Environmental Management System at the Department of Production Engineering: Implementation and Maintenance

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Abstract

The adoption of environmental policies in organizations is no longer an option. Increasingly, society demands control activities in both private and public companies. Education institutions are listed as a reference model for environmental awareness, since they are opinion makers and vocational. Hence, the Department of Production Engineering (DPE) developed a study to implement an Environmental Management System in order to obtain certification of internal spaces granted by the Coordination of Environmental Management (CEM). In the business plan model was conducted a survey to identify its Environmental Aspects and Impacts (SEAI), which includes six steps: identification of potential causes, calculation of the Index of Environmental Risk Assessment (IER), prioritization of recommended actions, elaboration of action plans; implementation of action plans, and review of potential causes. All areas of the DPE were verified, identified the causes associated with potential environmental impacts, and were listed recommended actions. To perform the calculation of the IER, were evaluated the Environmental Impact Severity (S), the index of the cause of Occurrence (O), the degree of Detection (D), and Ease of Implementation of Recommended Action (E), which follow a scale of one to ten. The score was performed by a multifunctional group. After, was prioritized the actions, creating a Pareto chart. Thus, one can check the actions that contribute most to the reduction of total IER and generate an action plan. With this detailed material, made possible the launch of the Environmental Management DPE

Keywords: environmental management system; environmental certification.

1 Introduction

The Environmental Management (EM) identifies ways to minimize problems for the environment, according to Dias (2008). The entry of this concept in business planning has been showing a trend, and - more than that - a competitive necessity. The correct rationing of natural resources generates (creates) an image enhancement of the institutions that adhere to this pro-environmental polity. Andreoli (2002) states that, in addition to reducing waste disposal costs, the development of clean and cheap technology, as material recycling, is not just principles of EM, but a matter of business survival.

Buchholz (1992) describes sustainability as a trend to the strategic interests in organizational, looking for opportunities, internal and external development. Sanches (2000) presents two standpoints of the study: The environment as a basis for business or development of ideas. In this sense, the adoption of EM arises as a differentiating criterion between institutions.

This idea is reinforced by Corrêa (2006), when he points out the complacency of higher education institutions with ecological awareness. For him, the EM's initiatives should come from there, because it is there that most of the professionals develops, manages, teaches, makes research, and influences the society and the organizations.

The *Universidade Federal do Rio Grande do Sul* (UFRGS) leads since 2007, through its Coordination of Environmental Management (CEM), the identification and assessment of impacts and environmental aspects in their various environments. In parallel with this scenario, the University is preparing to meet the requirements for obtaining environmental licensing. To this end, it established its Environmental Policy,

which "is committed to continually improving its environmental performance by adopting procedures and practices aimed at preventing negative environmental impacts, in accordance with legal requirements, generating alternatives that foster community sustainability university and the whole society "(CEM, 2010).

The survey of negative environmental impacts is being conducted in some departments in different units of UFRGS, initiated by the CEM. However, the DPE, aware of the importance of this movement, with proactivity, sought to adapt itself to the precepts of environmental management. This way, the purpose of this work is the implementation of Environmental Management System (EMS) in DPE environments.

Among the expected results, there may be mentioned the mapping of impacts on the spaces of the DPE as well as identifying the major causes of these impacts. Also it is expected to begin the planning of actions to reduce impacts. These results and the guarantee of continuity to the cycle of improvements proposed will contribute, in the near future, to obtain certification of their physical spaces, and to strengthening of the environmental culture of the Department. Major outcomes expected include the project idea disseminated in other universities worldwide.

The work is divided into six sections, where the problematic of the research is introduced initially. In the second section, it is possible to find the theory associated with environmental management systems and environmental certification. The third section contains the methodological procedures that form the basis for practical application described in section four. The partial results obtained are in section five and finally, in section six, the final thoughts on the method, the results obtained and the next steps are presented.

2 Environmental management systems and environmental certification

An EMS relates the workability of one environment with the proper use of natural resources available. Giordano (2000) states that the EMS is the item of the general structure of a company that observes the impact that their products, services and operations have on the environment, considering the time may be short, medium and long term.

According to NBR ISO 14001:2004, "EMS is part of a management system of an organization used to develop and to implement its environmental policy and manage its environmental aspects" (ABNT, 2004, p.2). Carlos et al. (2004) warns, however, that because of the standard is not mandatory, following set guidelines for their participation, the non compliance with the requirements of NBR ISO 14001 can leave the image of the organization battered with institutional damage that can lead to economic losses.

The Certification of UFRGS's Physical Space, developed by CEM, follows the design of other types of certifications, however, is focused on the university environment. This concern arises in counter to the idea that environmental precautions apply only to industries, since it is an erroneous thought and may contribute to the perpetuation of environmental disregard by Higher Education Institutions (HEI). As Tabanez and Padua (1998), environmental education provides the increases of knowledge, attention to values and improvement of skills that foster greater integration of people with the environment. Vaz (2008, p. 9) concludes that "higher education institutions are poorly explored and restricted in relation to its environmental management."

How shows Brandli and Tauchen (2006), the *Universidade do Vale do Rio dos Sinos* (UNISINOS), which developed the project Green Campus in 1996, is the most important example of the Brazilian universities. It was the first university in Latin America to be certified according to NBR ISO 14001. With the certification, it was found that the most significant environmental impact was the consumption of water and electricity. Currently, the 'Positive Power' program is underway, aiming to educate the academic community to power saving, searching for a new attitude toward the rational use this feature. (UNISINOS, 2010).

Ribeiro et al. (2005, p.5) shows the existence of three barriers within the University regarding the conduct of an EMS: "the lack of information about sustainable practices in society, a not to value the environment

for several employees of the organization and society, as well as the university community in general do not perceive the university as a potential source of pollution." Ribeiro et al. (2005, p.2) point out also that "the leading role assumed by the Higher Education Institutions in the process of technological development, preparing students and providing information and knowledge can and should be used also to build development of a sustainable and just society. "

Campani et al. (2006) identified after surveying some negative environmental impacts in university environments, that some potential causes of environmental aspects are common to multiple locations, thus the actions to be taken to reduce the impact can be replicated in different environments. Always with the focus on the larger goal of environmental management that must be the "constant search for improving the environmental quality of services, products and work environment in any public or private organization" (Campani et al., 2006, p. 1 .)

3 Methodological Procedures

To carry out the project, with focus on achieving environmental certification on future, we used the method of Survey of Environmental Aspects and Impacts - SEAI developed by Campani et al (2007). This method is divided into six steps detailed in the flowchart of Figure 1.

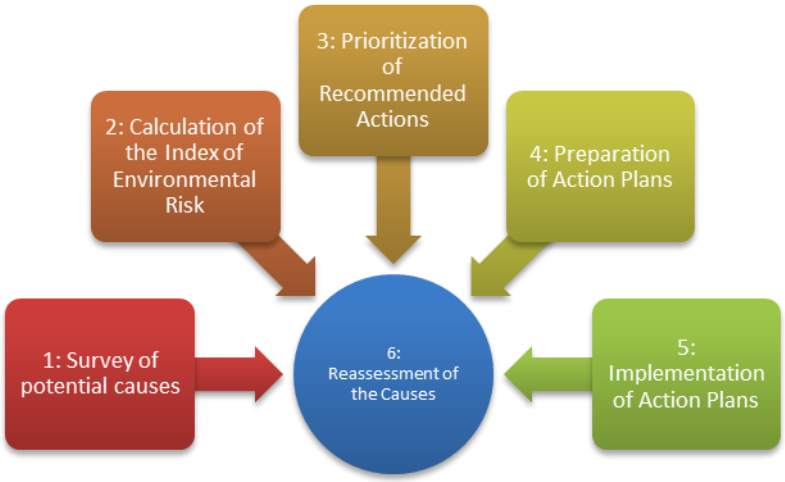

FIGURE 1: Methodology of research: Source: author (2012)

Step 1 - Survey of Potential Causes is developed initially by mapping of the existing environments to be evaluated. In this step, are identified the basic potential causes associated with each environment, and quantified items that leverage it. For each potential cause identified is associated its impact and the environmental aspect, in addition to identifying the current form of control of the cause and possible recommended actions.

In Step 2 - Calculating the Index of Environmental Risk (IER) for each of the causes identified are applied four spreadsheet to evaluate the SEAI, that given in the following index: levels of criticality: Severity of the Environmental Impact Assessment (S) Occurrence Index (O) Level of Detection (D), and Ease of Implementation of Recommended Action (E).

The four tables follow a scale rating of 10 discrete points (1-10) wherein the lower limit position is less impact on the environment and on exceeding worst case. These tables follow the logic of the evaluation tool used in the Analysis of Failure Mode and Effects Analysis (FMEA). The following is the definition of each of the boundaries of those ranges, and its description.

Figure 2 presents the evaluation of Environmental Impact Severity (S). It can be observed that the value 1 represents a cause that generates poor visibility in the system, while the upper limit, value of 10, the cause generates serious risks to the environment and to persons in the vicinity of the company.

Value	Description
1	It will hardly be visible.
2	Too low to cause any impact.
3	Low but may cause impact to the environment in the long term.
4	Non-compliance with the Environmental Management Policy of the Company. Low or very low impact on the environment.
5	Non-compliance with legal and regulatory requirements. Low potential for loss to the environment.
6	Non-compliance with legal and regulatory requirements. Moderate potential for harm to the environment.
7	Only impact the health of the people directly involved with the task.
8	Serious damage to the health of people directly involved with the task, with low impact to the environment.
9	Serious damage to the health of people directly involved with the task, with a moderate impact on the environment.
10	Serious risks to the environment and health of people outside the company.

FIGURE 2: Scale assesses the severity of environmental impact (S). Source: Campani et al. (2007)

The Density Index (O) is detailed in Figure 3. This index measures the frequency of occurrence of the cause of the negative impact. In its lower limit, the value 1 represents a cause of the unlikely event, where it was not observed in period greater than the reference. In the upper limit value of 10, a constant occurrence is observed, and the cause arises where the task is executed.

Figure 4 contains the third evaluation to be conducted - Level of Detection (D). The value represents a question that which has its rapid detection and it is possible to apply a quick solution. In the limit 10, is one cause, probably, without control, because it is difficult to detect it and solve it.

Figure 5 shows the limits in terms of Ease of Implementation of Recommended Action (E), which classifies how easy or how difficult the detection / solution of the question, as well as their level of control. For that, we evaluated the costs associated with the improvement / elimination of the cause, depending on the availability of technology, the number of people involved in the implementation of the action, together with the time needed to deploy it.

The calculation of the IER, according to Dulac et at. (2009, p. 5), results from the "multiplication of the values of four levels of criticality: Severity, Occurrence, Detection and Facility, which are assigned for each recommended action" to reduce / eliminate the causes of environmental impact on the environment. Equation (1) calculating the details IER.

Value	Description	
1	unlikely	There was no occurrence in time greater than the reference.
2	Remote	Occurred once in the period, but it is unlikely a recurrence.
3	very Low	Occurred once in the period, and may occur again.
4	low	Occurred twice in the period of observation.
5	medium Low	Occurred three times during the observation period.
6	average	Occurred four times during the observation period.
7	medium High	Occurred five times during the observation period.
8	high	There was six times during the observation period.
9	very High	Large likely to occur each time the task performed.
10	always	Occurs when you perform the task.

FIGURE 3 - Scale of assessment of rate of occurrence of the facts (O). Source: Campani et al. (2007)

$$IER_{\text{Recommended Action } i} = Si \times Hi \times Di \times Ei$$

where: i = $IER_{\text{Recommended Action}}$ = Environmental Risk Index Recommended Action i
Si = Environmental Impact Severity i
Hi = Index of Occurrence Cause i
Di = Level of Detection Method of Control i
Ei = Ease of Implementation of Recommended Action i

EQUATION 1 - Calculation of the Environmental Risk Recommended Action

Value	Description
1	Rapid detection and rapid resolution.
2	Rapid detection and medium-term solution.
3	Detection and medium-term quick fix.
4	Rapid detection and long-term solution.
5	Sensing the medium term and medium-term solution.
6	Detection and long-term quick fix.
7	Sensing the medium term and long-term solution.
8	Detecting long-term and medium-term solution.
9	Detection long-term and long-term solution.
10	Without detection and / or unresolved. (No control)

FIGURE 4 - Evaluation scale the level of Detection (D). Source: Campani et al. (2007)

value	Description		
	cost	Nº of people	Time
1	There is technology cost of the same or impractical.		
2	high	all	high
3	high	Only concerned with the task	high
4	high	all	low
5	high	Only concerned with the task	low
6	low	all	high
7	low	Only concerned with the task	high
8	low	all	low
9	low	Only concerned with the task	low
10	Low cost or cost benefit of immediate feedback.		

FIGURE 5 - Scale Evaluation of Ease of implementation of recommended action (F). Source: Campani et al. (2007)

With the completion of the calculation of the IERs of the recommended actions is possible to calculate the Total Index of Environmental Risk (TIER) of the environments that are being evaluated. The calculation is the sum of all IERs obtained. The TIER serves as a reference for the next time it is run the system again. Who is running the SEAI for the first time is considered that is holding its 'ground zero' in the environmental management system.

In Step 3 - Prioritization of Recommended Actions, based on the values obtained in the IERs, each recommended action must be organized from largest to smallest (following the logic of Pareto). After this ordering, identify which are the recommended actions that should be prioritised within the environmental management is clearer.

In Step 4 - Preparation of Action Plans, based on the priority actions recommended in step 3, action plans are developed. It is suggested to use the tool 5W2H for detailing these plans, since it allows, among other things, the definition of responsible persons, of the execution time and costs that will assist the next step.

In Step 5 - Implementation of Action Plans - is carried out the operation of the planned actions in the previous step, focusing on the adequacy of physical spaces with lower generation of environmental impact.

In Step 6 - Review of Potential Causes, are measured results obtained with the implementation of actions and recalculated the scores of actions (IER and TIER). This step aims at maintaining the continuity and the results achieved, and the next rounds of the method must improve, within the philosophy *Kaysen*

4 Method of Application of Waiver of Environmental Aspects and Impacts in a department of UFRGS

This section discusses the case study conducted on DPE for the conduct of the first activities of the environmental management system to be deployed and maintained in the department.

4.1 Surveys of potential causes of environmental aspects and impacts of dependencies DPE

After the decision making for the implementation of the EMS Department, occurred the formation of the project team, which was trained by the CEM for the conduct of the stages of SEAI and facilitate the survey of environmental aspects and impacts. Initially it was presented the spreadsheet containing a list of potential causes of aspects / impacts common to the types of activities in a university. The team had to identify potential causes for each environment DPE.

This stage of the work started in December 23, 2009, was completed in three shifts, to survey the structure of two laboratories (LOPP and LASTRAN macro-area with three offices and 16), five classrooms (four in the fifth floor and other two on the 6th floor of Building Engineering), 3 baths, amphitheater, office, meeting room, office design, computer support and living space-as seen in the plant department, in Figure 6.

FIGURE 6 - Sketch of the plant used for the analysis.

4.2 Calculation of the Index of Environmental Risk (IER)

The calculation of the Index of Environmental Risk (IER) follows the logic Analysis of Failure Modes and Effects Analysis (FMEA). Turrioni and Andrade (2000) point out the logic of FMEA as a simple and consistent aid in raising the importance of environmental aspects and impacts. Campani et al. (2007), based on studies by Andrade (2000) in the USP, adapted the standard tool for to be adopted by the University as an official instrument of implementation of EMS in physical spaces. For the treatment of data collected DPE, each potential cause had investigated his situation, to determine if there was any control or indicator on it. Thus, the recommended actions could be defined for each potential cause.

The following, the severity levels of each index are defined, for to can calculate the IER of each recommended action: Severity of Impact (S); Cause of Occurrence (O); Degree Detection (D), and Ease of Recommended Action Implementations (E). Table 1 contains a partial example of identification of potential causes, environmental aspects and impacts, as well as the final score (IER) of four recommended actions.

Moreover, the sum of all IERs is the TIER of the department, being an indicator for the success of EMS compared several cycles of application of the methodology.

TABLE 1 - Example of calculation of the IER

Environmental aspect	Environmental Impact	G	Potential cause	O	Current Form of Control	D	Recommended Action	F	IER
Generation of waste	Atmospheric contamination	9	Disposal of fluorescent bulbs (600 bulbs)	10	no	10	Control lamps for routing of City Hall	10	9000
	Depletion of Landfill	5	Inconsistency with the selective collection	10	The UFRGS has a rule regarding selective collection	10	Disseminate selective collection system at UFRGS as Ordinance No. 3450 - 15/09/2008	10	5000
		5		10		10	Adapt selective collection system as Ordinance No. 3450 - 15/09/2008	10	5000

It should be noted further, that the TIER is a local indicator management, and should not be used as an example in an analysis of benchmarking of management system. The most appropriate indicator could be associated with reduction in the percentage of TIER, every new step done.

4.3 Prioritization of Recommended Actions

The definition of priority actions recommended came of the generation of a bar graph ordered from highest to lowest (Pareto logic) with the IER values of each action. The ordering allows the identification of the recommended actions have greater urgency and / or require less resources to be operationalized.

After the complete filling of the SEAI's spreadsheet, sought to validate the activities carried out with the CEM, since it was the first round of the system with the DPE (ground zero) and, furthermore, there was not total domination of the tool until that moment. The graphic part of the priorities of the DPE must be found in Figure 7.

4.4 Preparation of the Plan of Action

The action plan format contains 5W2H the planning of actions responding to 'what will be done?', 'Who is responsible?', 'When will the action?', 'Where the action will take place?', 'Why is this action important?',' How the action will be developed? 'and' how much action? '. Each recommended action in SEAI was described as much detail as possible, and different responsibilities can be set for each stage of development of an action.

Steps 5 and 6, the implementation of action plans and review of potential causes, respectively, have not yet started by the group. The following are the results so far.

5 Partial results Found

Listed below are the partial results of the project.

Ação Recomendada	IER
Control lamps for routing of City Hall	9000
Forward sheet material to be disposed to DEPATRI	7000
Discard sheet material is not as selective collection	7000
Develop plan for cleaning the fans	7000
Request to City Hall campus installation of mirrors in decision	7000
Optimization of the internal spaces of cabinets / shelves	7000
Dispose of materials and organization of the cupboards / shelves personal	7000
Adopt campaign against smoking developed by CGA	7000
Purchasing cabinets for material suitability archivable	6300
Control for disposal and / or refill ink cartridges	6000
Disseminate selective collection system at UFRGS as Ordinance No. 3450 - 15/09/2008	5000
Adapt selective collection system as Ordinance No. 3450 - 15/09/2008	5000
Control for disposal and / or refill toners	4800
Take control of cleaning of curtains	4480

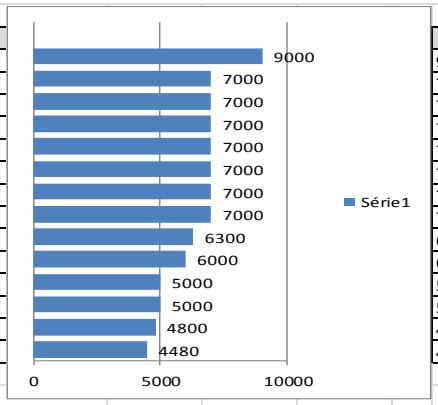

FIGURE 7 - Graph of the priority actions recommended DPE

5.1 Identification of Environmental Aspects and Impacts of DPE and Documents Generated

After collecting the data and definition of potential causes, was found the following environmental aspects: water consumption, electricity consumption, use of physical space and furniture, waste generation, material consumption and air quality. Associated with these aspects, there are the environmental impacts: air pollution, depletion of landfill, soil contamination, impairment of health of users, physical obstruction and impairment of natural resources. This activity is the basis for future decision making on the EMS to be implemented in the Department.

Order in FMEA	IER	MEASURE	PROCEDURE	RESPONSIBLE	TERM	LOCAL	REASON	BUDGET
		(What?)	(How?)	(Who?)	(When?)	(Where?)	(Why?)	(How?)
1	9000	Control lamps for routing of City Hall	Map the current state of control of lamps	team LOPP		DEPROT	Avoid incorrect disposal and air pollution	
			Establish routine monitoring	cleaning				
			Document to generate control input and output of lamp	team LOPP				
2	7000	Develop plan for cleaning the fans	Establish routine cleaning of fans	cleaning		room 500	Minimizing health risk to users by improving air quality	
			Create a label that is placed behind the door, to be written down from a monthly cleaning.	team LOPP				
			Register by completing the cleaning table: "Air quality".	cleaning				

FIGURE 8 - Action plan for two recommended actions

After completion of this activity was organized documents identifying where and what are the environmental aspects and impacts in the different physical environments of the Department. Six documents were developed, which grouped the causes identified in relation to its appearance in DPE environments. The document entitled General has the potential causes that manifest themselves in all environments, on the other hand, the documents entitled Amphitheatre 500, Laboratories, Rooms 502-508-510-515, Hall Laboratories, Hall classrooms and living room, contains a breakdown of causes that can only be expressed specifically in these environments. From these documents were 34 proposals recommended actions.

5.2 Identification of Priority Recommended Actions

The following is a brief description of the four main actions recommended for DPE

5.1.1 Control lamps for routing of the City University

This recommended action was that more scored, his IER was 9000 points, being very close to the limit is 10000.

Fluorescent lamps have received special attention in the project. "The phosphor powder, which represents 2% of the total mass of a fluorescent lamp, contains mercury and cadmium" (JUNIOR; WINDMÖLLER, 2008, p.3). The atmospheric contamination for that item is significant. In DPE, is estimated that six hundred fluorescent bulbs are in use. The monthly consumption could not be measured at the time of the current project, however, is already implemented a control. The control of the routing of these items to the City University will continue the following activities: mapping the current situation, establishment of routine monitoring, and document generation input and output of lamps in DPE.

5.1.2 Development Plan to improve air quality

By staying somewhat masked, the problems with air quality are hard to find. In this project, is planned unite all the recommended actions regarding this matter: prepare plan for cleaning the fans, drawing up

the plan for cleaning air conditioning filters, air conditioning's systematic preventive control and cleaning. With the creation of spreadsheet's 'Air Quality', seeks to generate documentation and control of these actions. In classrooms and laboratories, the use of air conditioners is intense. Therefore, this measure represents a gain in quality of life for all members of the department almost immediately.

5.1.3 Adoption of Selective Collection System

The DPE, from the beginning, was concerned with the environmental aspects. However, many actions were being erroneously performed. This action should take place in partnership between the Department, the company outsourced provider of cleaning services and supply room of the School of Engineering. It is proposed, the adoption of selective collection system according to Ordinance No. 3450 - 15/09/2008, establishing segregation at source of solid waste, with indicating's colors , in addition to training and awareness of contractors, and ensure that there is no shortage of garbage bags in the colors of the collection.

5.2 Plans of action

As described above, were deployed action plans for each of the 34 recommended actions. Each of these contains a number of procedures needed to achieve them (details of 'how'). Were detailed, approximately 71 procedures to meet all the recommended actions.

6 Conclusion

Below, we present the conclusions about the method, the partial results found and the next steps planned for the project.

6.1 Conclusions about the method

During development activities, difficulties in the management of spreadsheets were used frequently. The advice provided by CEM was instrumental in assigning scores coherent SEAI. It was observed that the understanding of the criteria is necessary for the continued application of the method and obtain valid comparisons of cycles performed.

Already, in the application of 5W2H, an opportunity was identified for improvement. The reorganization of the spreadsheet along the lines of 5W2H Ferreira (1996) was added and suggested for activities to the CEM. The change was based on a criterion of better visualization of demands relating them directly to your charge. So far, however, the change was not incorporated into the work pattern of the CEM.

6.2 Conclusions on the results

Brandli and Tauchen (2006) have control of consumption and reuse of water and waste management program as the two most actions undertaken in the 42 Institutions Higher Education (IHE) that they surveyed.

The work presents on DPE the same care with such actions, and numerous others contained in 5W2H developed. In a free comparison in relation to activities undertaken by international and IHE results, we conclude that the achievement of the activities recommended by the method adopted reverberate both in image and in socio-environmental Department's responsibility, since the actions being thought include donations of recyclable materials to ONGs that generate income for low-income population from the separation and packaging of waste for recycling.

6.3 Next Steps

While future activities of the work can be cited: awareness of the academic community DPE and Management School of Engineering; completion of the action plans of the recommended actions;

planning activities to strengthen the culture of environmental management in the Department, implementation of action plans, and then reassessing the scene of the Department in relation to potential causes, targeting, where the reduction of the TIER.

This study represents the key to the success of the EMS, to the extent that only with the participation of all stakeholders, the Department objectives are met.

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