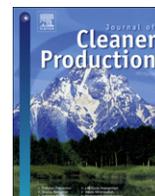




Contents lists available at SciVerse ScienceDirect

Journal of Cleaner Production

journal homepage: www.elsevier.com/locate/jclepro

Application of multi-criteria decision analysis in design of sustainable environmental management system framework



Nasrin R. Khalili*, Susanna Duecker

Stuart School of Business, Illinois Institute of Technology, 565 West Adams Street, Chicago, IL 60661, USA

ARTICLE INFO

Article history:

Received 27 February 2012

Received in revised form

12 September 2012

Accepted 30 October 2012

Available online 23 November 2012

Keywords:

Sustainability

Environmental management systems

Cleaner production

Multi criteria decision analysis

ABSTRACT

Proactive environmental management initiatives such as pollution prevention, cleaner production and sustainability are inherently multi-objective processes that require joint considerations of environmental, industrial, economic and social criteria in all stages of decision making. The success of such initiatives, however, depends on the solidity and the relevance of their strategic frameworks. This paper proposes strategic positioning of pollution prevention and clean production projects via design of a sustainable environmental management system (SEMS) that is responsive to regulatory requirements, and is relevant to industry culture and business structure. Built on the traditional and familiar environmental management system platform and the requirements of the multi-criteria decision making models ELECTRE III, the SEMS is capable of supporting design and implementation of defensible solutions to environmental problems industry face today according to sustainability criteria. The ELECTRE III model was selected as an integral part of the framework due to its ease of application, flexibility in design and selection of performance criteria, and capability to identify the best management solutions by giving an order of preference to multiple alternatives. The proposed SEMS framework is also in line with the Rio+20 sustainable development goals, objectives and guidelines that call for action and result-oriented strategies and institutional frameworks that could account for multiple stakeholders' key issues while suggesting environmental solutions according to the three dimensions of sustainable development. A case study that demonstrates the management of waste streams at a manufacturer of energy drinks and diet bars is provided to demonstrate how the SEMS can be designed and implemented.

© 2012 Elsevier Ltd. All rights reserved.

1. Introduction

The techniques used in environmental management have evolved over time. In the 1970s and 1980s the focus was on controlling significant pollution problems through regulation, standards, and assigning control mechanisms. The concept of Cleaner Production (CP) was introduced by the United Nation Environmental Programme (UNEP) Industry and Environment in 1989 as an integrated preventive environmental strategy with anticipated impact on reducing environmental and ecological risks (*via increasing eco-efficiency, conservation of raw materials and energy, elimination of toxic emissions, reducing negative impact of the product life cycle, and including environmental concerns into services-*

a sustainable consumption and production approach). The pollution prevention (P^2) programs and initiatives implemented in North America soon after followed the CP format focusing on reducing and/or eliminating waste at the source (*through modification of production processes, promotion of the use of non-toxic or less-toxic substances, implementation of conservation techniques, and re-use of materials rather than putting them into the waste streams*). Both the CP and P^2 initiatives offered design of continuous integrated preventative environmental strategies that could apply to processes, products, and services in order to increase the overall efficiency and reduce risks to humans and the environment (UNEP, 2001; Grutter and Egler, 2004).

The inclusion of economic and social criteria, and the need for the involvement of multiple stakeholders in strategic planning for environmental protection was initiated in the early 1990s and have resulted in the development of more proactive environmental management programs. These initiatives aimed at securing environmental and economic sustainability and emergence of voluntary and market-based programs that are growing in popularity today.

Abbreviations: Sustainable environmental management system, (SEMS); Environmental management system, (EMS); Multi-criteria decision analysis, (MCDA); Triple Bottom Line, (TBL); Accounting, Global reporting initiative, (GRI); Sustainability cost accounting, (SCA).

* Corresponding author. Tel.: +1 312 520 1768; fax: +1 312 906 6549.

E-mail address: khalili@iit.edu (N.R. Khalili).

To assist with the implementation of the CP/P² initiatives, in the mid 1990s the International Organization for Standardization proposed the ISO 14000 standards. In the United States, a similar approach was pursued and USEPA introduced design and implementation of environmental management systems (EMS) through which organizations could systematically assess, monitor, track and address their pollution, resource usage and impact on the environment (negative environmental externalities). These efforts were accompanied by a family of other environmental strategies and guidelines proposed by the European Commission, World Business Council for Sustainable Development, UNEP, other ISO standards (i.e. ISO 26000), Guidelines on Social Responsibility, Triple Bottom Line (TBL) Accounting, The Global Reporting Initiative (GRI), and the OECD guidelines for multinational enterprises) (Khalili, 2011).

The advantage of an environmental management system is that it can provide a consistent, yet customized approach to the design of environmental monitoring, regulatory compliance, pollution prevention, and design of clean production programs across the whole supply chain. The key steps presented in traditional EMS design include setting management goals and policy; creating an EMS team; characterizing operations; collecting and analyzing data; assessing environmental aspects of the operations and activities; developing solutions to address those aspects followed by their implementation, review, and modification, if and as needed.

Environmental management strategies today, however, are charged with design and implementation of integrated approaches that can ensure sustainability- that is, emphasizing the reduction of industrial pollution and its negative impacts on the environment, economy and society. It is no secret that today the concept and the application of sustainability have gained tremendous momentum from legislative, social, cost efficiency, and even business survival perspectives. A multitude of terms, techniques and frameworks have been developed and proposed to assist organizations with designing and pursuing their sustainability goals, objectives and initiatives. Understanding these various terminologies and how they fit together, however, can be overwhelming in and of itself, not to mention devising a viable strategy for pursuing sustainability.

The need for advancing CP/P² programs to include sustainability in organizations' strategic framework has been documented by many authors. As an example, Kjaerheim, 2005, suggested that the intangible benefits and human factors derived from clean production projects need to be addressed by investigating how current CP/P² models may be improved and how their concept can be expanded to more directly address sustainability concerns (i.e. impact of industry on human health, creating job opportunities, eradicating poverty, and improving safety) (Kjaerheim, 2005). If designed and implemented successfully, a sustainable CP/P² program should be able to address social, economic and environmental goals simultaneously and in a quantifiable manner.

Fig. 1 presents a simplified overview of the evolution of environmental management programs and the need for the development of an SEMS to assist with building sustainability projects within the existing environmental management initiatives such as those identified in the CP/P² programs.

In continuation of recent advances and efforts to include sustainability goals and objectives in environmental management strategies, this paper proposes a methodology for design of sustainable environmental management systems as a framework for materializing sustainability efforts in a comprehensive industry-specific manner. The proposed SEMS can be used to direct organizations' efforts toward designing products, formulating operations, and modeling their supply chain according to a well defined set of goals and performance criteria that are in agreement with the industry's perceived impacts on the social, economic, and environmental systems within which they are operating. As explained

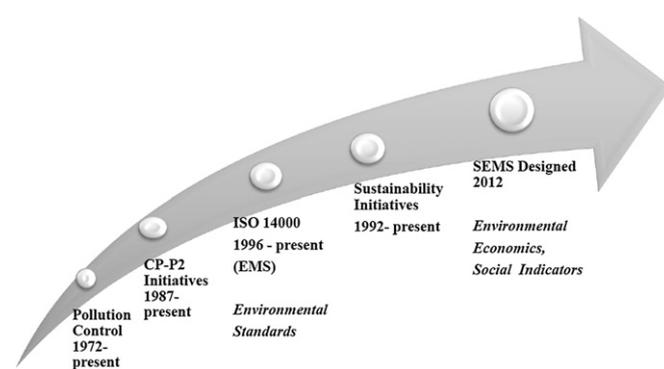


Fig. 1. Evolution of environmental management systems according to developmental goals and objectives.

in the following sections, the SEMS framework also includes guidelines for design of internal operational initiatives, and external collaborative efforts that support overall profitability while addressing sustainability at every institutional level.

2. Design of the sustainable environmental management system (SEMS)

This paper proposes a methodology for design of sustainable environmental management system (SEMS) frameworks to support sustainable operations and interdependencies among strategic, business, and manufacturing plans. It also responds to the growing need for utilizing decision-making guidelines that are specific to the management of environmental pollution in a sustainable manner.

The SEMS is a customized environmental management strategic planning tool for sustainability; it requires and directs development of specific economic, environmental, and social criteria in line with the organization's goals, and those of its internal and external stakeholders. The framework requires establishment of performance criteria and associated indicators to serve as input parameters to the decision-making model ELECTRE III. This model is selected because it has the capability of ranking and prioritizing environmental pollution prevention (or control) options according to their sustainability scores.

The SEMS framework is designed based on the familiar EMS platform; as such, it can be easily adopted, configured and customized to meet sustainability goals and objectives of organizations pursuing waste minimization, process optimization, or improvements in process efficiency and energy use. The SEMS can be also be used to develop environmental management solutions that are specific to and supportive of the organization's culture, business model and developmental goals. The similarities and differences of the EMS and SEMS frameworks are presented in Table 1a and b. As shown modifications to the EMS framework included:

- Changing the "EMS Team" structure, format, function, and responsibilities according to the requirements identified by the selected multi-criteria-decision-analysis (MCDA) model ELECTRE III that requires involvement of the principal decision makers (DMs), and multiple internal and external experts and stakeholders starting in the early stages of the SEMS design.
- Charging the SEMS team with responsibility to develop a set of performance criteria and associated indicators to assist with evaluating, and understanding the current state of the organization's performance, its strategic plan and direction, and the gap between the current and desired levels of performance

متن کامل مقاله

دریافت فوری ←

ISIArticles

مرجع مقالات تخصصی ایران

- ✓ امکان دانلود نسخه تمام متن مقالات انگلیسی
- ✓ امکان دانلود نسخه ترجمه شده مقالات
- ✓ پذیرش سفارش ترجمه تخصصی
- ✓ امکان جستجو در آرشیو جامعی از صدها موضوع و هزاران مقاله
- ✓ امکان دانلود رایگان ۲ صفحه اول هر مقاله
- ✓ امکان پرداخت اینترنتی با کلیه کارت های عضو شتاب
- ✓ دانلود فوری مقاله پس از پرداخت آنلاین
- ✓ پشتیبانی کامل خرید با بهره مندی از سیستم هوشمند رهگیری سفارشات