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Full Length Research Paper

Creating an environmental management system in a school community

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This study laid the ground work for an environmental management system in the context of public schools in Brazil. The impact analysis of a selected school showed a population of 1924 students, 175 staff and 40 auxiliary personnel, water consumption of 3131 m^3/year, energy consumption of 46.1 Mwh/year, solid waste production of 8.1 tons/year, average noise level around the premises of 65 db, total school area of 6936.5 m^2, water permeable area of 2841 m^2 and impermeable area of 4095.5 m^2. The analysis evolved into the definition of permanent responsibilities of staff members to create and maintain the management system.

Keywords: Environmental impact of schools, environmental management system in schools, practical environmental education.

INTRODUCTION

Environmental impact analysis is a common management tool in enterprises of the production and service sectors. Its application in the public school context has not been reported upon, but environmental education practices exist in a variety of forms. The classical handbook by Rau and Wooten (1980) guides enterprises and professionals in the execution of environmental impact analysis. Morrow and Rondinelli (2002) provide evidence of the positive results that can be achieved by companies who obtain ISO 14001 certification. A search for references to the school context revealed that as early as 2004, the International Organization for Standardization (ISO) launched the Kid's ISO 14000 Program with the declared objectives to develop environmental awareness among children, to teach them to implement environmental management in homes and communities and to open them to the value of networking with young people in other schools (ISO 2004). The program was developed in Japan and has since spread to many other countries. By 2009 an estimated 210000 children worldwide had participated and achieved a 70000 ton reduction of CO_2 emissions.

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Reports from 2005 relate efforts to involve school children in Cambodia to protect the architectural, historical and cultural site of Angkor from deterioration by tourism (ISO 2005).

The ISO 14001 certifiable norm itself details the procedure for any enterprise or community to implement an Environmental Management System (EMS) and apply for certification (ISO 14001). Thousands of enterprises worldwide have been certified. Moretti et al., (2008) elaborate on the advantages of certification. They show by practical examples that the certification can assist the enterprise in attaining its objectives. The importance of environmental education in the school context is described by Mamede and Leite (1999), but the treatment remains general. No specific procedures for environmental impact analysis or possible certification are given.

The present study concerned itself with the novel idea of inducing a school community to establish an EMS and possibly seek certification as a pioneering experience in the Brazilian school universe. It went beyond simple environmental education by measuring and quantifying the impacts a school exerts on its neighborhood and on the municipal environment generally. This type of impact is not usually known by students. Its quantification is a first step toward creating environmental consciousness. From the analysis, proposals were elaborated for the

Number of students:	1924
(distributed into three groups: morning, afternoon and evening)	
Number of staff	175
Number of auxiliary personnel	40
Water consumption	3131 m^3
Electrical energy consumption	46.1 Mwh
(of which 13.3 Mwh for illumination)	
Solid waste produced	8.1 tons
Total ground area occupied	6936.5 m^2
Water permeable area	2841.0 m^2
Water impermeable area	4095.5 m^2
Number of town sectors where students reside	91
Mean noise intensity on sidewalks around the premises	65 db
Mean noise intensity in school yard and lecture rooms	76 db
Number of trees of all sizes on school premises	214

Figure 1. Summary of environmental situation of school, year 2007

school community as a whole to work towards reducing the impacts with specific physical and temporal targets in mind.

The implementation and continuous operation of an EMS is a long-term effort that has to be supported by staff members. Students can at best contribute their temporary share during their period of school attendance. Consequently, the proposal defined the responsibilities in the ISO 14000 line of reasoning, namely assignments to specific parts of the community without identifying the persons who temporarily compose those parts. This translated into a management system where e.g. the reduction of energy consumption is the responsibility of the physics teachers and the maintenance of vegetation isles on the premises is the responsibility of successive classes of grade 10 students. The inherent hypothesis stated that once those general responsibilities are routinely attended to with the corresponding result reporting, the EMS can be considered functional.

METHODS

The specific school chosen for the test was a public school in the municipality of Uberlândia MG, which provides primary and secondary instruction from grades one to twelve. The idea that permeated the study was to create a precedent of an environmental impact analysis to be imitated elsewhere within the school universe.

The analysis contemplated the topics of solid waste with respect to characteristics, quantity produced and destination, drinking water, storm water, energy consumption, soil available for rain water infiltration, existing vegetation on the premises, traffic congestion related to student circulation and noise levels.

Data were collected by direct measurements, from school archives and personal observations. The municipal utility companies for water and energy supplied the consumption patterns of the school within the last five years. On the premises, the daily water consumption was obtained from five hydrometers by comparing the readings of successive days. The energy consumption with illumination was calculated from the number of light bulbs, which were counted, their power ratings and observed time of use. Similarly, the power consumption of appliances was calculated by identifying the power ratings of the appliances and noting their respective time of use. The noise level around the school was measured with decibel-meters. The solid waste produced was inspected, weighed and assigned to destinations different from the landfill.

The study measured the ground area of the school as water permeable and impermeable by physically determining the extension of built and open spaces, and determined the capacity of rain water collection from roofs by multiplying the roof area by the precipitation rate. The existing vegetation on the school premises was identified according to species and their adequacy for this environment.

From the data collected, an EMS was proposed with temporal and physical targets as well as assignment of responsibilities.

RESULTS AND DISCUSSION

A summary of the diagnosis for the year 2007 is presented in Figure 1.

Those results will be elaborated on now.

Water consumption

The five hydrometers installed on the premises indicated a total water consumption of 3131 m^3 for the year 2007. The following water uses were identified: lavatories, drinking fountains, school canteen and house cleaning. Of those, only drinking fountains and canteen require potable water. The consumption reduced to 5.6 liters per working day per person as compared to 140 liters per day per person in city residences. The data underlined the fact that any person consumes water in different places during the day to compose his or her total consumption.

Rain water collection

Data were obtained on permeable and impermeable ground area of the school complex and on regional precipitation. The total area was 6936.5 m^2, of which 2841.0 m^2 (41%) were water permeable and 4095.5 m^2 (59%) were constructed. The roof area available for rain water capture was 2540,3 m^2 or 62% of the constructed area. It remained to sum up the water permeable ground area (41%) and the constructed area (59%) covered by roofs (62%). As a result, (41+59*0.62)=77.6% of all rainfall on the premises may be absorbed or captured, and only 22.4% needs to be directed to the storm water sewer. This of course presupposes the installation of capture, collection and distribution equipment.

From available precipitation data in the region (City of Uberlândia 2008), the average monthly precipitation of the last 47 years was extracted. It is shown in Figure 2.

No attempt was made to use annual averages. As the year is clearly divided into a dry and a rainy season, yearly averages have only theoretical value. The annual water consumption for 2007 was found to be 3131m^3 as per Figure 1. As a first estimate, the rainfall during the wet season (October to March), if captured, would provide the yearly consumption in the school as follows:

$$2540.3 m^2 * (0.112+0.2111+0.3082+0.2882+0.1895+0.1766) m = 3266 m^3.$$

This value is in accordance with the measured consumption of 3131 m^3 within an error of 4.3%. A rain water reservoir of 25*25*2.50=1566 m^3, if full at the end of March, would be sufficient to attend to the consumption during the dry season (April to September), as it would provide 50% of yearly consumption.

Lavatories and housecleaning activities can use collected rain water, but separate piping would have to be installed. The return on this investment by reducing water demand on the public utility was proposed as part of the tasks to be tackled by teachers and students, but the basic advantages of rain water capture are evident.

Energy consumption

The energy consumption was determined from the count and power rating of all points of use and compared to the bill from the energy utility. The main item of consumption was related to illumination, which accounted for 29% of the bill. There were a total of 423 light bulbs, of which 224 would be turned on during the whole school day of 13 hours and 199 would only be turned on during evening classes of 4 hours. Other significant points of use were computing equipment (26%), freezers and refrigerators in the canteen (20%) and copying machines (20%). The remaining 5% were related to minor points of consumption. The appliance and bulb count yielded 3.647 Mwh for one particular month of measurement, and the utility bill average of the last year came to 3.840 Mwh/month or 46.1 Mwh/year.

Vegetation coverage

There were various isles of vegetation on the school premises, but none of them received gardening attention. The study identified two areas with dense and healthy vegetation, two areas with irregular and neglected vegetation and three bare areas without vegetation. The plant count for all isles yielded the following result: diameter above 2.5 cm = 6, diameter between 2.0 and 2.5 cm = 2, diameter between 1.5 and 2.0 cm = 5, diameter between 1.0 and 1.5 cm = 3, diameter between 0.5 and 1.0 cm = 26, diameter below 0.5 cm = 172 for a total plant count of 214.

Solid waste

The average waste production in the school was measured to be 45 kg/day with the following composition: dry recyclable material 51%, biodegradable material 36% and refuse 13%. With 20 lecture days per month and 9 lecture months per year, this amounts to 8.1 tons/year. Considering that 2139 people frequent the school every day, the waste production reduced to 21 grams per person per day. As was the case with water consumption, this amount is an addition to the 1000 grams per person per day of residential waste generation. It illustrates the fact that people produce waste in different locations during the day according to their activities.

Traffic and Transportation

Two aspects were diagnosed under this topic, namely noise level and traffic congestion. The legally accepted noise levels depend on the designated usage of town

month		
January	precipitation mm	288.2
February		189.5
March		176.6
April		61.4
May		35.9
June		6.8
July		1.2
August		4.1
September		31.7
October		112.0
November		211.1
December		308.2

Figure 2. Precipitation (mm) average monthly in the region (last 47 years)

Table 1. Noise levels measured according to location and time of occurrence error of measurement 3%

Location	Time Interval	Prevailing Activity in the School During the Time Interval	Noise Level DB
east sidewalk	3:00 – 3:25 pm	Classes	66.5
	3:30 – 3:45 pm	recreation	68.8
south sidewalk	6:20 – 6:30 pm	students leaving	67.0
west	high wall, no sidewalk		
north sidewalk	6:50 – 7:30 am	students arriving	64.8
	3:30 – 3:45 pm	recreation	68.9
	4:00 – 4:10 pm	classes	66.3
school yard	9:30 – 10:15 am	recreation	76.2

sectors. The admissible intensity is 55 db for residential areas and 65 db for mixed residential and commercial areas. For office environments the recommended maximum noise level is 45 db (ABNT 1997). The school is located in an area defined as mixed residential and commercial. The measured levels are shown in Table 1.

Generally the diagnosis did not identify any legal transgressions or obvious risks to the community and its surroundings arising from noise. The measured values reflect noise inside and outside the school. The eastern boundary of the school is a main avenue with heavy traffic all day. The levels of 66.3 and 66.5 measured on the sidewalks during class hours originate from street traffic, but are within the error of measurement of the admitted level of 65 db. During recreation periods, the noise in the school yard adds an extra 2.3 and 2.6 db to that from the streets. These are critical moments that need attention, because even with the error of measurement they are above 65 db, although the school is not responsible for traffic noise on the streets. The problem area was identified as the morning recreation period inside the school yard where the noise level rises to 76.2 db. The difference between measured levels on the sidewalks and in the yard was ascribed to the distance from source to probe. The higher level existing in the yard is not perceived outside the premises.

As for traffic congestion, it occurred close to the two gates during arrival and departure of students. They occupy the north and south sidewalks as they are dropped off and picked up. This type of congestion is the rule for Brazilian schools and is restricted to short time intervals, in the case at hand between 7:00 and 7:30 am and 6:00 and 6:30 pm.

A possible management system

In consequence of the impact analysis, the authors proposed to the school administrators, the participative development of an environmental management system (EMS) within approximately one year by assigning specific tasks to all segments of the school community with physical and temporal targets and demands for result reporting. The proposal indicated the formation of teams consisting of teachers and groups of students for carrying out each task. The tasks initially contemplated were the following:

Task A: Professional gardening.
Scope: Conserve existing vegetation and add appropriate new species of local origin to the school area available for gardening, ponder about the importance of vegetation for green house gas capture.
Time line: two years.
Responsible persons: biology teachers and grade 4 students.
Progress indicator: number of areas promoted to the state of satisfactory vegetation and maintained there over one year.
Task B: Solid waste management.
Scope: Establish best practice handling procedures for all waste and compare to production at home.
Time line: one year.
Responsible persons: chemistry teachers and grade 5 students.
Progress indicator: reduction of percentage of waste taken to landfill.
Task C: Water management.
Scope: Monitor monthly water consumption, identify points of irresponsible use and compare to consumption at home.
Time line: one year.
Responsible persons: arts teachers and grade 6 students.
Progress indicator: monthly reduction of utility bill.
Task D: Rain water capture and use.
Scope: determine to what extent rain water could be collected and used.
Time line: one year.
Responsible persons: mathematics teachers and grade 9 students.
Progress indicator: knowledge acquisition on the subject.
Task E: Energy management.
Scope: monitor energy consumption and identify unnecessary uses, compare with consumption at home.
Time line: one year.
Responsible persons: language teachers and grade 10 students.
Progress indicator: monthly reduction of utility bill.
Task F: Stimuli for innovation.
Scope: continuously search the media for innovative ideas and procedures to reduce environmental impacts in all areas of interest to the school.
Time line: indefinite.
Responsible persons: literature teachers and grade 12 students.
Progress indicator: number of selected ideas realistically applicable in the school.
Task G: Legal scriptures.
Scope: identify and disseminate all environmental laws and requirements applicable to the school and check the compliance.
Time line: indefinite.
Responsible persons: social science teachers and grade 11 students
Progress indicator: number of scriptures identified.
Task H: Traffic organization.
Scope: monitor the movement of vehicles bringing and taking students and establish procedures for reducing congestion.
Time line: indefinite.
Responsible persons: history teachers and grade 7 students.
Progress indicator: velocity of vehicle movement at the gates.
Task I: Noise control.
Scope: monitor the noise levels inside and outside the school complex and determine the contribution of the school community to overall noise.
Responsible persons: physics teachers and grade 8 students.
Time line: one year
Progress indicator: separation of school noise and traffic noise.
Task J: Documentation of progress.
Scope: Require regular progress reports from all groups and provide feedback.
Responsible persons: school administration.
Time line: indefinite.
Progress indicator: Regularity of reports produced and improvements obtained.

CONCLUSIONS

The physical interaction of the chosen school with the municipal infrastructure was dimensioned. The impact analysis was a pioneering experiment in the Brazilian school context. It represented the starting point for devising the environmental management system.

The consumption pattern of water and energy and the production of solid waste in the school were quantified.

The morning recreation period was identified to generate the highest noise level.

A proposal was elaborated to construct an environmental management system for the school within one year and with the participation of teachers and students.

The responsibility for progress was placed on staff, which is the permanent sector of the community.

Student involvement in the system represents an extracurricular learning tool.

The task of gardening will transmit notions on esthetics, ecology and utility of vegetation for mitigation of climate change.

The tasks of solid waste management will raise the idea of comparing generation per person in the school and in students' residences and will take the message to the families.

The tasks of water and energy management will confront students with the need to check utility bills.

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