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The Use of Information and Communication Technology in Company Environmental Awareness Amplification

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Abstract: Our investigation of over one hundred Czech companies with a certified Environmental Management System (EMS) has identified ten main barriers to EMS implementation. They obstruct the adoption of EMS principles and decrease environmental awareness of internal interested parties. We have developed a modified holistic model of creating and overcoming barriers in EMS implementation and in its continuous improvement through being based on five basic pillars and five interconnected business processes. Related to this is the development of a prototype for a web-based information system that supports overcoming barriers in the process of EMS implementation. The prototype, using mainly Java technologies, assists companies to easily communicate and generate tailor-made EMS documents/records/reports with information specific to different target groups, in particular to internal interested parties. This enables the increase of their environmental awareness. This open source prototype has been tested in cooperation with ten Czech companies.

Keywords: EMS; environmental reporting; environmental awareness; information systems

1. INTRODUCTION

Many companies have implemented Environmental Management System (EMS) based on the international standard ISO 14001:1996 since 1996. The European standard EN ISO 14001:1996 constituted the EMS requirements of the Regulation (EC) No 761/2001 allowing voluntary participation by organizations in a Community eco-management and audit scheme (EMAS). The standard ISO 14001:1996 has been modified to the new standard ISO 14001:2004 in 2004 in order to improve the compatibility of ISO 14001 with ISO 9001 and to clarify the existing text of ISO 14001 without the addition of any further requirements. The Regulation (EC) No 196/2006 amending to Regulation (EC) No 761/2001 takes account of the EN ISO 14001:2004. These new EMS standards enable companies to formulate a policy and objectives while taking into account legal requirements and information about major significant environmental impacts. It does not state specific environmental performance criteria itself. This paper describes our investigation of the barriers that obstruct EMS implementation and decrease environmental awareness in selected Czech companies. We have developed a modified holistic model of creating and overcoming barriers

in EMS implementation (and its continuous improvement). The prototype of a web information system based on the above-mentioned model is presented. It enables the amplification of the environmental awareness among interested parties and supports an EMS implementation

2. INVESTIGATION OF BARRIERS IN EMS IMPLEMENTATION

2.1 Introduction

The research team consists of members from the Faculty of Economics of Technical University Ostrava, Masaryk University and University of Technology Brno and has investigated environmental awareness of employees (about one thousand informants) in more than hundred Czech companies, which have an implemented and certified EMS (with respect to standard ISO 14001) since 2000.

It has been found that the majority of informants agreed that there is insufficient environmental awareness on site despite previous environmental awareness training. Employees (internal interested parties) claim that while they generally have some awareness, they typically report that they cannot remember having had training. This suggests that

there was not a strong direct link between the EMS and what informants do on a day-to-day basis in terms of controlling environmental issues. Employee's unwillingness to participate in recycling initiatives is a common indicator of their insufficient environmental awareness, and this manifests in various guises. The research team interviewed a number of informants and found typical responses such as "not seeing the point of doing that" and "I would do it but others don't, so I don't see the point".

It was also observed that the EMS is indirectly promoted through strategic "information points" of company designated on site, mostly without appropriate ICT (80%). These "information points" contain the records/documents of environmental work, preventive actions and emergency procedures applicable to a particular area. Again, the researchers investigated how frequently employees refer to the "information points", and a random selection of employees responded thus: 68% of people interviewed answered "never", 22% answered "once out of curiosity" and 10% answered "for a particular reason."

Some consistency has been identified in terms of EMS documentation and record control which fosters a sense environmental awareness using ICT: Data aims to be centralized in one place (Central Repository); Procedures are concentrated in one manual (stored in a document database). They appear in a order, without necessarily reflecting the reality on the shop floor; Document control is monitored through an EMS system with ICT tools that keep track of the environmental procedures' distribution. At the bottom of each page of these documents, the environmental procedures state, at which "information points" a particular procedure should be distributed; The EMS manual as the central high-level source of information gives directions to procedures, pro forma documents and other related work procedures.

On the other hand, a certain inconsistency has also been identified in various aspects of the documentation system of many of the companies investigated: When keeping records, it is not always stated who is responsible for tracking particular paper work (32% of investigated companies); When monitoring certain parts of an EMS (e.g. waste recycling, machinery maintenance, incoming legislation), not all information can be found (data are not retrievable – 28% of investigated companies). For example, it is not clear when the next measurement inspection can be

expected and thus the records are kept more on a reactive basis than proactive or preventative basis; Essential information on utility bills is collected at a different site (documents at a different site), and this creates difficulties for other EMS team members to view environmental cost of the production (78% of investigated companies). Moreover, important documents like site visit reports, and the minutes of management review meetings are not stored at designated points; There is no specification of the level of detail on which activities, tasks and their monitoring should be documented (56% of investigated companies), rather, it is left to common sense; Since there a sense of ownership of particular aspects of the EMS prevails between the EMS team, the location of information is not always communicated to other members of team. This was found to be the case in 34% of the companies investigated.

The document review of investigated companies also revealed a number of recurring issues identified through non-conformities. The nature of non-conformity issues was identified as: Management related issues (12%); Documentation related issues (23%); Records and monitoring issues (22%); Communication related issues (15%); Housekeeping issues (18%); and Training issues (10%).

2.2 Model of creating/overcoming barriers in EMS

Ten main barriers have been identified [Balzarova, 2005], [Hřebíček, Kokrment, 2005] from the analysis of non-conformity issues. These barriers obstruct the adoption of EMS principles and decrease environmental awareness: *Insufficient or not properly identified benefits from EMS; Lack of consistent EMS data; Complexity of approach to EMS; Time pressure and lack of EMS team staff; Inadequate knowledge and skills of employees; Struggle to understand the role of EMS for the company; Lack of explanation of EMS concepts and learning; Positive attitudes are not translated into actions; Ineffective methods of environmental aspects the determination and evaluation.*

Balzarova [2005] proposed the overall conceptual model which illustrates how barriers are created and overcome as well as how awareness is raised in the process of EMS implementation (according to ISO 14000 standards). Hřebíček and Kokrment [2005] modified her model to the holistic model based on five basic pillars and interconnected business processes which are suitable for using appropriate ICT tools.

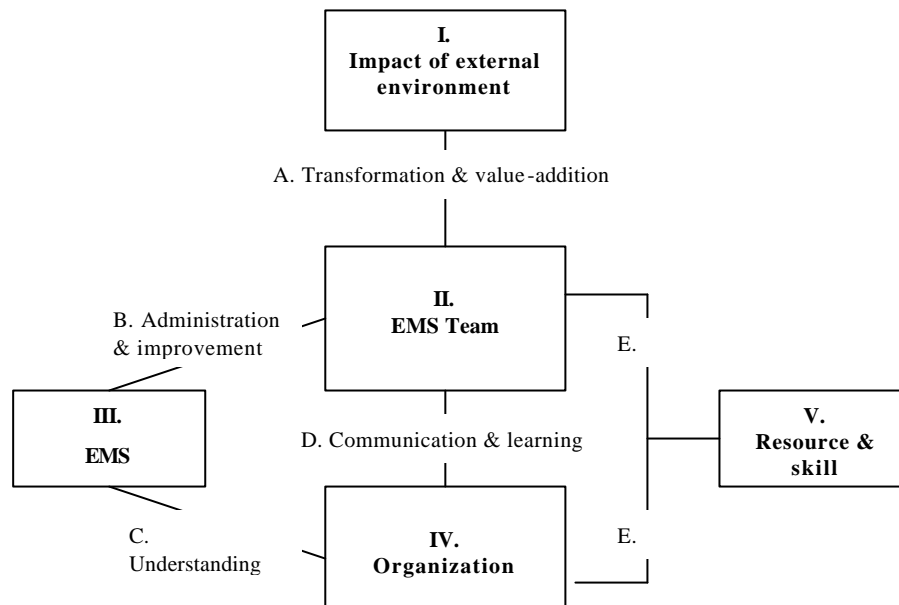


Figure 1. Model of creating/overcoming barriers in EMS implementation (and its continuous improvement)

They are as follows:

- I.** *External environmental impact:* i.e. the external influences on a company which are critical for the implementation and continuous improvement of EMS. These include such things as new legislation issued by the government, requests of external interested parties including external audits, cooperation with environmental agencies.
- II.** *EMS team:* i.e. a group of managers and internal auditors directly responsible for maintaining the EMS system. Their role is paramount since the EMS team has to balance the needs, requirements and pressures from all stakeholders (interested parties) and is the main communication and executive channel.
- III.** *EMS:* this represents the *Environmental Management System* as such, i.e. the system that is being certified/validated by external auditors for compliance with ISO 14001:2004/EMAS II.
- IV.** *Organization:* i.e. the whole company organization including its structure as a complex social-technical system.
- V.** *Resources and skills:* i.e. a set of company resources and skills of interested parties that lead to creating/overcoming barriers in EMS.

The model we have developed establishes the set of five processes leading to creating/overcoming of the barriers:

- A.** *Transforming & value-adding* process dealing with analysis and transformation between External environmental impact and the EMS team;
- B.** *Administration & improvement* process dealing with the maintenance of the EMS team and continuous improvement of the EMS itself;
- C.** *Understanding & acceptance* process describing the interaction between Organization and the EMS itself;
- D.** *Communication & learning* process dealing with interactions between the EMS team and Organization;
- E.** *Availability* is the essential process that enables the use of Resources & skills necessary for the company organization and the EMS team in EMS itself.

The results in the companies we looked at show that it is the process of *Administration & improving* that consumed the majority of the EMS team's time and at the same time it creates/overcomes barriers in environmental awareness. The extensive bureaucracy is one of the barriers in EMS. Documentation, monitoring and measurement and recording link the company EMS together with its strength and weaknesses in environmental performance. The majority of these companies demonstrated in various ways their struggles to manage the "paperwork obligations".

It was shown that they have a large percentage of non-conformance issues related to communication and documentation. It was recognized that using ICT tools in the process *Communication & learning* could dramatically improve environmental awareness in the majority (82%) of the companies we studied [Hřebíček, Kokrment 2005]. The failure of EMS implementation was identified mainly in the case of missing document/communication management software, which uses appropriate ICT tools.

3. TRENDS OF ICT SUPPORT OF EMS IMPLEMENTATION

Our research has identified three major trends in ICT support of EMS implementation: *Interconnectivity* with cross-media communication, documentation, monitoring and measurement, recording and reporting; *Customization*; *Standardization*.

The Internet/intranet has become one of the largest platforms for communication and publication of EMS information. The intranet may also be the proper place for communication and company e-learning EMS. We could see that companies used the Internet/intranet in two ways of *Communication & learning* processes. Most of the companies (78%) only published a digital version of their printed documents and reports (HTML or PDF), which fails to exploit all the possibilities of the Internet. The rest of the companies (22%) used various commercial ICT tools (mostly groupware products) for communication and reporting. Also, their documents/records/reports could benefit from the functions of these tools. This provided them with more possibilities for both documents/records readers and companies publishing documents/reports. Their readers could choose the information they are interested in and they could easily navigate through the amount of information. These companies have been able to easily generate versions of documents and “reports” containing information tailored to different target groups (interested parties). These documents/reports can be produced in various forms.

Current open source ICT tools allow companies to *customize* both the *content* and *form* of EMS communication and information management. The customization of the content means that companies are able to deliver that information to various interested parties. The customization of the form means that companies are able to deliver content (or customized content) in different forms, which different interested parties prefer. The preferred

format for document/report generation is PDF (Portable Document Format) which is suitable for printing, which rarely has problems with portability. Reports can also appear as web presentations, in e-mail, and many other possibilities.

Standardization of environmental documentation, communication and reporting is coming. Several international standards or initiatives have been accepted: ISO/DIS 14063:2004, [G3, 2006] etc, so the content and form of the communication and reports are described quite well. This is especially helpful in comparing the reports of various companies. Solutions for the standardization of the form are usually seen in the set of standardized DTDs (Document Type Definition) or XML (extensible Mark up Language) scheme, which describes the general structure of the XML documents. These are very suitable for pro forma reports. The latest effort in this area is the third generation of GRI Guidelines, [G3, 2006].

4. DEVELOPMENT OF A REPORTING INFORMATION SYSTEM

Using prototyping principles for environmental information systems and requirements described above, we have developed the prototype of open source web information system for EMS. It enables an efficient communication with both internal and external interested parties (employees, EMS team, company managers, public and external interested parties and other report readers).

It consists of two main parts: *Central Repository* (CRep) and *Reporting Wizards* (RWiz):

The *Central Repository* for storing all the EMS documents/records/reports, information and data, which could be the subject of communication/reporting is based on an open source relational database (Postgre SQL) which provides an effective access to data. The CRep should allow both manual and automatic (or semi-automatic) input of data/records. Automatic input is of great benefit because much of the appropriate information is already stored in company information systems. It could be also useful to have some possibility of automated output of the documents/reports/data, such as to the target group information systems or to report readers from the public.

The *Reporting Wizards* consist of a set of modules and ICT tools that should facilitate easy communication with both internal and external interested parties (in Czech). They can be used to generate documents/records/reports tailored to their needs, such as what information they would like to have in their reports and how they would

like to have their report (e.g. in PDF, HTML format). Company employees could use the RWiz to prepare some generic reports for different target groups.

A difference between our prototype and conventional communication management systems lies in a strict application of workflow principles and standards using open source information technology. The prototype of the Reporting Wizard is based on the architecture of the Workflow Reference Model published by Workflow Management Coalition (<http://www.wfmc.org>) where data/document flow management is not included into workflow management system. Data and documents used by workflow are administered separately in the Central Repository.

The Reference Model provides the general architectural framework for the reporting workflow. It identifies interfaces covering, broadly, five areas of functionality between a RWiz and its environment: *Import and export of reporting process definition; Interaction with users; Calling appropriate ICT tools or applications; Interoperability between different reporting systems; Administration and monitoring functions.*

The proposed open source prototype is based on multi modular architecture. There is a special emphasis laid on the modules of process definition tools, modules of workflow enactment service and workflow application programming interface (WAPI) using XML and other semantic web standards.

Reporting and communication processes are manipulated and stored in the special XML format called process definition. The function of process definition is to describe a process in a form, which supports automated manipulation, such as enactment by a workflow management system. The process definition consists of a network of activities and their relationships, criteria to indicate the start and end of the process, and information about the individual activities, such as participants, associated IT applications and data, etc.

Process definition is made separately by PDT (Process Definition Tools) and passed in a workflow enactment service through a WAPI interface.

As EMS output and input formats we have been mainly using XML (whenever possible) in communication processes of EMS since 2002, but its native format was used also with necessary conversions because the large volume of input data is stored in existing company information

systems. Processing general EMS records/data into documents/reports is customized for various interested parties in various forms (XHTML, PDF, text, etc.). Each document/report contains data from three main categories: the basic part, which includes all the records/data that are the subject of communication/reporting. Note that not all of these data are contained in the final customized document/report. Secondly, there is the information about the interested parties - the target group and foreword for each specific target group. These data are transformed into the structure demanded by the specific target group. The next step is the application of the design for the target group. And finally, the data are sent for serialization processing which produces the final document in XHTML, PDF format.

5. CONCLUSIONS

A valuable part of the *Communication & learning* process is the feedback that is received from the target groups. It confirms or controverts their environmental awareness. The EMS team can be sure that the *Communication & learning* process has reached the target group only by identifying its reaction, i.e. it has received the intended information, and that it has understood the EMS itself. When the *communication & learning* process has succeeded in all of these aspects, there is still a need for the company to obtain feedback from the different interested parties and then the response showing that the company understands their views, is interested in them, and will consider them.

In the event, a *Communication & learning* process on prevention, for example, has failed in any of these aspects, a quick reaction may be necessary. A failure in the *Communication & learning* process can be remedied by providing clearer information through more direct access and discussion. A negative reaction to the information by some of the target groups is more serious - it may foreshadow opposition to the environmental program. The reaction should be investigated to provide a full understanding of the concerns; at best, the issue can be resolved by improved communication. Companies issuing environmental reports or other documents for public information can include forms for feedback within the reports. The feedback can assist the company in continuously improving the environmental awareness of its employees and managers.

The resources allocated to the EMS should include how the feedback will be handled. Feedback gained through opinion research can be handled internally. However, a company undertaking two-

way communication (with/without ICT support) must be prepared to seriously consider the feedback and to provide a prompt response. This does not mean that a company always needs to change its plans (with/without ICT support) based on this feedback, but the interested parties need to be assured that they have been heard.

Companies should use the developed prototype of this web information system in cooperation with the Faculty of Economics as the open source ICT tool amplifying environmental awareness. It is available to evaluate the effectiveness of their communication activities and to refine and improve the environmental awareness of interested parties.

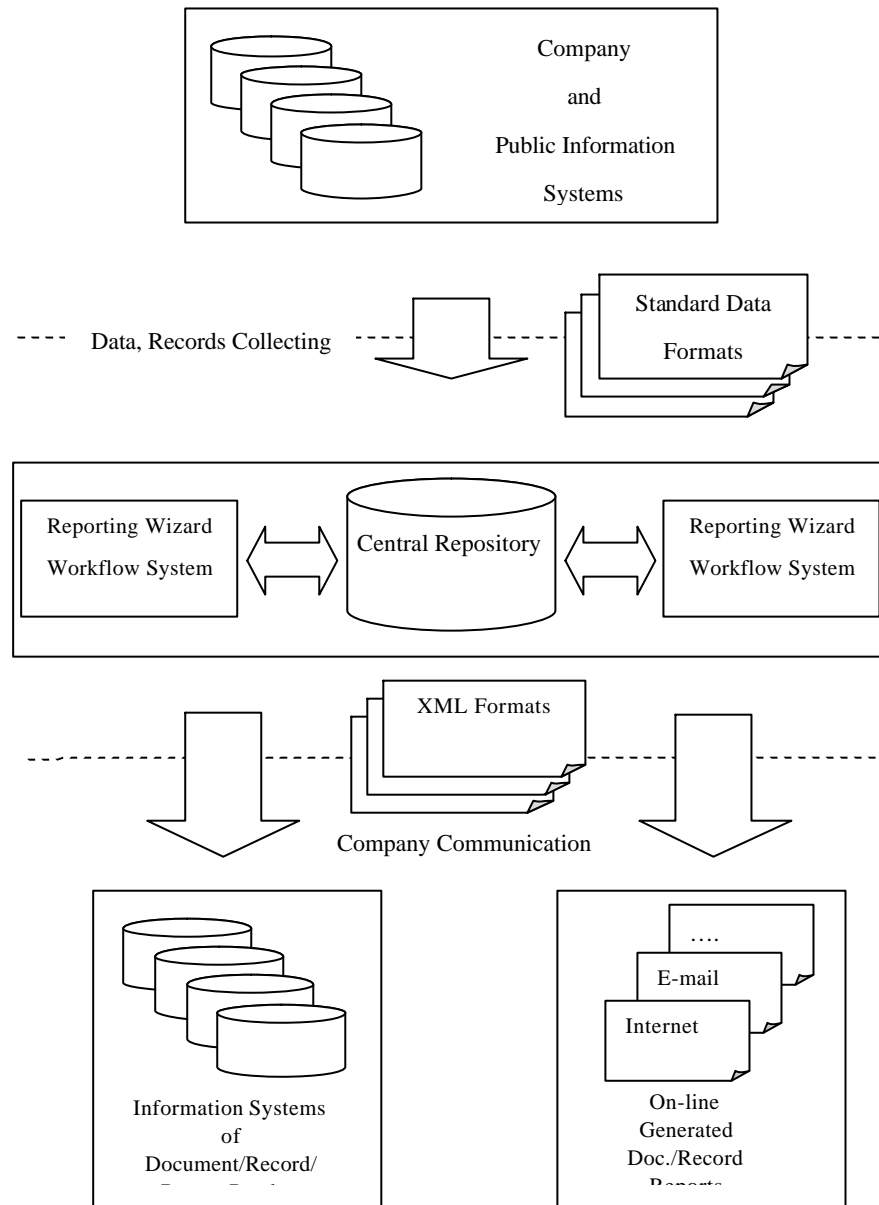


Figure 2. Architecture of the web information system

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