony between ecosystems and the human activities. We can observe that the definition of sustainable development is ample and possess several fields of performance that converge to common well-being. The sustainable consumption, in this paper, is one of the ways to promote the development sustainable. The definition of sustainable consumption consists of the awareness of the countries, the companies and the people in becoming responsible consumers, transforming the current economic model into a type of socially fair development and ambiently balanced, abandoning the exaggerated consumption. One of the tools to promote the sustainable consumption is the environmental LCA and environmental costs that will be discuss below.

2.1. Methods of impact analysis that contemplate the LCA

The methods of environmental impact analysis are compose of procedure groups whose purpose is to identify, to foretell and to interpret the effect and impacts on the environment as consequence of actions proposed, such as: public politics, environmental programs, new projects, new activities. According to Jolliet et al (2003), in accordance with ISO 14042, the results of the inventory analysis is classified and characterized in impact categories, each one with an indicator, being able to be situated in some point among the results of the inventory analysis and environmental indicator. Inside of the structure of the LCA, there are three basic methods each: classic method, method of guided damage and mixing method.

2.1.1. Classic method

The emissions described in the inventory are converted by means of specific calculations into categories of environmental impacts. When the analysis is made in this impact category is called analysis in the average point. The classic methods aim modeling quantitatively the impacts in this point. This procedure tries to limit the uncertainties of other methods that consider a single indicator for each type of substance. The average points as the greenhouse effect, reduction of the ozone layer and acidity are converted into impact percentage, then the analysis of the environmental performance must be done. Subjects of impact categories are common mechanisms and defined on the basis of scientific knowledge (CHEHEBE, 1997), as the greenhouse effect or also grouped mechanisms can be two or more subjects, as the ecotoxicity that is defined for the water and the ground (CHEHEBE, 1997). Examples of this method are: (a) CML (GUINÈE et al., 2002) and (b) EDIP (WENZEL et al., 2001).

a) CML 2002 Method

In 2001, the Center of Environmental Science of the University of Leiden (CML) in Holland, published an operational guide describing the procedure to be applied to lead a LCA project in accordance with the standards of the ISO. This guide deals with the categories impacts in two groups: exhaustion of natural resources and energy and the pollution. The implantation of this method occurs in the database of the inventory, where the characterizations for the input flows and output materials and pollutants are calculated. The result of the calculation obtained in the database of the inventory is used for analysis of the environmental impact.

b) EDIP Method

The EDIP (Environmental Design of Industrial Products) is the result of a cooperative program among university, industry and danish authorities with the objective to project cleaner products (WENZEL et al., 2001). Method EDIP, the inventory, in terms of amount and type of emission, is translated into known environmental impacts. Thus, the inventory is transformed into a list of items consumed and potentials for impacts in the environment. This method deals with the impacts categories in three main groups: environmental effects, resource consumption, and working environmental effects. For the classification, the normalization and the valuation the method has specific way to do these calculations of balance (ISO, 1997).

2.1.2. Guided Damages Methods

These methods aim modeling quantitatively until a final indicator. The impact categories or average points result in individual indicator that can be added promoting a single result of impact. These methods, many times, assume high uncertainties. However, for the analysis of products this method is sufficiently convenient due to the easiness comparison that it provides. Examples of this method are: (a) Eco-Indicator 99 (GOEDKOOP and SPRIENSMA, 2001) and (b) EPS 2000 (STEEN, 1999).

a) Eco-Indicator 99 or EI99 Method

In 1999 was published the method Eco-indicator 99 in order to evaluate the impact of the life cycle. The method consists of calculating environmental score (GOEPKOOP; SPRIENSMA, 2001) through its standardized indicators with the purpose to environmental evaluate the products through the processes and its flows of materials. This method deals with impacts categories in three main groups: the extraction of natural resources; the use of the land and the potentials of emissions. These three groups of indicators converge to a single normalized indicator. An assumption of the method is that all the emissions and the use of the land occur in the Europe and, therefore, all the damages occur in this region, except for the damages to the natural resources, the damages of climate change, depletion of the ozone layer, cancerigenic substances emission, inorganic substances long scale of dispersion that provoke pollution of air and some radioactive substances that are considered in method as global (GOEPKOOP; SPRIENSMA, 2001).

b) EPS 2000 Method

Methodology EPS 2000 (Environmental Priority Strategies in Product Design) is a guided method to be used in the choice between two concepts of products. The indicators are chosen for this purpose and appropriate to give values for the impacts categories. For each material, a load environmental index is evaluated. This index attributes values to the emissions and the extraction of resources are based in five criterions (GOEPKOOP; SPRIENSMA, 2001): health human; ecosystem production capacity; reserve of abiotic resources; biodiversity, cultural and recreation values. The indexes are multiplied by the loading of materials, emission and extraction of resource that are evaluated to a common unit. The result is the unit called load unit. EPS Method isn't based on the targets of current emissions; it considers a pessimistic system those points to new future costs.

2.1.3. Mixing method

This method aim reducing the uncertainties of the guided damages methods using four groups of environmental indicator. So, the approaches are softer and with this it reduces errors. Example of this method is Impact 2002+. IMPACT 2002+ is an impact evaluation methodology developed in the Swiss Federal Technology Institute of Lausana (EPFL). The methodology combines average points and a damage approach. This method deals with categories impacts in four main groups: analysis of the destination; the use of the land; health human; and ecotoxicological impacts. The substances which result of the inventory analysis in the life cycle are grouped in similar impacts inside 14 environmental impacts categories. These categories converge to four environmental impacts. The IMPACT 2002+ methodology offers an attractive combined approach of average points and environmental indicator. In the methods that contemplate the LCA, the necessary characteristics for the methodology development for products evaluation are the capacity of the method in comparing similar products, the easy understanding of the generated data and the easy acquisition of information on the method. In accordance with this criterion, the methods Eco-Indicator 99 and EPS 2000 are most important, because its analysis reduce to a single indicator facilitating the comparison and the understanding of the data between studied products. Then, in table 1 a summary of the characteristics of these methods is presented that contemplate the LCA where they are compared according to some criterion, commented in this paragraph.

Table 1- Comparison of the methods that contemplate the LCA

Method ⇒ Criterion ⇓	CML	EDIP	Eco-indicator 99	EPS 2000	Impact 2002+
compare products	+	+	++	++	+
Easy understanding of the data generated	+	+	++	++	+
Easy acquisition of information on the method	+	+	++	+	+

(+)Fills the requirement partially; (++) Fills the requirement integrally

2.2. Methods that contemplate the environmental costs

Bibliography describes some methods used for environmental cost evaluation:

a) Total Cost Accounting - TCA;
b) Life Cycle Cost - LCC;
c) Full cost Accounting - FCA;
d) Life Cycle Environmental Cost Analysis - LCECA.

2.2.1. Total Costs Accounting (TCA)

The objective of the method is to provide a disciplined and organized approach to improve the make decision on the basis of the real costs experienced by the companies that can cause impacts in the society and the environment. The TCA can be described as a cost guided accounting method in the long term that reflects the reality of the environmental costs. These costs are not considered in the conventional methods described in the production costs. In this method the costs considered are less tangible. They are the future expenses as the cares with health and the expenses with the damages to the properties and the costs of responsibility are those referring to the acceptance of the company, the products as, for example, of the company image perceived by (EPA, 1995) the population.

2.2.2. Life Cycle Cost (LCC)

LCC aims, besides determining the costs in the company, to incorporate the costs related with all the phases of the product life cycle. In this method the habitual limits of accounting are exceeded, considering practical problems as the applicability of this information. One expects that the purchase price of the materials reflects in any way the costs that have occurred until the point of selling. To estimate the external costs is laborious and can not supply to much informative value, due to low quality and inconsistency of the information (ONU, 2001).

2.2.3. Full Cost Accounting (FCA)

The FCA considers an additional category of costs that TCA and LCC methods do not consider, that is, the social costs had related to the production, use and disposal. The method makes possible to incorporate in the process of company decision the environmental aspects, being capable to identify barriers and opportunity for the investments. Some of the objectives of the FCA are: to understand internal environmental costs better; to define, to quantify and where possible to reduce the external environmental impacts of its activities and to integrate the information of cost with the environmental impacts to help in the makedecision.

2.2.4. Life Cycle Environmental Cost Analysis (LCECA)

The LCECA is a tool used to interpret the results of a LCA in terms of environmental costs. Kumaran (2004) presents a list of environmental costs that aims identifying the practicable alternatives to elaborate an efficient final cost. The environmental costs developed are: effluent control; effluent treatment; residues discarding; implementation, operation and maintenance of the environmental management system; environmental taxes; rehabilitation; energy and reuse and recycling strategies. The method identifies the possible alternatives for effective costs and determines which product is friendlier environmentally. The LCECA can find the environmental costs in each stage of the product life cycle not being necessary the complete study of the LCA. In the methods that contemplate the environmental costs, the necessary characteristics for the methodology development for products evaluation are the capacity to analyze the products along the life cycle, low dependence of the information generated by the organizations and low necessity of computational resources. LCC method is the best one which fills these requirements and the summary of the analysis is in table 2.

Table 2 - Comparison of the methods that contemplate environmental costs

Method ⇒ Criterion ⇓	TCA	LCC	FCA	LCECA
Analyses along the life cycle of the product	+	++	+	++
Low dependence of the information generated by organizations	+	++	++	++
Low Computational necessity	++	++	++	+

(+) Fills the requirement partially; (++) Fills the requirement integrally

2.3. Methodology to evaluate the costs and the environmental impacts of manufactured products

Kotler and Armstrong (2003) define the organizational purchase process the identification, by the purchasers, of products and services that the organizations need to acquire and that, after that, find, evaluate and make its choices among suppliers and the diverse marks available. These same authors tell that in the purchases of products or services the involvement of many people exists during the decision process (figure 1). Each one has its particular desires and intentions. These personal yearnings can influence the acquisition process. The evaluation methodology has as main objective to choose amongst the bought products the ones that have less environmental impacts. This procedure prevents that the parameter of comparison among products takes into account economic aspect only. This project has environmental character and tells that the central objective of the environment studies is to prevent that a project, justifiable under the economic point of view, results tragic or catastrophic for the environment. Then, to minimize the future problems with products acquired in the present time, this evaluation methodology of materials aims to choose environmental products that have less impacts and costs amongst the offered ones in the market without personal interferences in the process.

The considered model, figure 2, aims preventing the unnecessary personal interactions, replacing the informality for a methodical process. This consists of replacing the common influencers for technician influencers formed by the product engineering that is responsible for the detailed products and services specification and by the manufacture engineering that is responsible for the processes evaluation of the suppliers during the life cycle of the products to be acquired.

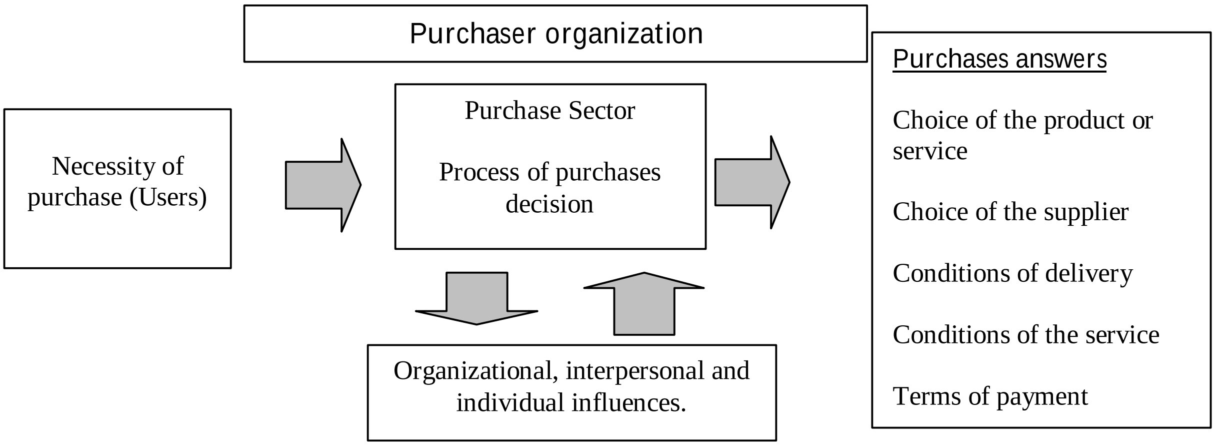

Figure 1 - Macro model of organizational behavior of purchases (Adapted KOTLER; ARMSTRONG, 2003)

The product specification is situated in the basic routine of purchases. In the methodology proposal for the evaluation of materials, figures 2 and 3, are created a stage for products specification to formalize the necessity to possess technical values in substitution of the informal values and not technical. Moreover, in the suppliers election stage an internal phase of environmental evaluation of the supplied products is created.

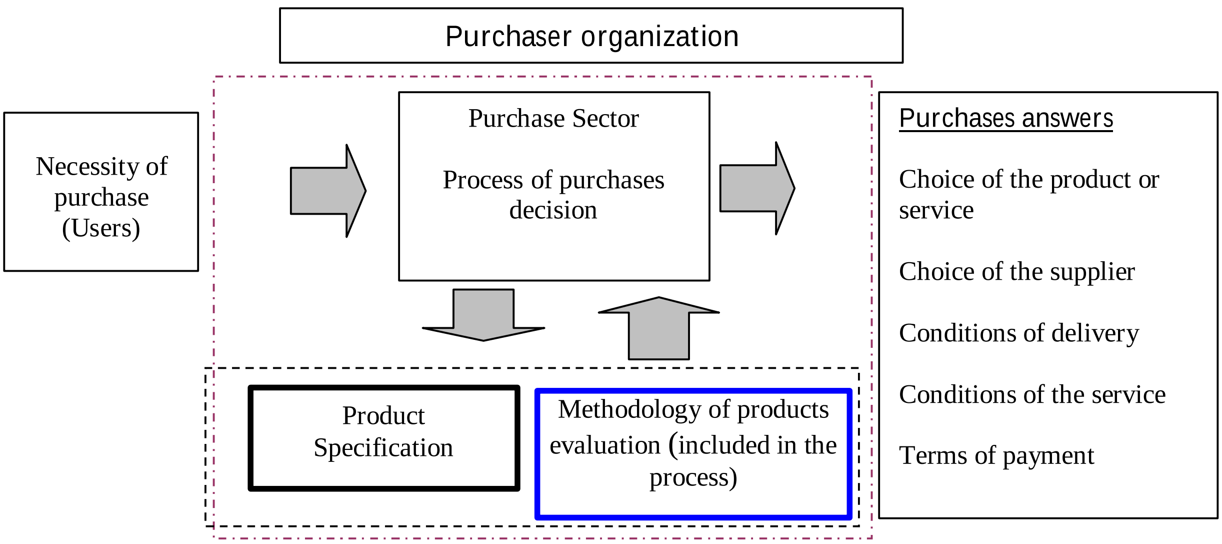

Figure 2 – Macro model of organizational behavior of purchases (Adapted KOTLER; ARMSTRONG, 2003)

Figure details the stages of the proposal methodology. The first stage of this methodology is the products analysis of the possible suppliers. The products of these suppliers must have relevance and significance for the environmental process. In the second stage the objective and the target are defined (first stage of the LCA). The introduction of the study limits is important in this stage. These limits will have to be the same for all the analysis. Stage three is the elaboration of the inventory in the life cycle (second stage of the LCA) that it can be searched in the existing database or be acquired in other compatible bases. Stage four is divided in two phases: 4(a) it is the analysis of environmental impact using a quantitative method by means standardized scores for substance or process (third stage of the LCA) and

4(b) it is the qualitative evaluation of environmental costs using indicators of material cost, energy, water and transport. The phase 4(b) doesn't belong to the LCA, however it uses the data of the inventory as information for the cost indicators development. In the fifth stage occurs results interpretation and comparison that consist of the resultant indicators (4a and 4b) analysis. The results are the punctuations of the analyzed products. The approval term is a spread sheet which contains the punctuation by means of indicators of the products analyzed for the methodology. The LCA in this case that is called simplified, because contains the definition of the objective and target, the inventory and the valuation of the impacts, but exclude the phases of classification and characterization of the environmental impact (BITENCOURT, 2001), therefore, ready scores from EPS2000 and EI99 methods are used. After the document issue, return to the common flow of purchases.

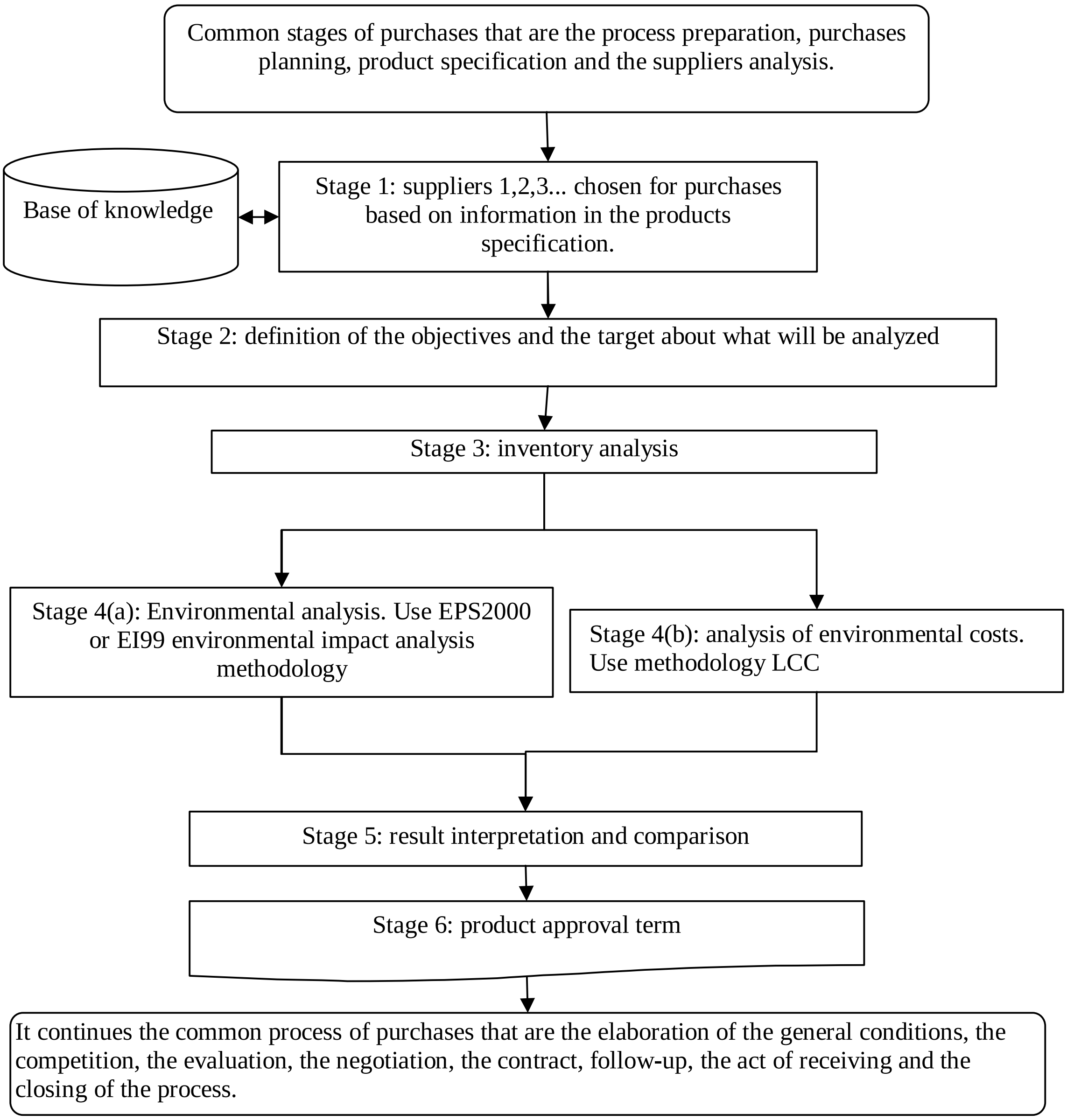

Figure 3 - Methodology to evaluate the costs and the environmental impacts of manufactured products (Developed by the author)

2.4. Case Analysis

A case analysis was developed, using the cost and environmental impact methodology to a ¾" metal ball valve and a ¾" PVC ball valve. Both have similar function and representative application in the industries. The environmental analysis found by the inventory was compared with Eco-indicator 99.

In EI 99, the standard indicator is a value that shows the total environmental impact in the process or manufacture phase, use and disposal. Due to its low values, the transports and the packing was disrespected. In this study case, standard indicator had used base data of eco - indicator 99 (2005). For situations as zamac, brass and bronze, there aren't values in the database, so had been used the composites values as, for example, the brass in which was considered 60% of copper and 40% of zinc, making the addition.

Table 3 - Metal valve Analyses by Eco-Indicator 99

Part Denomination	Quantities	Mass Kg (A)	Material	Score mPt/kg (B)	Result mPt (A)x(B)
Manufacture					
Body	1	1,63E-1	Bronze	1430	233,09
Handspike	1	8,63E-2	Zamac	3103,20	267,81
Cover	1	7,01E-2	Bronze	1430	100,24
Ring	1	3,90E-3	Brass	2120	8,27
Bolt	1	1,67E-2	Brass	2120	35,40
Sphere	1	5,29E-2	Brass	2120	112,15
Disposal					
Valve		0,2331	Bronze	-70	-16,32
		0,0735	Brass	-70	-5,14
		0,1122	Zamac	-70	-7,85
				Total	727,65

Table 4 - PVC valve Analyses by Eco-Indicator 99

Part Denomination	Quantities	Mass Kg	Material	Score mPt/kg	Result mPt
Manufacture					
Body	1	7,50E-2	PVC	270	20,20
Handspike	1	1,98E-2	PVC	270	5,35
Cover	1	1,87E-2	PVC	270	5,05
Ring	1	2,27E-2	PVC	270	6,13
Bolt	1	6,73E-3	PVC	270	1,82
Sphere	1	1,90E-2	PVC	270	5,13
External ring	1	7,40E-3	PVC	270	2,00
Disposal					
Valve	1	1,693E-3	PVC	2,8	0,47
				Total	46,15

In the EPS 2000, the indicator is one score that shows the environmental impact of the substance. To calculate the environmental impact of the valves we have to multiply values to LCA analysis with standard score. These values are gotten in STEEN, 1999. The LCA analyzes was developed for PVC e metal valves. Those Total Parameter in LCA emissions analysis was found in the bibliography and estimate data.

Table 5 – LCA metal valve and analysis with EPS 2000

Parameter	Unit	Parameter Total	Standart Score EPS2000	Result
IN				
Coal	kg	9,59E-02	4,98E-02	4,78E-03
Lead	kg	5,95E-07	1,75E+02	1,04E-04
Cobalto	kg	5,30E-13	2,56E+02	1,36E-10
Chromium	kg	3,84E-07	8,49E+01	3,26E-05
Tin	kg	7,68E-09	1,19E+03	9,14E-06
Natural gas	kg	6,74E-02	1,10E+00	7,41E-02
Magnesium	kg	1,47E-07	0,00E+00	0,00E+00
Molybdenum	kg	5,85E-13	2,12E+04	1,24E-08
Niquel	kg	2,19E-07	1,60E+06	3,50E-01
Palladium	kg	5,71E-13	7,43E+06	4,24E-06
Oil	kg	1,10E+00	5,06E-01	5,56E-01
Platinum	kg	6,49E-13	7,43E+06	4,83E-06
Silver	kg	1,38E-08	5,40E+04	7,45E-04
Rhenium	kg	5,95E-13	7,46E+06	4,44E-06
Rodium	kg	6,09E-13	4,95E+07	3,01E-05
Zinc	kg	1,12E-01	5,71E+01	6,41E+00
OUT EMISSION TO AIR				
HFC-134a	kg	3,82E-07	1,44E+02	5,51E-05
HCFC-22	kg	1,44E-08	1,94E+02	2,79E-06
CFC-13	kg	1,43E-08	1,39E+03	1,99E-05
CFC-12	kg	3,11E-07	1,04E+03	3,24E-04
Acetone	kg	4,73E-07	1,46E+00	6,90E-07
Buteno	kg	2,69E-09	2,58E+00	6,94E-09
Cadmium	kg	1,50E-05	1,02E+01	1,53E-04
Acetaldehyde	kg	4,06E-08	2,11E+00	8,57E-08
CFC-11	kg	4,38E-09	5,41E+02	2,37E-06
Propene	kg	7,31E-11	2,64E+00	1,93E-10
Ethan	kg	1,01E-07	1,95E+00	1,96E-07
Methanol	kg	2,90E-08	1,44E+00	4,17E-08
Chromium	kg	4,02E-07	2,00E+01	8,04E-06
Mercur	kg	9,96E-09	6,14E+01	6,12E-07
Toluene	kg	2,79E-09	1,95E+00	5,44E-09
As	kg	2,13E-07	9,53E+01	2,03E-05
Methane, 5-chlorine-, CFC-10	kg	1,15E-08	9,70E+02	1,12E-05
Xileno	kg	7,85E-11	2,17E+00	1,70E-10
Ethene	kg	3,68E-06	1,46E+00	5,37E-06
HCl	kg	3,89E-09	2,13E+00	8,28E-09
Butane	kg	1,00E-08	2,14E+00	2,14E-08
Ammonia	kg	2,45E-05	1,96E+00	4,79E-05
Propane	kg	6,94E-04	2,24E+00	1,56E-03
Pentane	kg	3,47E-09	2,25E+00	7,81E-09
CFC-114	kg	3,96E+00	1,11E+03	4,39E+03
1,3 Butadiene	kg	1,95E-01	1,07E+01	2,09E+00
Lead	kg	8,28E-11	2,91E+03	2,41E-07
Benzene	kg	1,60E-10	3,65E+00	5,85E-10
hydrogen sulfide	kg	6,76E-09	4,96E+00	3,35E-08
Methane	kg	3,75E-07	2,72E+00	1,02E-06
sulphur Oxides	kg	-7,38E-22	3,31E-01	-2,44E-22
Óxidos de enxofre	kg	2,26E-09	3,27E+00	7,38E-09
Nitrogen Oxides	kg	6,97E-10	3,83E+01	2,67E-08
PM 10	kg	2,87E-08	3,60E+01	1,03E-06
PAH	kg	9,60E-08	6,43E+04	6,17E-03
NMVOC	kg	8,95E-03	2,14E+00	1,92E-02
Carbon dioxide	kg	2,95E-07	1,08E-01	3,19E-08
sulphur Dioxide	kg	1,36E-07	3,27E+00	4,44E-07
OUT EMISSION TO WATER				
BDO	kg	3,80E-08	2,01E-03	7,64E-11
COD	kg	2,02E-06	1,01E-03	2,04E-09
Match not specified	kg	1,30E-10	5,50E-02	7,16E-12
Mercur	kg	4,80E-10	1,80E+02	8,64E-08
Total nitrogen	kg	3,26E-07	-3,81E-01	-1,24E-07
OUT SOLID RESIDUE				
Cadmium	kg	1,25E-11	5,00E+00	6,24E-11
			Total	4,40E+03

Table 6 – LCA - PVC valve and analysis with EPS 2000

PARAMETER	UNIT	PARAMETER TOTAL	SCORE STANDART EPS2000	RESULT
IN				
Coal	kg	9,62E-03	4,98E-02	4,79E-04
Oil	kg	1,16E-01	5,06E-01	5,89E-02
Natural gas	kg	6,68E-03	1,10E+00	7,34E-03
Uranian	kg	1,35E-07	1,19E+03	1,61E-04
OUT EMISSION TO AIR				
Ammonia	kg	6,37E-09	1,96E+00	1,25E-08
Chlorine Fluorine Carbon	kg	8,99E-07	9,70E+02	8,72E-04
Methane	kg	4,06E-04	2,72E+00	1,10E-03
Carbon Monoxide	kg	2,24E-04	3,31E-01	7,41E-05
Carbon Dioxide	kg	3,11E+00	1,08E-01	3,36E-01
PM 10	kg	1,32E-04	3,60E-01	4,76E-05
hydrogen sulfide	kg	1,69E-09	4,96E+00	8,39E-09
sulfuric acid	kg	3,13E-07	2,13E+00	6,66E-07
mercury	kg	1,09E-06	6,14E+01	6,71E-05
Metal	kg	3,77E-08	NC	
Mertimercaptana	kg	1,20E-07	NC	
Nitrous oxide	kg	8,28E-06	3,83E+01	3,17E-04
Nitrogen oxides	kg	1,28E-03	2,13E+00	2,72E-03
Sulphur oxides	kg	4,15E-04	3,27E+00	1,36E-03
Sulphur dioxide	kg	4,23E-04	3,27E+00	1,38E-03
Volatile Organic Composites (VOC)	kg	6,52E-07	6,43E+04	4,19E-02
NMVOC	kg	7,43E-04	2,14E+00	1,59E-03
OUT EMISSION TO WATER				
BDO	kg	7,96E-05	2,12E-03	1,69E-07
COD	kg	7,52E-05	1,01E-03	7,59E-08
Nitrogen composites	kg	3,38E-10	-3,81E-01	-1,29E-10
Mercur	kg	2,02E-09	1,80E+02	3,63E-07
Ammonia	kg	1,00E-06	-3,81E-01	-3,81E-07
			Total	4,54E-01

Four environmental costs indicators was developed by using the inventory (Total Parameter) in the table 5 and 6:

a) Water cost;
b) Energy cost;
c) Transport cost;
d) Main raw material cost.

The result of this environmental, that is, the sum the four indicators above, is in the table 7, as well as the LCA analysis result with EPS 2000 and Eco-indicator analysis. The table 7 demonstrates the environmental performance of the metal and PVC valves. We cam see that values of the PVC value are much better than the values of the metal valve. Then PVC valves, in this analysis, produce lower environmental impact compared with metal valve.

Table 7 Environmental Performance

Method	Metal valve	PVC valve
EPS 2000 (ELU)	4,40E+3	4,54E-1
EI99 (mPt)	727,6600	46,1500
Environmental Cost (U$)	7,6265	4,7346

This analysis was enough to verify the proposal methodology (figure 3). It's suitable for sectors which acquire materials that demand technical data to decide purchase.

For the purchase sectors, this quantitative analysis is enough. The objective is to evaluate which product is the best according to environmental aspect.

Finally, the comparison between environmental cost in table 7 shows that the metal valve process has higher impact. This fact occurred because the processes to manufacture these values use more natural resources. It's related to the amount of pollutants emission, which cam be verified in tables 5e 6.

Applying this methodology the companies will get benefits in the long term. The scarcity of natural resources is inevitable, so this methodology can become the companies prepared to face these difficulties in the future.

Moreover, Brazilian companies frequently are not worried in giving final destination to its products. In the future, worrying and giving final destination to the products will common, adding new costs to the products, what today the acquisition model does not contemplate.

The proposal methodology fills these requirements anticipating necessities that probably will happen.

3. REFERENCES

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5. RESPONSIBILITY NOTICE

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