Creating corporate environmental information systems

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Abstract

Environmental information systems (EISs) only apparently offer a solution to the problem of inadequate knowledge concerning the relationships and impacts involved in corporate environmental protection. The function of such systems is to acquire, edit and communicate environmental data in a target-oriented way in order to reduce uncertainties.

An environmental information system cannot be reduced to a computer system. The essential point is to create systematic corporate procedures for supporting the user-oriented editing of environmental data to ensure communication and decision-making in accordance with ecological principles.

Keywords: Environmental Management; ISO 14000; Environmental Information Systems; Environment oriented corporate learning; Ecology oriented Assessment.

1 PRECONDITIONS FOR ECOLOGICALLY-ORIENTED ACTION

The purpose of an EIS is to provide user-oriented environmental data,

- so that employees can act in an environmentally friendly way,
- so that environmental goals can be formulated,
- so that the success of these goals can be monitored, and
- so that data can be made available to those groups who need it.

At the core of this enterprise are people, their needs and their powers of intervening in a relevant way (Fig. 1). Employees must learn to understand their company and its impacts on the environment on the basis of environmental data in order to enhance their ability to make appropriate decisions. This data therefore should lead to an improvement in their ability to perform their functions within the framework of economic and ecological criteria. The essential point is to develop ecologically based knowledge and understanding as well as the ability to make decisions in accordance with it.

Fig. 1: Environmental data systems are based on the people in the company and their need to act in an appropriate way.

This is why environmental data can only be the means to an end, which is the creation of a new and improved understanding of the way the company works.

This process must go beyond the mere collection of ecological data. It must lead to knowledge about the relationships between particular courses of action and their impacts on the environment. It then becomes clear that precisely those who wish to develop this competence must study such relationships in depth. The focus shifts away from the development of computer-aided tools and the data itself to determining the need for environmental information and the EIS. This process defines the thrust of the entire future project.

2 CONCEPT OF AN INTEGRATED ENVIRONMENTAL INFORMATION SYSTEM

A corporate environmental information system comprises all the measures, attitudes, instruments and organisational facilities needed to acquire, edit and communicate environmental data for supporting appropriate decision-making by a company's employees. The problems involved in structuring information systems were described by Wollnik (1988) in his "Reference model for information management" on the basis of three levels of handling information. The following treatment will be based on applying this model. These three levels will henceforth be abbreviated to "Utilisation", "Systematics" and "Infrastructures". *Data utilisation* implies requirements on *systematic handling of information* and this in turn requires specific *infrastructures*. Support services between these sectors flow in the reverse sequence (Fig. 2). The following treatment concentrates on the two sectors of data utilisation and information systematics.

Fig 2: The environment information system with its three sectors of data utilisation, systematics and infrastructures

2.1 Data utilisation

The development of an environmental information system must be oriented consistently towards its purpose. This means that data utilisation is at its very core. Because employees must ultimately make environmentally-friendly decisions on the basis of the data available to them, this sector must be at the focus of creating such a system. It must be investigated, understood and the system's contents oriented towards it. Four types of requirement are of essential importance here, namely:

- *Continuous ecologically oriented improvement* of activities, products and services (continual improvement) (cf. ISO 14001, ISO 14004, Aichinger et al. 1997),
- Satisfaction of the legal stipulations (*legality* or legal compliance),
- Meeting the requirements of the stakeholders (*legitimacy*, interested parties), especially those of the customers, and
- Assessment, especially of the *long-term benefit* of the environmental activities (Schlatter et al. 1997b).

In the normal work sequence "Plan, Do, Check and Act" (Deming 1986), the targets, questions or problems that must be attained or solved are derived from the requirements of these four sectors (Fig. 3).

Fig. 3: Objectives and targets are derived from the numerous requirements that the company must satisfy (cf. ISO/TC 207/SC1 1996a).

The action to be taken is derived from these objectives. Corresponding data must then be provided to ensure that this action is oriented to the targets and that appropriate success checks are performed.

When environmental data is discussed within a company, the human factor is often forgotten. The essential question is: which people or groups make the essential decisions that determine the extent of future environmental impacts (cf. Züst/Wagner 1992). The decision-makers must be supplied with data allowing them to recognise the effects of their decisions at an early stage.

Making decisions within a corporate context means recognising one's power to intervene in products, processes, infrastructure and management, to be aware of the relationships between environmental impacts and their causes and to try to continuously improve one's efforts to benefit the environment on the lines of the ISO 14001 standard. Products and thus their development represent one of the most important areas of such intervention (Züst/Wagner 1992; cf. Frei/Caduff/Züst 1996; Frei 1997).

2.2 A systematic approach to supplying environmental data

An environmental information system provides important support for an integrated approach to environmental management. Particular attention must therefore be paid to embedding and operating the EIS within the framework of the company's overall activities. The structures set up to develop and operate the EIS must also be integrated into the company's operations (Schlatter et al. 1997a). A systematic approach to supplying environmental data comprises the analysis of the company, the development of a common corporate awareness and its mapping in suitable data structures.

Data editing in line with targets and user needs must be based on an understanding of the EIS throughout the company. Only if the data supplied reflects an understanding of the system and its limits can it be understood and interpreted by those for whom it is designed. To this end, the company or its relevant parts must be systematically mapped and the system's limits defined. Such mapping provides clarity and transparency for the subsequent stages of acquiring data, formulating characteristics and achieving effective communication.

This system understanding must then be used to analyse the company's environmental context and to determine its significant aspects. Environmental management does not mean trying to handle as much environmental data as possible. It should aim at identifying the most important impacts in the sense of ISO 14001 by a stepwise approach and then continually improve them. This is done by analysing their causes and by determining who (individuals or groups) can affect these causes. This process yields the circle of people to whom the specific environmental data should be addressed.

2.3. Integration of sub-concepts

Integration of the sub-concepts presented above reveals the relationships between the planned activities of these people, the data they need as well as the infrastructures required for the efficient acquisition, storage, editing and communication of this data. The major task involved in creating a corporate EIS is to examine and discuss the environmental requirements and to establish an environmental dialogue both within the company and with external requirements groups.

This makes clear that an EIS cannot simply be purchased on the market as a black box. It must be developed by the company together with its future users. This requires not only the commitment of top management, but also their willingness to co-operate in the project. The decisive factor is whether an authentic dialogue can be successfully established within the company (Schlatter 1998). Only if the ultimate recipients of the data are included in the development of the system and especially in the discussions of how the data should be used and its requirements determined, is there a chance that concrete action will be taken.

Fig. 4: Concept of an integrated environmental information system. (This figure is the result of combining Figs. 1 and 2.)

3 APPROACHES TO AN ECOLOGY-ORIENTED ASSESSMENT

The continuous improvement of an organisation's environmental performance referred to its activities, products and services, such as is described in the ISO 14001 standard on environmental management systems, is one of the main tasks of corporate environmental protection. An organisation must therefore learn to recognise which decisions may lead to environmental impacts and what is their significance for local, regional and global environmental problems. To this end, it must have an in-depth understanding of its own activities and how it is embedded in the economy as a whole. This leads to the question of which principles can be reasonably used to carry out an ecology-oriented assessment.

3.1 Environment-oriented enterprise modelling

Questions of ecology require the reference between the *company and product* and their *ecological surroundings* to be brought out in concrete terms. The quantity and quality of current and expected future environmental impacts from a company's activities, products and services must be examined. The necessary environmental context can be brought to light by examining the upstream and downstream processes not in terms of aggregated values, such as kWh, but rather of emissions and the consumption of environmental resources.

Process functions can be conveniently mapped by a qualified material balance. This represents the material and energy flows of numerous product or process functions in a differentiated way. It allows environmental data to be formulated in terms of targets. As a basis for this model, an elementary function was defined with reference to the draft ISO 14031 and ISO 14041 standards (Fig. 5).

Fig. 5: Elementary functions showing inputs and outputs (Caduff/Züst 1996)

The output represents not only the products but also the undesired flows, that can be divided into by-products and emissions. This latter term comprises all flows that are released directly into the ecosphere. Products and by-products undergo subsequent treatment. All input and output flows can be specified in more detail. Thus products, by-products and emissions in turn consist of materials, energies or resources. Complex processes can be mapped by interlinking these elementary functions.

Processes, products and services should not be considered merely within one's own company. Responsibility for the products manufactured by a company extends over all the phases of their life cycle from development via production, utilisation to waste disposal (Fig. 6). The environmental impacts must be continuously improved over all these product life phases. This means that products and processes should not be regarded separately in individual phases nor considered from a purely technical viewpoint.

Fig. 6: Integrated consideration of the intervention and decision-making procedures within a company.

Detailed analysis of a product system may require a division into sub-systems. The relevant allocation and aggregation rules are described in ISO 14040. The environmental impacts of the material and energy flows caused by a product must then be assessed on the basis of these requirements. The practical work that this step involves is usually under-estimated (Züst/Caduff 1997) and it is often carried out with insufficient care.

3.2 Framework of an ecology-oriented assessment

The ISO 14040 standard on life cycle assessment describes the framework for the effective performance of an ecologically oriented assessment. It proposes — on the basis of the work of SETAC — that this assessment be subdivided into four cyclic steps (Fig. 7):

- *Goal and scope definition:*

The goal and scope of the assessment must first be defined. This ensures that the limits of the subsequent investigations are set and the thrust of the assessment as well as the basis for selecting the method to be used are defined. This step must also include a definition of the functional unit mentioned above.

- *Inventory analysis:*

An inventory of the required data is then set up. This activity is as a rule based on a criterion plan. An appropriate life-cycle model of the kind presented above can provide significant support to this sub-step.

- *Impact assessment:*

The assessment of the environmental impacts is the core of the whole procedure. This step contrasts the elementary flows recorded in the second step in terms of the local, regional and global environmental problems that they cause and assesses the corresponding importance of these flows. This step can be extremely difficult to set up, especially for the dependent variables.

- *Interpretation:*

The interpretation step ensures that the previous steps are continually checked in a critical and systematic way. Thus it may prove useful to examine significant impacts on the environment in detail. In the case of unreliable information, it is also helpful to vary the magnitude of the relevant properties and to record and assess the changed impacts that then result.

Fig. 7 shows a general procedural grid that must be adapted or possibly extended as a function of the assessment situation. Total aggregation techniques are used for the life-cycle assessment (e.g. Ahbe 1995). As a rule, these techniques are based on a linear approach, the individual environmental effects being multiplied by specific factors and then summed. A sequence analogous to the one shown in Fig. 7 is then indispensable to avoid incorrect interpretations. In various applications, we observed that this method could be used particularly to lend significant support to the ecology-oriented assessment of alternative actions thanks to the increased transparency obtained.

Fig. 7: The four sub-steps of a systematic assessment to ISO 14040.

4 USER-ORIENTED STRUCTURING AND UTILISATION OF ENVIRONMENTAL DATA

The structuring and utilisation of environmental data must, as mentioned above, be consistently oriented to those people who will use it in order to act in a manner that benefits the environment. Two main problem areas arise here: firstly the question of how the specified environmental data must be edited to be understood and implemented by its recipients. For even if this data is available in user-oriented form, a basic problem relating to environmental psychology becomes apparent, namely the much decried gap between awareness and action. This leads to the second question: how we can get people to make decisions that benefit the environment?

4.1 Structuring user-oriented environmental data

In structuring user-oriented environmental data for the various internal and external requirements groups, three main aspects must be considered: the supply of adequate contents, their presentation in line with the recipient's needs and the form of data transfer to the recipient. All three aspects must be oriented to the corporate, social and private context of the recipients so that they can understand the data they receive and act accordingly. This context, especially the ways in which environmental problems and appropriate behaviours are discussed on a daily basis,

is decisive for allowing the environmental information to be implemented in concrete terms after being edited and communicated.

- *Content:*

Environmental data comprises not only records of material and energy flows but also all relevant documents that help people to include the environment as a factor along the entire process of performance creation. The contents of this data must be adapted to its recipients and their scope of action.

- *Presentation:*

The data must be presented to respond simultaneously to both right-brain and left-brain characteristics as far as possible (Busse 1995, pp. 95ff.). In other words, it should be visualised or related to reference values. Image, text and reference values are usefully communicated in a combined display (Buschor 1996, pp. 80ff.). The reference values should relativise the data shown, i.e. be linked to familiar parameters such as last-year's value, ideal value, confidence interval or mean value.

- *Transfer:*

It is not sufficient merely to present data in an optimal way in order to convince its recipients to take it seriously. Those responsible for editing or communicating this data must effectively sell it to the recipients. The relevant marketing process or at least the data organisation it involves is a management task.

In addition to assuring an efficient and cost-effective acquisition, editing and communication of environmental data, a second much more fundamental set of problems must be tackled: namely the *concrete changes in attitude* that the dissemination of data in a company can trigger, changes that manifest in new habits of communicating and decision-making (Buschor 1996; Arnold 1997). This is precisely what a corporate EIS must achieve: to improve the company's ability to control its operations and to persuade its employees to behave differently and in a more *appropriate way*. This means that the *structural framework conditions*, the *local work organisation* and the prevailing *habits* and *organisational routines* must be taken more seriously (Rüegg-Stürm 1996).

4.2 Using environmental data

Previous concepts of comprehensive data acquisition yielded a flood of data that was hard to make sense of and involved high costs for recording, storage, processing and interpretation. Moreover, the resulting benefit was usually small. The reason for this deficit is that technical-scientific data about material and energy flows alone do not lead to any improvement in the environment. The employees must first convert this data into decisions that benefit the environment in an effective way. But precisely these people, their ability to observe, communicate, learn and act as a group have so far been largely excluded from discussions on environmental matters. The analysis of the requirements for

environmental information and the creation of an EIS must no longer be delegated to a single agency within the company. For what is needed is the collective working out of the environmental information required and the development of the EIS by those people who will subsequently receive this data. It offers the opportunity for a joint investigation of the company's own circumstances that can lead to the acquisition of just the right kind of background knowledge. This will then create the preconditions for the data - irrespective of how attractively packaged and user-oriented it may be - to be understood and interpreted, used as information and thus to become effective in changing attitudes.

An EIS project is doomed to failure if its conceptual elaboration is left to a handful of experts. The right understanding of ecological matters can be developed and a thoroughgoing environmental awareness can grow, especially at the start of a new strategic orientation, only when at least the key actors and promoters are included in a collective learning process. New system concepts can then be developed and appropriate structural changes planned. If open conflicts and controversies arise in this process, so much the better. This is merely an indication that things are really moving. In addition, it is important to deal with conflicts and points of friction as early as possible in every process of change. Otherwise they will start to develop a diffuse life of their own and make matters difficult for everyone involved (Schlatter et al. 1997a).

The key to the successful handling of environmental information lies in a collective learning process by all those involved in its interpretation, i.e. all groups within the company participating in the common discussion aiming at developing a new understanding of the problems involved and their possible solutions. It is vital to create organisational and cultural preconditions allowing group processes to take place, to be encouraged and used in a target-oriented way. The aim should be to establish regular discussions within the community so that environmental data can be interpreted to *bring out its implicit meaning for everyone concerned*.

5 RECOGNISING THE IMPACT OF ACTIONS

During our research, we learnt that an EIS is much more than a computer system and that it is insufficient to focus exclusively on the data relating to material and energy flows. Ultimately, it is the people in the company who must learn something new on the basis of the data available to them and must act accordingly. The people, their thoughts and decisions rather than information technology must be placed at the very centre of these considerations (cf. Özdil 1997).

After being edited in user-friendly form, the environmental data must flow back to where the important decisions defining these environmental impacts are made. The awareness that planning activities in particular define most of the later environmental impacts of products, activities and services throughout their life phases shows that it does not suffice to be limited exclusively to the material and energy flows in one's own company.

In addition to the correctness of the contents of an EIS, the focus of attention must in future move away from the data and towards the decisions themselves. In parallel to the technical work of data supply, the employees must be included in the process of determining the need for environmental data and must be made aware of its importance. Special care must be taken to define the purpose and form of editing the data and the means of communicating it. The data must be structured so that it is directly relevant to its recipients' activities and allows them to recognise the impacts of their decisions and to adapt their actions accordingly.

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