



Towards a design for ecological management and product sustainability – European and Brazilian approaches

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ABSTRACT

Purpose: The purpose of this paper is to compare the European and Brazilian approaches employed on the design for ecological management & product sustainability based both on the Polish and the Brazilian experiences on this field. to provide practice for environmental management on management of the design manufacturing activities.

Design/methodology/approach: This work aims to present and compare two major EMS - Environmental Management Systems: The system ISO 14001 and the EMAS - Eco-Management & Audit Scheme.

Findings: According to the principles of environmental management systems, continuous improvement is necessary for all processes and technology companies wishing to implement the EMS.

Practical implications: The implementation of environmental management systems (ISO 14001 when both EMAS) provides a number of benefits to organizations, such as maximizing the efficient use of resources, waste reduction, demonstration of good corporate image, environmental awareness of employees, gains in understanding the impacts, environmental impacts of business activities and increased profitability through improved environmental performance.

Originality/value: The paper presents the analysis of environmental management concept in two different cultural and economic systems.

Keywords: Sustainability; Ecology; Design; Management

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MATERIALS MANUFACTURING AND PROCESSING

1. Introduction

This work aims to present and to compare two major EMS - Environmental Management Systems: The system ISO 14001 and the EMAS - Eco-Management & Audit Scheme, established by European Union countries. Although these systems share a common goal, to provide expertise for environmental management, there are differences between them. Currently, EMAS can be seen as a refinement of the ISO 14001 concepts, because its application seeks continuous improvements, through modernization of processes, focusing on environmental protection. Among the benefits of implementing EMAS are: increased efficiency in resource utilization reduced waste, improved corporate image, the development of environmental awareness among employees, a better understanding of the environmental impacts of business activities and improved environmental performance.

One of the most strategic targets of the European Union (EU) it is to make the community more dynamic and competitive, as well as to continue as a knowledge-based economy. In order to achieve these ideals, the EU seeks to more actively engage in economic, social and environmental development. From an environmental standpoint, this implies the need to clearly separate the concepts of environmental degradation and level of economic growth by introducing rules for sustainable production and consumption, protection and management of resources [1]. One of the mechanisms towards this is EMAS - Eco-Management and Audit Scheme [2].

The first conceptions of environmental management systems date back to the 1980s. Since then, these ideas have been developed. The main common goal of the current environmental management systems is to achieve a continuous reduction of the impacts of human activities on the environment. As an example of the formalized environmental management system, it can be mentioned that they need to meet the ISO 14001 [3].

The European Union, taking into account the guidelines of Agenda 21, introduced EMAS - Eco-Management and Audit Scheme in 1993. The proposal was a voluntary system for the industries of the countries that wanted to work actively to reduce the negative influences on the environment [4]. In 2001, we carried out a review of EMAS and made modifications in order to extend its range of application [5]. Today, ISO 14001 and EMAS are the two most important standards in the field of environmental management and should retain this feature for many years [6-7]. Thanks to these Environmental Management Systems (EMS - Environmental Management Systems), organizations could consistently organize their strategic actions for environmental protection. Through the review and modernization of technological processes, in accordance with the requirements of the EMS, a design for ecological management & product sustainability is obtained by the reduction or complete elimination of negative environmental impacts, thus enabling an improvement in the activities at the various organizations employing it [8-9].

2. EMS conforming to requirements of the ISO 14001 text format

In 1992, after the success of ISO 9001 in relation to quality management, the organization created the ISO Technical

Committee TC 207, whose aim was to provide an initial proposal of what the international standards for environmental management would be. The first series of standards ISO 14000 (ISO 14001, ISO 14004, ISO 14010, ISO 14011 and ISO 14012) were published in late 1996.

In Brazil, the Brazilian Committee of Environmental Management - ABNT / CB-38 was created, supported by the ABNT (Brazilian Association of Technical Standards), whose structure was similar to the ISO TC 207 committee, and this first Brazilian version of the ISO 14000 was also published in 1996. The first revision of ISO 14001 was introduced on November 15th 2004, being adopted in Brazil in the same year by ISO 14001:2004. The standard ISO 14001:2004 specifies the requirements regarding the environmental management system. This approach enables organizations to work and to introduce policies and goals taking into account current legislation and other requirements that affect them, as well as information on significant environmental aspects. The standard addresses these environmental issues, providing who identifies it and who oversees the environmental influences?

The following changes were implemented in the EMS & ISO 14001 [3,10]:

- Definition: harmonized with ISO 9001:2008;
- General requirements: scope (limits) of the EMS must be clearly identified;
- Planning: EMS policy needs to be communicated to employees on behalf of the organization;
- Implementation and operation: enhanced competency requirements for persons working on behalf of the organization and method for external communication of relevant environmental aspects;
- Verification: documented procedure is no longer required for operational monitoring and measurements; new emphasis on assessing compliance with legislation and other requirements and meeting requirements for records storage;
- Management Review: input and output requirements added;
- Annex A: Annex A has been enhanced to include cross reference to ISO 14004:2004 and ISO 19011:2002;
- General destination: it can be applied to any type of organization;
- Proactivity: the new standard tends to prevent harmful influences to the environment through the expectation of the risk of environmental damage;
- Development: the effects of improvements in environmental activities are its goal;
- Voluntary Appearance: requirements become valid when the standard is received;
- Base systems, supported by documentation procedures.

The benefits of adopting ISO 14001 [7] can be mentioned to reduce labour costs through improved efficiency in the use of raw materials and energy consumption, decreasing the amount of waste, the replacement of raw materials with others without deterioration in the final product, the optimization of raw materials, selection of materials and products, increasing the efficiency of the infrastructure used, the preparation process of storage, packaging and transport of materials and waste reduction, eliminating costs and payments related to the use of the environment.

Other benefits regard the compliance with legal requirements related to environmental protection through waste

management, improvement of competitiveness through environmental awareness, reduction of environmental risks through their identification and preparation prior to threats, preventing the emergence of these threats, meeting customers' requests, improving the assessment together with the environmental protection services and better insight into the development of society, and increased engagement by employees.

3. European ecological management and audit system (EMAS)

The member countries of the European Union must meet the regulations of the European Parliament and Council, called EMAS (n. 761/2001 of the European Parliament and from March 19th 2001), which rules on the voluntary participation by the various organizations in the management system and environmental audit of the European community. This is the most important European Union statutory act as regards the sphere of environmental protection. This regulation applies to all organizational units, although not specifically aimed at industrial enterprises, but also all kinds of public institutions, schools, associations, etc. [11-13].

To be EMAS certified, the organization must meet the following conditions [12]: meet the requirements of environmental protection law, start the environmental management system described in Annex I of the EMAS Regulation, carry out regular environmental audits and present environmental statements, as required by environmental auditors under certain time limits set by regulations.

The implementation of environmental management and audit an organization is related [13] to the completion of environmental reviews in accordance with Annex VII of the EMAS regulation, and the introduction of an environmental management system fully compatible with the requirements of Annex I the requirements and related environmental management system. Added to this are environmental audits,

preparation of environmental statement and verification, recording and publication. For the Brazilian organizations that produce products for export to the zone of influence of the European Union, it is important to be aligned with these procedures in order to remain current and competitive with other organizations following these regulations.

4. Differences and similarities between ISO 14001 and EMAS

The EMAS current regulation includes the environmental management system according to ISO 14001 [11]. The structure of environmental management systems, compatible with both ISO 14001 and the EMAS Regulation is based on the model "PDCA - Plan, Do, Check and Act." This model leads to continual improvement through [14]:

- **Planning:** planning, including identifying environmental aspects and establishing goals;
- **Do:** implementation, including training and operational control;
- **Check:** Checking, including monitoring and corrective actions;
- **Act:** review, including monitoring of progress and actions to implement necessary changes to the EMS.

The EMAS is conducted similarly to the environmental management system, whose requirements are described in ISO 14001. However, some essential elements that occur in the EMAS Regulation and are not explicit in ISO 14001 are, for example, the requirement for publication of the environmental statement and the follow up / environmental review. Thus, the introduction of a system compatible with ISO 14001 is the first step for activities related to EMAS Regulation.

These systems take into account the results received, the registration and control of which are different for each organization. Similarities and differences between systems are presented in Tables 1 and 2.

Table 1.
Brazilian comparisons between the Ecological Management systems Adapted from [13-15]

Characteristic	EMAS	ISO 14001
<i>Type</i>	<i>Formal</i>	<i>Formal</i>
<i>Applicability</i>	<i>European Union</i>	<i>International Standard & Brazil</i>
Most important Requirements	Continuous Improvement in ecological management systems through BAT ("Best Available Techniques"	Continuous Improvement in ecological management systems through the achievement of environmental goals.
Evaluation of results	Validation by an accredited person indicated by an authority of an EU member state	Certification Auditor
confirming documents	Certificate confirming the participation in EMAS	Certificate issued and signed by an accredited branch of certification.
Register	Register at the European Union by the number of the concession.	There is no international register. In Brazil, the ISO standards are linked to the Brazilian Institute of Metrology - INMETRO.
Monitoring & Surveillance	Ecological Control and compliance with the laws of environmental protection carried out every 3 years.	Internal Auditors, Annual External auditors, certification renewed every 3 years.
Specification	Needs to publish environmental report addressed to public opinion	Possibility of fast introduction based on other ISO management systems

Table 2.
Comparisons between the Ecological Management systems Adapted from [13-15]

	EMAS	ISO/EN ISO 14001
Status	Under legal bases (EU Member States & EEA countries). Regulation of the European Parliament and the Council under public law	Under no legal bases. (International: worldwide) ISO standard under private law
Organisation	The entity to be registered shall not exceed the boundaries of the Member State, and it is intended to go towards the entities and sites	Does not go towards the entities or sites
Environmental policy	Includes commitment to continual improvement of environmental performance of the organisation	Does not include commitment to continual improvement of environmental performance but of the system performance
Initial environmental review	Compulsory preliminary review the first time the company sets its environmental status	Initial review is recommended, but not compulsory
Environmental aspects	Identification and evaluation of environmental aspects (direct & indirect). Establishment of criteria for assessing the significance of the environmental aspects	Requires only a procedure able to identify environmental aspects
Legal compliance	Compulsory demonstration. Requires full legal compliance. There is a compliance-audit	Only a commitment to comply with applicable legal requirements. There is no compliance-audit
External communication	Open dialogue with the public. Public Environmental Statement (validated for verifiers)	No open dialogue with the public. Only answering relevant communications from external interested parties is required. Control by the public is not possible
Continual improvement	Required annual improvement	Requires periodical improvement without a defined frequency
Management review	Is broader and requires an evaluation of the environmental performance of the organization, based on a performance-audit	Requires environmental performance in management, but not through a performance audit
Contractors and suppliers	Requires influence over contractors and suppliers	Relevant procedures are communicated to contractors and suppliers
Employees' involvement	Active involvement of employees and their representatives	No
Internal environmental auditing	Includes system-audit, a performance - audit (= evaluation of environmental performance) and an environmental compliance-audit (= determination of legal compliance)	Only Includes system audit against the requirements of the standard
Auditor	Requires the auditor's independence	Auditor's independence advised
Audits	Check for improvement of environmental performance. Frequency required: 3 years are verified at least once.	Environmental system performance check. No frequency required.
External verification	Accredited environmental verifiers	No
Verification/ Certification Scope	Verifiers accredited according to NACE codes	Certifiers accredited according to EAC code.
Authorities are informed	Compulsory validation by the Environmental Statement	Not compulsory
Logo	yes	yes

5. Role of EMS in search procedures for sustainable technology

The ISO 14001 and EMAS are general and universal, in order to enable its implementation and use in any organization. They are also proactive in that tend to prevent sustainability faults and ecological misunderstandings in products and processes through

studies and projections, looking for a voluntary progress based on the systems and procedures. The requirements of continuous improvement for environmental projects through the continuous reduction of the negative influences in the environment are common principles shared by all environmental management systems.

The EMAS Regulation and the ISO 14001 standard are formalized systems that lead to the creation of management

systems. They meet the requirements for improving the environment, but need not include its results in actions of preventive strategies for environmental protection. As a consequence, they lead to the creation of systems according to requirements set without necessarily applying the concepts of sustainable development.

Both systems allow and recommend the use of preventive environmental protection methods for reducing the use of resources and minimizing energy consumption and waste generation (or even elimination), all connected with the production process.

These recommendations related to reducing negative environmental impacts are the basis of a "sustainable technological process - STP." Under the definition of STP technologies are understood [15] aiming at the rational use of energy sources, and the use of renewable sources. Similarly, STP emphasizes the use of the minimum amount of resources per unit of product produced, giving priority to the use of renewable resources. Elimination of toxic chemicals that can cause damage to humans or the environment is also considered, as well as considerations of the life cycle of the product and its biodegradability and recyclability at the end of its projected life. Finally, we considered the elimination of the waste formation process and safety for employees of corporations, as well as to the people living close to corporations.

6. Technology acting to serve the environment

The automotive industry is a great 'consumer' of technology. Opportunistic by nature, in each new scientific discovery, it seeks an opportunity to create and to develop new products. One example is alternative fuel cell power generation. Its main appeal is the fact of generating clean electricity, with high efficiency and no need of recharge, as in conventional batteries.

The USA government estimates that by 2025, all vehicles running on the American roads will be economic hybrid vehicles, including a mix of electric and internal combustion engines. This is very important, as all these initiatives still needing to import more oil today than they did before. They consider that hybrid cars are an alternative solution that only prolongs the use of oil, extracted from non-renewable sources, but not a definitive solution.

Another device that reduces automobile emission levels is the catalytic converter. Installed in the exhaust system of the vehicle, this device has the purpose of treating toxic gases, prior to their release into the atmosphere. The catalytic converter metals are platinum, rhodium and ruthenium, all elements being rare and very expensive. Studies in nanotechnology with carbon nanotubes showed that it is possible to reduce the concentration of these elements and still increase the efficiency in reducing emissions. Since the Nano film promises to make the surface of the windshield hydrophobic and self-cleaning, it thus eliminates the traditional cleaners that are made of steel, rubber and plastic.

Some stickers contain magnetic nanoparticles which react when subjected to a thermal electromagnetic field, and this activates the adhesive properties. A major advantage is that the counterpart does not get very hot, the tools are simple, the process

is fast and spends little energy. Furthermore, it is a reversible process, i.e. when reheated, the glue is released (DFD - Design for Disassembly). It is believed that this may replace some bolt assemblies, also aesthetically undesirable, sometimes difficult to access with traditional screwdrivers.

Directing the activities towards an environmental management system is taken into account as a part of the document elaborated "National Environmental Policy (Strategy) for 2009-2012 with a view on 2016" (in Poland). The objectives of the implementation of the adopted environmental strategy mainly include:

- Promotion of ideas of environmental management systems and encourage the organization to join to EMAS,
- Creating public awareness of EMAS,
- Development of EMAS in the small business sector and public administration at local level.

Pro-environmental technological design must be a criterion as important as functionality and aesthetics, and perhaps more important to achieving customer satisfaction. Unless the client is not environmentally aware, the task of modern designers is to create products that can raise this awareness or convince people of their benefits. This is a disregarded area in the sphere of education of engineers and designers [18].

The implementation of EMAS is generally a consequence of the implementation of the strategy for Cleaner Production (CP) in the company or the environmental management system based on the ISO 14001 requirements. The consequence such an action is not the equivalent of the direct acquisition of EMAS registration by the company having implemented the CP strategy or meeting the ISO 14001 requirements.

In Poland, a number of different operators constitute the national register of EMAS, mostly for large companies. It inclines to undertake to transfer the problem associated with the environmental management to small and medium-sized companies.

There are nearly 50 organizations registered in EMAS Poland - A basic list of those organizations is available at the General Direct for Environmental Protection web page.

The certification based on ISO 14001 requirements is still the most popular model of certification in environmental management, required for many industries in their relationship with suppliers; it is still increasing in countries such as Great Britain, Italy and Spain.

The Polish Register of Cleaner Production and Responsible Entrepreneurship is the most important element of the Polish system of the Voluntary Environmental Commitment of cleaner production. The inclusion in the registry is the most important prize for participants of the system. This program has been conducted since 2002.

The certificates of the Polish Register of Cleaner Production and Responsible Entrepreneurship are awarded by the "Polish Cleaner Production" Association. 30 were granted it in 2013, 33 in 2012, 42 in 2011, and 41 in 2009.

It seems that looking for the requirements of environmental legislation is a kind of limiting concept. Analogously to schemes concerning quality, not only conservative adaptation to the subsequent requirements in the sphere of the environment should be obeyed, but also the importance of improved solutions should be stressed.

As an environmental strategy, EMAS requires enterprises to implement the activities increasing the technology innovation while meeting the legal requirements regarding the environment and cost. This is an attitude agreeing with sustainable design of technological processes, being an important area in technology management.

7. Conclusions

The implementation of environmental management systems (ISO 14001 when both EMAS) provides a number of benefits to organizations, such as maximizing the efficient use of resources, waste reduction, demonstration of good corporate image, environmental awareness of employees, gains in understanding the environmental impacts of business activities and increase in profitability through improved environmental performance.

Moreover, the formal environmental management systems ISO 14001 and EMAS help companies adopt the increasing number of requirements of environmental protection directed to sustainable development.

These benefits allow searching for sustainable technological processes not yet achieved in practice today.

According to the principles of environmental management systems, continuous improvement is necessary for all processes and technology companies wishing to implement the EMS, which should take these principles into account.

Technology management comprising environmental issues is associated with the implementation of concept design for the environment in enterprises, particularly when designing new technological processes or improving existing ones.

The activities undertaken in the field of technology management should include the aforementioned activities based on available management tools, such as FMEA directed to environmental aspects.

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