# UNIVERSITÄT KAISERSLAUTERN

**Lehrstuhl für Betriebsinformatik und Operations Research**
**Prof. Dr. Heiner Müller-Merbach**

**Internet-based environmental reports by companies - towards an efficient and customised corporate environmental reporting**

**Ralf Isenmann und Nicolas Warkotsch**

Universität Kaiserslautern
Lehrstuhl für Betriebsinformatik und Operations Research (BIOR)
Gottlieb-Daimler-Straße
67653 Kaiserslautern
Tel.: 0631 205 3771
Fax: 0631-205 3381
E-Mail: bior@sozwi.uni-kl.de
Internet: http://www-bior.sozwi.uni-kl.de

# 1 Abstract

Corporate environmental reporting makes good business and environmental sense. A big challenge for companies is to utilize the technical benefit of state of the art IT, especially of Internet-technologies and Internet-services. In this paper an approach of internet-based environmental reports by companies is presented. Three different levels are discussed:

- The first level deals with the **basics of corporate environmental reports** (CER) by companies. Illustrating the order within the emerging field of CERs a morphological box is suggested (section 1). Building on this, general requirements for corporate environmental reports are outlined (section 2).

- On the second level, the general reporting requirements are specified by IT-relevant challenges, seen as **starting points for internet-based environmental reports** (section 3). The immense technical benefit of using the Internet towards efficient, integrated, interactive, hypermedia-featured, dialog-oriented, and customised environmental reporting is analysed (section 4). On the basis of the technical benefit analysis, the state of the art of internet-based CERs is presented (section 5).

- The third level refers to the **IT-application** turning from the basics, IT-challenges and technical benefit to consequences for environmental reporting companies in practice. Thereby a fundamental framework for internet-based CERs is sketched (section 6). Grounded on this framework a basic architecture of an IT-implementation is explained (section 7).

**Keywords**: Corporate Environmental Report (CER); EMAS; Environmental Management System; HTML; Hypermedia Document; Internet; State of the Art IT; three-layer Web-application; World Wide Web, XML

**Table of contents**

## 2 Introduction: Three levels of internet-based environmental reports by companies

Corporate environmental reporting is taking a more central role, either for economic success or towards sustainable development. Through corporate environmental reporting, companies are first able to identify and reduce environmental impacts, and second they are able to achieve competitive advantages. Considering profoundly that corporate environmental reporting makes good business and environmental sense, companies could utilize the technical benefit of state of the art IT, especially of Internet-technologies and Internet-services. This benefit serves as a powerful vehicle towards an efficient and customised environmental reporting. In this paper an approach of internet-based environmental reports by companies is presented. Three different levels are discussed:

- The **first level** deals with the basics of corporate environmental reports (CER) by companies. Currently there is no detailed codification for CERs given by law. In order to clarify conceptual differences, a morphological box is proposed. This morphological box serves as to illustrate the order within the emerging field of CERs (section 1). Building on the morphological box, general requirements for environmental reporting companies are outlined (section 2).

- On the **second level**, the general reporting requirements for environmental reporting companies are specified by IT-relevant challenges. These challenges are seen as starting points for internet-based environmental reports (section 3). The immense technical benefit of using the Internet towards efficient, integrated, interactive, hypermedia-featured, dialog-oriented, and customised environmental reporting is analysed (section 4). Admittedly, companies are just realising the possible conceptual benefit. They are still at the beginning to exploit the Internet use in practise consequently. During the last few years, the number of environmental reports on the Internet has increased rapidly. Moreover, there has been significant progress in publishing environmental reports on the Internet. Thus, the state of the art of internet-based CERs is presented (section 5).

- The **third level** refers to the IT-application, turning from the basics of CERs (section 1, 2) and both IT-challenges as well as technical benefit (section 3, 4, and 5) to consequences for environmental reporting companies in practice. Thereby a rough, but fundamental

framework for internet-based CERs is outlined (section 6). Building on the framework, a basic architecture of an IT-implementation is explained (section 7).

## 3 Morphological box of corporate environmental reporting

Since the beginning of the 1990s, companies are communicating environmental impacts produced by industrial operations and the performance of their environmental management systems (UNEP, & SustainAbility, 1994; GEMI, 1994). Until now CERs have been the main vehicle of **environmental communications**. CERs cover all corporate publications whether at corporate or site level, containing a comprehensive survey of environmental impacts as well as the performance of environmental management systems, inclusive environmental statements according to the EMAS (Environmental Management and Auditing Scheme) in the EU (Steven, &Letmathe, 1999; Steven, Schwarz, & Letmathe, 1997).

Unlike annual financial statements, there is no detailed codification for CERs given by law (European Commission, 1999, i; UNCTAD, 1998, 18). No generally accepted standard format exists for companies to voluntarily report environmental information. In literature the approaches differ, in practise the published CERs show a rather heterogeneous picture (e.g. survey of German environmental statements: Steven, & Letmathe, 1998). In companies there is great uncertainty how to publish CERs (FEE, 1999, 3). Consequently they are still seeking help in preparing, updating, and validating their reports (Federal Environment Agency Austria, 1997). Altogether CERs occur under different terms, with various contents, and in many special forms. The emerging field of CERs ranges from simple one-way information on paper-based green glossy brochures and printed PR-folders to comprehensive electronic publications as interactive, hypermedia-featured, and dialog-oriented reports on the Internet.

Confronted with vast new terms, contents, and forms of uncatalogued reporting diversity, it is helpful to identify and understand the order that underlies evolving corporate environmental reporting. Particularly, the emerging field of corporate environmental reporting is illustrated by a morphological box (fig. 1).

| actor | international | | | | public | | national private | urban | | ... |
|---|---|---|---|---|---|---|---|---|---|---|
| object | enterprise | site | company | group | city | town | nation | continent | world | ... |
| form | freestanding | | | | additional | | | | | ... |
| graduation of voluntariness | voluntary | | | obligatory | | | liable | | | ... |
| purpose | resource management | | | publicly information | | | stakeholder communications | | | ... |
| term and content | environ-mental tip | environ-mental map | environ-mental atlas | environ-mental folder | ER incl. input output inventory | ER incl. eco-balance | eco-report | environmental statement | environmental handbook | ... |
| method | quantitative analysis of materials and energy | | | assessment of environmental impacts | | | evaluation of environmental impacts | | | ... |
| media | print media paper journal brochure folder news | | | LP,MC,CD | electronic media video broadcasting television | | disc CD-ROM networks (internet,ISDN) | computer-based media | | ... |
| kind of publishing | traditional publishing | | | electronic publishing | | | | | | ... |

*Figure 1: Morphological box of corporate environmental reporting*

The morphological box is considered to be expedient for illustrating diversity systematically (e.g. Zwicky, 1967). Like figure 1, the box should be seen as simply schematic. However, it can prove useful to survey the **relevance of corporate environmental reporting** in a broader sense. Thus the morphological box serves as a rough scheme twofold, firstly to indicate the great range of terms, various contents, and special forms, and secondly to clarify the conceptual differences. According to the initial purpose of introducing the basics of CERs on this first basic level, the morphological box consists of nine fundamental characteristics (Isenmann, & Warkotsch, 1999a): (i) actors representing environmental reporting corporations, (ii) general objects of environmental reporting, (iii) specific forms of environmental reporting, (iv) differences in graduation of voluntariness, (v) main purposes of environmental reporting, (vi) identified terms and contents of environmental reporting, (vii) applied methods for environmental reporting, (viii) media used for the workflow of environmental reporting, and (ix) preferred kind of publishing.

• With respect to environmental reporting actors, international and national corporations can be distinguished. **International** institutions like OECD and World-Watch-Institute are publishing environmental reports such as „World Watch Reader" on global environmental issues, or the „OECD environmental performance review" (OECD, 1997) focused on specific nations. On **European** level the European Environment Agency is preparing a regular state of the environment report (EEA, 1999). On **national** level you can identify

e.g. public corporations (survey in Germany: Page, Schikore, & Mack, 1996), private business corporations, and urban corporations (survey of about 450 urban corporations in Germany: Becker, 1999).

- The general objects of CERs symbolise the considered topics. They are characterised by the actors of CERs. According to environmental reporting actors and to the level considered, the objects of CERs differ. There are e.g. CERs of **enterprises**, **sites**, and factories, of companies, multinationals and world-wide business groups, or, spatial structures of cities, towns, countries, nations, and the entire world.

- The specific forms of CERs refer to the characteristics of location, running from (i) **additional** environmental information incorporated within annual and financial reports included e.g. in balance sheet, income statement, status report, and appendix (European Commission, 1999, 16 and passim), internal management reports or other forms like social or ethical reports through to (ii) **freestanding**, separate and comprehensive CERs published on printed media either as well or alternatively presented on the Internet respectively on CD-ROM. Often companies are reporting in a freestanding form.

- With respect to different graduations of voluntariness, CERs probably could be grouped into three categories (DTTI, 1993): (i) By **voluntary** reporting, companies either contribute to sustainable development or achieve competitive advantages. Voluntary reporting demonstrates environmental stewardship. It is a part of an active environmental communications strategy and core element of an offensive environmental management system towards „Sustainability Reporting" at company level (Sustainability Reporting: CERES, 1999). (ii) **Liable**, reporting is based on environmental laws. Environmental reporting companies have to observe several liabilities with regard to period, content, and form of reporting. Within governmental liabilities the environmental statements under EMAS symbolise an exceptional position: Participation in EMAS itself is voluntary, but by participating EMAS, the legal basis including the regulations for CERs become constitutional. These regulations represent the prerequisites for the participating sites registration in the list of EMAS-validated sites. (iii) **Obligatory** reporting is a consequence of the exceptional public exposition of companies, particularly multinationals. Environmental accidents or perfidious campaigns in mass media are typical triggers for

obligatory reporting. In other words, companies are forced to environmental reporting in order to settle public affairs.

• Three central purposes of CERs can be distinguished (e.g. Jaeckel, 1992): resource management, public information, and stakeholder communications. (i) CERs represent important documents for internal **resource management** of material, energy, and products as well as the reduction of environmental impacts. (ii) Concerning **public information**, CERs serve as the main source from which the general public is provided with environmental information. (iii) **Stakeholder communications** exceed public information. Seen as stakeholder communications, CERs have to meet the stakeholders' requirements including different information needs, and preferred channels. Consequently, stakeholder communications aim to promote an open dialog with the companies stakeholders. CERs explicitly include the exchange of different opinions, in order to inspire confidence and commitment. Against this background, such dialog-oriented communications are typically directed at a variety of stakeholders. CERs should offer feedback, conducting dialog, in order to prevent mistrust.

• The identified terms for CERs represent the name of the available publications, while the contents summarise the considered topics, subjects, and themes. The contents are corresponding with special terms, which are suggested in literature and used in practise. CERs are considered as a sum of all the companies' publications with a comprehensive survey of environmental impacts and performance of environmental management systems including environmental statements under EMAS. Fundamentally, a CER consists of four main elements:

– general description of the company,

– general information on environmental policy including environmental guidelines,

– quantitative analysis of material, energy and product (input output inventory), and

– review of the environmental impacts especially for air, water and earth.

These four fundamental elements build a **basic minimum scheme**. Further, by a detailed taxonomy, nine characteristic terms representing special contents can be identified: (i) environmental tip, (ii) environmental map, (iii) environmental atlas, (iv) environmental folder, (v) environmental report including input output inventory, (vi) environmental report including eco-balance (Ökobilanz), (vii) eco-report, (viii) environmental statement, and (ix) environmental handbook. Environmental tip, environmental map, and environmental atlas are particular terms used for publications by public or urban corporations in order to provide information for the public about environmental monitoring and hot topics for consumers.

- The media represent the vehicles, instruments and tools, which are usually used for the preparation, administration, distribution, and presentation of CERs. Building on this, three groups of media are distinguished:

− (i) **printed** media like newspapers, journals, brochures, folders, newsletters, magazines, and books,

− (ii) **electronic** media like LP, MC and CD, video, video-CD, broadcasting and television, and

− (iii) **computer-based** media like diskettes, CD-ROM, and networks like ISDN and Internet.

While both, for printed media and electronic media the use of state of the art IT is focused on the processes of preparation and administration, they are used for computer-based media generally, from preparation and administration through to distribution and presentation.

- The preferred kind of publishing corresponds with the used media, which refers at least to the result of the reporting workflow: the published CER. (i) Traditional publishing and (ii) electronic publishing are distinguished. For **traditional publishing**, state of the art IT is used especially for preparation and administration e.g. to support registration, archiving, and retrieval. CERs are usually published on printed media, which have to be distributed physically by mail. Published on electronic media CERs have be transmitted electronically as a radio broadcast or a television program. (ii) **Electronic publishing** represents a recent

kind of publishing which allows efficient, interactive, hypermedia-featured, dialog-oriented, and customised online-CERs. The technical benefit of state of the art IT in electronic publishing could be used permanently in order along the entire workflow of environmental reporting. Hence, CERs as printed media and electronic media could be supplemented symbiotically or partly substituted by computer-based documents representing software.

This paper is focused on CERs by companies, but the findings are also helpful for other non-commercial public and urban environmental reporting corporations e.g. such as municipalities, hospitals, universities, or cities, towns, countries, and national organisations.

## 4 Requirements for corporate environmental reports

CERs by companies have to meet many different requirements (Loew, & Fichter, 1999), especially those of legislators, non-governmental institutions (NGOs), government, science, management, target groups and the general public particularly the mass media (fig. 2).
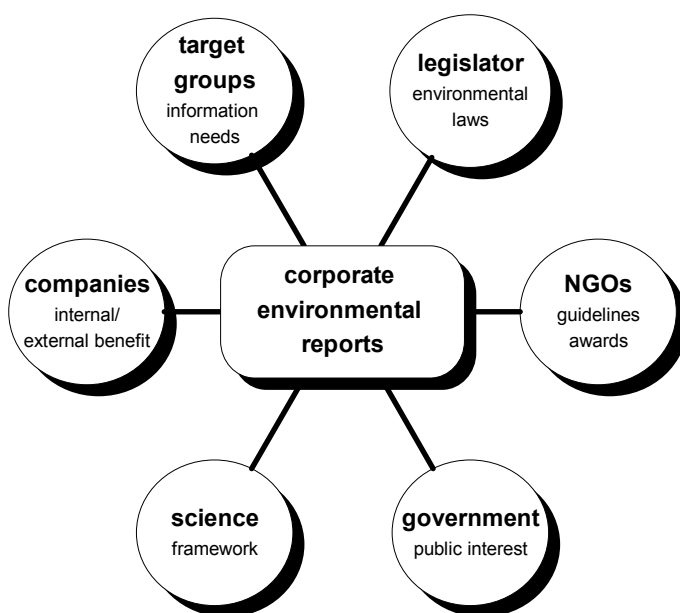


*Figure 2: General requirements for corporate environmental reports*

- **Legal requirements** of the legislator refer to liabilities of registration, information, presentation and control for environmental impacts. The legal requirements are based on national environmental laws on the one hand and on other international community regulations with a standard legal basis like EMAS in the EU. EMAS keeps an exceptional position: Participation in EMAS itself is voluntary, however if participating in EMAS, the legal basis of the community regulations goes into force. In this case, environmental statements are required for registering sites in the lists of sites by the national competent bodies. The EMAS regulations (especially article 5) are basic for CERs, notably the content, the periodic preparing and dissemination of environmental statements which have to be validated by an independent environmental verifier (Federal Environment Agency Austria, 1997). The compulsory environmental statements required under EMAS lean towards standardising information at given sites which is reported to the public.

- **Requirements of non-governmental organisations** (NGOs) such as councils or industrial initiatives are grounded either on specific standards, guidelines, and manuals or on award schemes and ranking exercises of institutions on a national, European or international level:

− Six of the most important **reporting guides** are (e.g. global survey: FEE, 1999, 30; Unger, 1997): (i) „Sustainability Reporting Guidelines" formerly „Valdez principles" from the Coalition for Environmentally Responsible Economies (CERES, 1999), (ii) „CEFIC Guidelines on Environmental Reporting for the European Chemical Industry" from the European Chemical Industry Council (CEFIC), (iii) „Environmental Reporting - A Managers Guide" from the World Industry Council for the Environment (WICE), (iv) guidelines from the Public Environmental Reporting Initiative (PERI), known as „PERI Guidelines", (v) framework of „Environmental Reporting Incredients" from the United Nations Environmental Programme (UNEP), and (vi) national German standard DIN 33922 „Environmental reporting for general public" from the Institut für Normung e.V. (DIN, 1997). According to these reporting guides, each provides valuable insights into the emerging field of CERs. Finally, the intent of all the recommendations is to help companies in preparing, publishing and distributing CERs.

− Beside the recommended reporting guides, **award schemes** play an increasing role in encouraging better CERs (Adams, 1995; European survey: Loew, & Fichter, 1999, 26). Two of the most famous awards are (i) „Annual Environmental Reporting Award Scheme" administered and sponsored by the Chartered Association of Certified Accountants (ACCA) in the United Kingdom, and (ii) „Ranking Exercise of Environmental Reporting and EMAS Statement" from the Institute for Ecological Economy Research (IÖW) in Germany. Despite the variation in the criteria applied, the underlying purpose is just the same: to stimulate and reward initiatives in CERs. Hence, awards and ranking exercises aim to establish best environmental reporting practise. Winning companies could improve their Public Relations. Apart from encouraging improvements these measures represent important requirements by neutral third parties.

• **Scientific requirements** generally refer to (i) the standardisation in the used method of environmental reporting, (ii) the improvement of the environmental reporting's substance, and (iii) to the standards in validating CERs by environmental verifiers (Steven, & Letmathe, 1999). The general purpose of scientific requirements is to compensate the so far missing detailed lawful codification in two ways: Firstly, they should remove the companies' uncertainty for preparing, updating, and validating. Secondly, they should build a valid and accepted platform for benchmarking CERs and for improving stakeholders use of CERs:

− **Standardisation in methods**: This means making the measurement for environmental reporting transparent, feasible, and credible. Environmental laws as well as standards, guidelines, and manuals are primary focused on the contents of CERs, not on the underlying methods of data capture, nor the measurement of the quantitative input output inventory. For benchmarking, ranking exercises, and solid intertemporal comparisons it is necessary to base CERs on a generally accepted framework of good environmental reporting practise analogously to the established accounting standards in annual financial statements. Suggested by the Fédération des Experts Comptables Européens, the environmental reporting framework consists of so-called „underlying assumptions" and „qualitative characteristics" (FEE, 1999; similar following German law: Steven, Schwarz, & Letmathe, 1997): The underlying assumptions fundamentally refer to the used method of

reporting while the qualitative characteristics should ensure the reports substance. The FEE's exemplary framework contains five underlying assumptions: (i) the entity assumption, (ii) the accruals basis of accounting, (iii) the „going concern" assumption, (iv) the „precautionary principle", and (v) the concept of materiality or significance. The nine qualitative characteristics cover: (i) relevance, (ii), reliability, (iii) understandability, (iv) neutrality, (v) completeness, (vi) prudence, (vii) comparability, (viii) timeliness, and (ix) verifiability.

– **Substance of environmental reporting**: Building on a transparent standard method, the input output inventory should be summarised by comprehensible documentation that is clearly structured and written in a concise and systematic manner. Thus the CERs substance is considered as an attribute that makes the information useful and stakeholder-relevant. Regarding methods and substance and to avoid information overload, ecological indicators and environmental characteristics should be used as instructive instruments for demonstrating the companies' environmental performance. Nevertheless, ecological indicators and environmental characteristics are not required for environmental statements under EMAS.

– **Standards in validating**: The European-wide implementation of EMAS in all the individual member states also requires accompanying national legislation, especially acts for the environmental verifiers accreditation. Validating reports by environmental verifiers are defined by regulations of different national laws. Usually validating and environmental verifiers audits are influenced by the verifiers' experience and expertise. Consequently, there are substantial differences, caused by a mixture of primary consulting and following validating. Furthermore, in some cases an environmental verifier might be overloaded. Verifiers often have little or no experience and expertise with processes and systems which are spreading out to all industries.

• **Governmental requirements** are considered additionally to methodical and substantial requirements from legislator, NGOs, and science. These are specifically focused on the criteria of general public interest on the one hand and hold a unique position within the several environmental management systems e.g. like EMAS, BS 7000, and ISO 14000 on the other hand (Steven, & Letmathe, 1999): Particularly, the governmental requirements

contain five criteria: (i) to promote participation in environmental management systems in order to make them work as helpful instruments of environmental politics; (ii) to use standard „environmental performance indicators" to verify the companies postulated reduction of environmental impacts; (iii) to encourage members of the public to order CERs and to use them in their decision-making; (iv) to engage companies for environmental reporting in order to encourage environmental reporting as a critically important lever towards sustainable development at company level; (v) to convince NGOs that corporate environmental reporting makes good business and environmental sense in order to establish reporting as a core element of good business practise.

- The **requirements of companies** refer to internal and external benefit. Through CERs companies could gain real value in the sense to achieve competitive advantages (Ernst & Young, et al., 1999, 2; Fichter, Loew, & Clausen, 1998): Internal benefit could be enabled particularly by (i) developing an environmental controlling system, (ii) systematically identifying environmental impacts, (iii) installing an environmental accounting management system, (iv) improving efficiency throughout the production processes, and (v) engaging the employees (Steven, Schwarz, & Letmathe, 1997). External benefit could be exploited e.g. by (vi) enhancing environmental stewardship, (vii) conducting a dialog with the stakeholders, (viii) and by targeting a unique market position (Fichter, 1998). Another recent requirement which links internal and external benefit is the integration of environmental information into corporate communications. In many companies environmental information is so to speak limited to freestanding reports. CERs are separated from other communication forms like general corporate communications or other management indicators such as financial performance or risk assessment (UNCTAD, 1998, 16). Hence, most of the CERs published actually have addressed only some of the intended stakeholders. The number of stakeholders addressed could be extended by either integrating environmental information into corporate communications like Investor Relations (Hank, 1999, 114; Schiller, Pelizaeus, & Werneke, 1999), Supply Chain Management, and Balanced Scorecards or by a systematic combination of environmental reports with other reports.

- **Requirements of target groups**: Environmental reporting is generally based on the increasing information needs of the companies target groups on environmental impacts. Environmental reporting is potentially directed at all the companies stakeholders, though typically the information needs are heterogeneous (FEE, 1999, 11; Schulz, 1995) which means that all needs could not be easily met. Companies have to aim environmental reporting at certain key-stakeholders or target groups. Target groups like employees, lenders, investors, suppliers, customers, governments and the public represent the VIPs, groups and institutions of the companies stakeholders. These groups have considerable influence on the companies operations or are affected by the companies operations through legal, business or public relations (Freeman, 1984; Nork, 1992; Dyllick, 1992). Environmental reports are addressed primary to the above mentioned target groups (Steven, & Letmathe, 1999, 73; Fichter, 1998, 78; Vollmer, 1995, 78; Schulz, 1995, 50):

– With growing general environmental awareness, employees are interested in the environmental performance of their employers and companies. Further, they want to be informed about the targets and activities of the environmental management systems. Employees like to understand whether companies are seen by local community groups and see theirs employer's business as a going concern, recognising that environmental performance might have some influence on this.

– Customers however are interested particularly in environmental impacts by the use and the disposal of products produced and offered by the companies.

– Members of the public wish to see that companies are behaving as good neighbours in the local community, not just from a compliance perspective, but also in respect of long term sustainability. Credible and understandable environmental information helps the public in their evaluation of this.

By providing the target groups with the specific environmental information they needed, the companies could create real value and attain internal and external benefit (Ernst & Young, et al., 1999). The general requirements as listed above are not exhaustive, but even in brief lays bare the recent developments which must be considered in an approach of internet-based environmental reporting.

## 5 IT-relevant challenges for environmental reporting companies

Based on the first basic level illustrating a morphological box (section 1), the general requirements for environmental reporting companies (section 2) have to be specified consequently by IT-relevant challenges on this second level. Hence, it is useful to sketch the companies challenges towards the rising Internet economy (Shapiro, & Varian, 1999; Zerdick, Picot, & Schrape, 1999). The IT-relevant challenges are considered not to replace or to drop printed CERs but to supplement these by electronic publications on computer-based media especially like on the Internet (Isenmann, & Warkotsch, 1999b).

Although the Internet encourages paperless information (Elkington, & Priddey, 1997, 52) and companies are slimming down the size of printed CERs, many stakeholders still wish to print off CERs and read them later. Concerning the media-specific benefit of printmedia and computer-based media, it is not going to be a case of either printed CER or internet-based CER, but of both (e.g. Isenmann, & Warkotsch 1999, 75; Charter, 1998, 2). Despite the fact that the number of Internet users is rapidly increasing (KPMG, 1999), for environmental statements according EMAS the exclusive publishing on the Internet is not up to the European community regulations: The public availability of environmental statements such as exclusively on the Internet offends EMAS, art. 3 lit. h (Nissen, & Falk 1996, 42). Environmental statements are considered as instruments of stakeholder communications, therefore companies have to be active in order to „disseminate to the public". Hence, the challenge of internet-based CERs is to **make printed media and computer-based media work like in tandem**. By complementing CERs on printed media and computer-based media, the specific benefit of each media is still respected (media-specific benefit: Stibic 1985). The main reasons for internet-based CERs are explained by a matrix of starting points with four columns (fig. 3).

| starting points for internet-based CERs | | | |
|---|---|---|---|
| **media-specific** | | **cross-media** | |
| **computer-based media** | **traditional media** | **external view** | **internal view** |
| ● improvment of environmental communications<br><br>● benefit by computer-based media<br><br>● surplus by internet-based CER | ● limits of printed media with respect to efficient generating, customisation and smart presentation | ● support for verifying and validating<br><br>● platform of electronic markets<br><br>● trend for standardisation<br><br>● stakeholder-tailored information | ● electronic availability of data base<br><br>● teamwork publishing |

*Figure 3: Matrix of starting points for internet-based CERs*

The matrix shown in figure 3 is suggested as a practical overview. The four columns represent different groups of starting points for internet-based CERs, from computer-based media and traditional media, both representing media-specific starting points to external view and internal view representing cross-media starting points. According the principle of top-down, the matrix is specified from abstract to concrete:

- **Computer-based media**: (i) By hypermedia-featured, dialog-oriented, and customised CERs on the Internet, companies could improve their environmental communications in order to develop an exceptional market position. (ii) CERs on the Internet allow companies to exploit the technical benefit of computer-based media for efficient, integrated, interactive, hypermedia-featured, dialog-oriented, and customised corporate environmental reporting. (iii) In addition to CERs on printed media, companies could offer the stakeholders a surplus by internet-based CERs: They could offer customised and stakeholder-tailored digital information products.

- **Traditional media**: Paper-based CERs on printed media are strictly limited with respect to an efficient preparation and distribution on the one hand and to the required dialog-oriented and customised environmental communications on the other hand.

- **External view**: (i) Environmental verifier could utilize hypermedia featured CERs as a helpful data base to support the complex documentation of verifying and validating the environmental management systems (Schoop, & Schraml, 1995, 52). (ii) Electronic

marketplaces on the Internet represent a expedient platform, which improves environmental communications by creating an open dialog between companies and stakeholders or allows to benchmark environmental performance at large (Butner 1996).(iii) In spite of the different picture of already published CERs, there is a trend for standardisation. This trend for coming convergence is grounded by the developments of environmental laws and guidelines as well as by scientific requirements such as the framework of good environmental reporting practise (FEE, 1999; Isenmann, & Warkotsch, 1999c; Clausen, & Fichter, 1996). Thus the quota of standard CER elements such as preface, description of the company, and description of environmental management system will expand. (iv) The demand for customised information is still increasing. Firstly, stakeholders are becoming more critical and focused in their information needs. Secondly, managers are going to exploit the use of CERs for achieving competitive advantages. Building on this, CERs have to be fine-tuned and stakeholder-tailored according to specific stakeholders or target groups and their different information needs (Spencer-Cooke, 1995). For this fine-tuning and stakeholder-tailoring, companies could utilize Internet-technologies and Internet-services, e.g. internet-based Push- and Pull-technologies for distributing which would provide adequate real-time data and online-information (Isenmann, & Lenz, 2000). Push-technologies are so named because they reverse the normal method of information access in order to select what companies are offering. By using Push-technologies, stakeholders could submit their information needs individually focused on the Internet while the server automatically pushes the information matching the stakeholders' needs exactly and to the preferred channel.

- **Internal view**: (i) Often in companies the necessary data base for CERs is already captured in documents in electronic form (Schraml, & Schoop, 1996, 63): Low-level structured data are captured e.g. by quality management systems (GEMI, 1994) or environmental management systems, findings of controllers, internal environmental departments, and office automation, while high-level structured data are captured by the use of production planning and control systems. (ii) Due to the complexity of the workflow of environmental reporting, CERs are published by a team, using the benefit of computer supported cooperative work (CSCW) including workflow management systems (Lurk, & Alber, 1998).

The starting points for internet-based CERs illustrated in the matrix above are understood as a powerful vehicle towards efficient and customised corporate environmental reporting. The general experiences of the reporting companies in the last few years still confirm that the benefit of environmental reporting exceeds the costs by far. Using Internet-technologies and Internet-services enables companies to combine the requirements of environmental reporting on the one hand with the IT-relevant challenges on the other hand: firstly, to meet the environmental reporting requirements, secondly, to achieve competitive advantages, and thirdly, to spur the shift towards efficient, interactive, hypermedia featured, dialog-oriented, and customised environmental reporting.

**6 Technical benefit of internet-based environmental reporting**

In addition to the IT-relevant challenges for environmental reporting companies (section 3), the technical benefit of internet-based CERs is discussed. The Internet allows companies to utilize many helpful IT-applications. One of the central applications for companies implemented into an environmental management system is to **support the workflow of environmental reporting**: from the efficient preparation and comfortable administration on the one hand to a fast distribution and smart presentation with global reach and 24-hour availability, interactivity, hypermedia-featured, and customised, and at least, individualised information on the other hand. Internet-based CERs enable an efficient and customised environmental reporting (Isenmann, & Warkotsch, 1999b; 1999d). According to the workflow of environmental reporting, the technical benefit of internet-based CERs is divided into two domains (fig. 4):

- efficient preparation and comfortable administration of CERs and

- fast distribution and smart presentation with global reach and 24-hour availability by interactive, hypermedia-featured, dialog-oriented, and customised online-CERs.
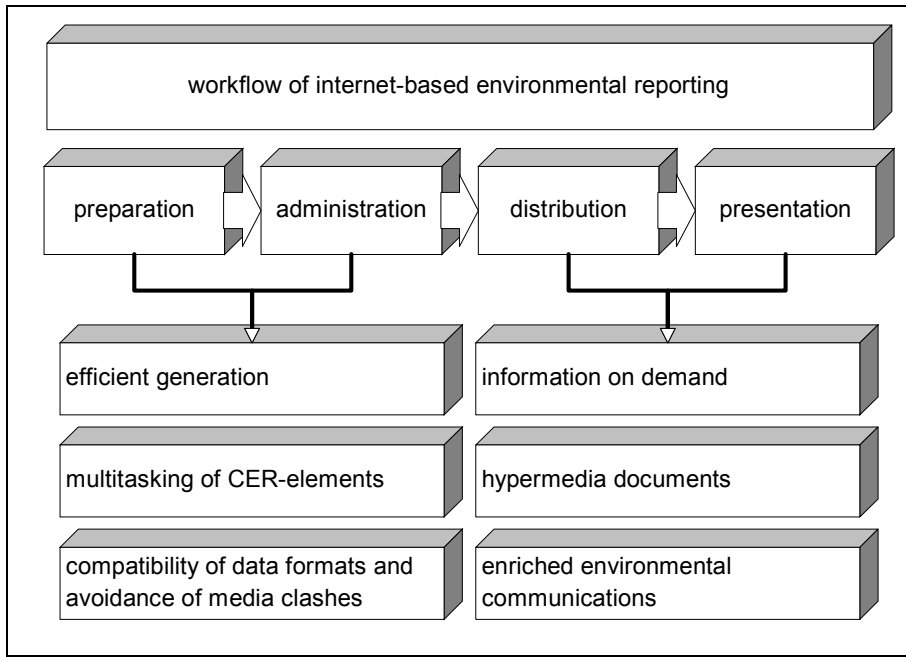
workflow of internet-based environmental reporting

preparation → administration → distribution → presentation

efficient generation

information on demand

multitasking of CER-elements

hypermedia documents

compatibility of data formats and avoidance of media clashes

enriched environmental communications

*Figure 4: Technical benefit of internet-based CERs*

The technical benefit for preparing and administrating CERs contains three main points: (i) IT-based efficient generation, (ii) multitasking of CER elements, and (iii) compatibility of different data types, data formats and data sources.

- **IT-based efficient generation**: Based on standard data modelling and data warehousing, CERs could be generated efficiently. General elements of CERs like preface, description of the company, and description of the environmental management system could be administered comfortably as marked documents despite the storage in different data sources. Media clashes are herewith avoided.

- **Multitasking**: CERs could be separated into general elements, which could be easily administered, and which could be mastered to compound documents. Standard data modelling of CERs enables environmental reporting for several reporting purposes and for different media including the requirements of special layout, design, and document formats.

- **Compatibility**: By a standard document-format of CERs either the workflow of environmental reporting could be facilitated or a data exchange could be enabled.

Moreover, generating and updating could be accelerated. Intermediate operations due to the data storage in special formats or to the presentation in specific media would be avoided.

In addition to the above points, a level of „**environmental reporting excellence**" could be created: Obligatory elements of CERs, representing a basic and minimum framework, could be defined in data bases and document type definitions (DTD). These obligatory elements are part of each CER, irrespective of liability, reporting purpose or corporate guideline.

The utilization of Internet-technologies and Internet-services enables updated online-environmental reporting with global reach and 24-hour availability. CERs could be customised according to the specific stakeholders information needs, desired channels and personal requirements. The technical benefit for distributing and presenting CERs contains three main points: (i) information on demand, (ii) hypermedia documents, and (iii) enriching environmental communications.

- **Information on demand**: This principle means that stakeholders could access online-CERs on demand. Interactivity could be realised e.g. by an interface using automated forms such as HTML-forms (Hypertext Markup Language). Stakeholders could select environmental information from a menu with given topics which they can choose from. The menu is designed so that the form resembles its traditional paper form, or the stakeholders could submit a free-text form focusing on specific requirements. By applying CGI-scripts (Common Gateway Interface) and Java-applets, documents are generated dynamically, customised and include the desired information according the stakeholders' information needs. The stakeholders could select e.g. language, profoundness, depth, breadth, time and presentation of CERs by themselves (Isenmann, & Busch, 2000). In other words: They become editors of their personal CERs. Information on demand is like seeing a CER that the stakeholders create themselves. They click on preferences from a menu and the CER is generated, e.g. someone wants information dealing with air emissions during 1998 and all sections that mention some EMAS. Moreover, by using Push-technologies, CERs ensure a permanent updating. The physical distribution of printed media could be avoided.

- **Hypermedia documents**: CERs could be designed as hypermedia documents, representing a combination of hypertext and multimedia: According to a hypertext document, a CER is structured like a network of documents embedding so-called hyperlinks to link to other documents. By incorporating hyperlinks the user is taken to another specified section (internal links) or another website (external links). According to a multimedia document, a CER represents a compound-document including different media respective containing different data types: Time-dependent, continuous data types like simulation, audio and video as well as time-independent, discrete data types like text, graphics and images could be mastered collectively. Hypermedia featured CERs fit the human cognitive and perceptive faculty (Conklin, 1987, 37):

− There is no constraint for strict sequential order in contrast to printed media. Hypermedia documents contain all structures, from linear to non-linear like hierarchy and network (Frisse, 1988, 249).

− The hypermedia structure like a network corresponds with the context of CERs, especially supporting the processes of associated perception and capturing (Conklin, 1987, 20).

− Hypermedia documents allow different specification and detail of CERs, from high-level and rough surveys to low-level and detailed environmental information. Stakeholders could select from several levels of specification. Thereby, hypermedia documents support a selective perception and comprehensive capturing of environmental information (Stibic, 1985, 176).

− There is no media-specific constraint for presenting environmental information by discrete data types (Conklin, 1987, 18). While printed media are focused on time-invariant data types such as text, graphics and images, e.g. broadcasting as electronic medium is focused on the time-variant data type of audio. Hypermedia documents allow multimedia communication to support the perception and capturing of environmental information by multiple channels: reading, viewing, watching and hearing are intertwined.

– Hypermedia documents improve the respective size of information. Thus complex environmental topics could be made clearer.

- **Enriching environmental communication**: Compared with printed media or electronic media, CERs on the Internet enrich environmental communication with respect to (i) time, (ii) immediacy, (iii) interactivity, (iv) and range. Specifically they may conduct an open dialog with the stakeholders particularly with the public which is requested explicitly by most of the NGOs' standards, guidelines and manuals:

– Internet-services like electronic mail (e-mail) and Internet Relay Chat (IRC) enable asynchronous communication as well as synchronous communication. Thereby simultaneous dialog between companies and their stakeholders could be opened.

– Concerning the immediacy, Internet-services allow direct communication without the use of any other media. Via e-mail for example urgent or more detailed questions could be addressed directly and answered immediately. In addition, frequently asked questions (FAQ) could be answered by a menu of FAQs.

– Internet-based CERs realise both, one-way communication as well as reciprocal communication as two distinct forms of interactivity.

– Internet-services enable either customised and individualised one-to-one communication or standard mass communication for all the stakeholders.

Beside the enrichment which can be considered from an telecommunication engineering view, there is addition benefit from a semiotic view. This benefit can be found in the transfer of semantics as well as in additional pragmatic information.

**7 State of the art of internet-based environmental reporting by companies**

Building on the technical benefit of using the Internet for environmental reporting (section 4), companies are still at the beginning of internet-based environmental reporting in two ways: Firstly with respect to quantity, up until now internet-based CERs are limited to a relatively small number of companies. Secondly with respect to quality and user friendly

presentation, internet-based environmental reporting is only in its infancy (Isenmann, & Warkotsch, 1999a). In summary, the majority of environmental reporting companies have not realised the challenge of combining the recent requirements for environmental reporting with the rapid development of state of the art IT. The tremendous opportunities and capabilities of internet-based CERs are not fully exploited yet: Either the possible benefit is still uncovered or it is not used in practise consequently. Against this background, the state of the art of internet-based CERs is presented.

Environmental reporting by companies is **still dominated by paper-based CERs on printed media as traditional publications in comparison to CERs on computer-based media like electronic publications on the Internet, on diskettes or CD-ROMs**. Recently, the media for presenting CERs are spreading (Jones, & Walton 1999, 412; Charter, 1998, 2): Several companies are experimenting with specific forms of printed media and with computer-based media . Daimler-Benz AG (1997), for example, published their CER in a newspaper form, Beiersdorf AG (1996) presented a noble hard-cover report in book form, whereas EPCOR Group (1996) presented the CER as a poster. Other companies e.g. Hoechst (1996) and ENI (1995, 1996) produced a CD-ROM. Increasingly companies make their CERs available via PDF on the Internet (survey: CEI 1999).

The growing use of computer-based media for CERs is grounded in the development of the applications of state of the art IT, which have improved drastically. These applications especially include (Isenmann, & Busch, 2000): (i) desktop publishing systems for convenient electronic publishing, (ii) standard markup languages like SGML (standard general markup language), XML (extensible markup language), and still in the future EML (environmental markup language) for professional document management, (iii) methods for document type modelling and preparing DTDs, (iv) availability of groupware to support the workflow of environmental reporting, (v) high-quality and high-speed data transfer on data highways, (vi) software-tools to generate CERs automatically for publishing in various media, and (vii) the utilization of Internet-technologies and Internet-services in companies.

Hence, the Internet is becoming an expedient instrument for companies to communicate their CERs (Jones, & Walton 1999, 416). Altogether, the development of state of the art IT enables efficient, integrated, interactive, hypermedia featured, dialog-oriented, and

customised environmental reporting. Based on Internet-technologies and Internet-services, companies could utilize the technical benefit to meet the **challenge of the future** professionally.

CERs on the Internet are a relatively **recent phenomenon**, both for researcher and companies, even for companies with several years of environmental reporting experience. Jones and Walton (1999, 425) emphasise, that the analysis of CERs put on the Internet „is clearly at an embryonic stage". If you searched for CERs on the Internet 1995 or earlier, you would not find very much. What was characteristic for CERs by companies on printed media until 1990 generally, seems to be quite typical for CERs on the Internet today: Internet-based environmental reporting and CERs on the Internet are only in the **infancy**. This might primarily cause surprise, but recent surveys on international level (SustainAbility, & UNEP, 1999; CEI, 1999) as well as empirical studies on national level (Welsch, 1999; Warkotsch, 1998) confirm this finding:

- Companies are still in a **very early stage** of environmental reporting on the Internet generally and in internet-based CERs especially. Compared with printed media the companies are five years behind in development of internet-based environmental reporting. Regardless of this, there has been dramatic progress in internet-based environmental reporting in the past three years (SustainAbility, & UNEP, 1999, 18).

- Until now the overall penetration using computer-based media consequently for environmental reporting is very low. In Germany, for example, **scarcely 3% of EMAS-registered companies** have put their environmental statements on the Internet. From 2085 German companies with EMAS registration until June 1999 only 56 offered their environmental statements directly from their website (Isenmann, & Warkotsch, 1999d).

- The quality of CERs on the Internet so far seems to be rather poor. Many CERs show **significant shortcomings**, notably in terms of user-friendliness, updating, facilities for dialog, interactivity, and downloads, customised information and hypermedia-features. Furthermore, the majority of CERs on the Internet are **static** documents, slight adaptions of existing paper-based CERs or, a mere word-for-word **one-to-one copy** of CERs from printed media (Jones, & Walton, 1999, 416; Charter, 1998, 2; Elkington, & Priddey, 1997,

52). Companies often do not pay attention to the logistical aspects of their websites, including search facilities, navigation, hypermedia-features, feedback and contact information.

- The reason for this premature stage in internet-based environmental reporting is structured into four aspects:

- (i) Both, environmental reporting and the utilization of the Internet are relatively **recent phenomena** for companies. The responsibility for maintenance and updating etc. often falls on different corporate departments (Jones, & Walton 1999, 425). In several cases, the validating by neutral third parties and verifiers is difficult. Thus, internet-based environmental reporting for companies is not only a question of technical usage state of the art IT in general, but also an organisational process with several side effects of trail and error learning.

- (ii) With the exception of a few contributions, the systematic analysis of the **technical benefit** of using the Internet is **overlooked** (Charter, 1998, p. 1). Usually the consequences for the workflow of environmental reporting, for the content, and the design of CERs are still discussed on a secondary level or in such a limited way that they have a minor impact on environmental reporting up to date.

- (iii) There seems to be a great **need for practical guidance** in implementing an internet-based environmental reporting in companies. Although many checklists exist for paper-based environmental reporting on printed media, there is a gap of helpful guidance for internet-based environmental reporting concerning either the media-specific benefit and capabilities of the Internet or the consequences of the workflow of reporting, with regards to content and design of CERs (basics and key components: Jones, & Walter 1999; Isenmann, & Busch 2000; Isenmann, & Warkotsch 1999e; Denisow, et al. 1998; Charter 1998).

- (iv) The network of resources on the Internet containing information on analysis, collections, and best practise of environmental reports on the Internet is just being developed and will be continuously updated and improved (CEI, 1999; IISD, 1999; CSEAR, 1998; CAROL). Benchmarking, rating, and sector-specific analysis of CERs put

on the Internet will be more comfortable. Establishing the best available internet-based environmental reporting will be a medium to long-term process of development.

For companies the **backlog** of using internet-based environmental reporting still seems very large. Admittedly, from a short to medium-term perspective internet-based environmental reporting might mean additional costs, varying from entity to entity. For those companies already publishing CERs and for those with some experience using state of the art IT, the additional costs might be minimal. For those companies new to such internet-based environmental reporting, the initial costs might be substantial e.g. to put in place: data capture, data storage, metadata management, data analysis and decision support which represent the necessary IT-prerequisites. Moreover, the installation of a workflow for environmental reporting will also mean some initial costs. But from a long-term perspective the attainable benefit might exceed the costs. Generally, companies are requested to weight the costs of various environmental reporting media approaches against stakeholder needs and resource requirements to meet such needs.

For some companies the use of the Internet for corporate environmental reporting might seem purely a smart accessory, a nice extra or just a buzzword in comparison to traditional corporate environmental reporting. However, the idea and approach of internet-based environmental reporting represent much more than a buzzword, which is used loosely. The utilization of internet-based environmental reporting is definitely not loose and should not be looked lightly. Internet-technologies and Internet-services are not limited to offer new channels for distributing or presenting CERs. They are going to spur a **shift** for environmental reporting companies from responsibility and accountability to sustainability (Kerkhoven, & Nelson 1994, 6). Furthermore, based on two global surveys in „The Internet Reporting Report" carried out from SustainAbility, & UNEP (1999, 21), the Internet is seen as „indispensable tool for sustainable development reporting" (similar: Jones, & Walton, 1999, 425).

The World Wide Web (www) offers companies a very successful Internet-service for distributing and presenting CERs: hypermedia-features, online-information, global reach and 24-hour availability. Moreover, the **workflow** of environmental reporting could be improved by the technical benefit of internet-based environmental reporting fundamentally:

Environmental data could be captured in different data sources, combined despite various data formats, analysed for decision supporting, professionally mastered and hypermedia-featured, customised according the stakeholders' information needs, and distributed and presented to the preferred channel via e-mail, or perhaps alternatively cross-media via fax or printed via mail. Aside from this, the **content** and **design** of CERs will be transformed (Jones, & Walton, 1999, 417): Online-availability, downloads in Portable Document Formats (PDF), additional environmental documents, interactivity, feedback opportunities, contact details, automatic order forms, environmental electronic forums on the one hand and hyperlinks, graphical designed websites, navigation, search engines, regular updates and site promotion on the other hand represent some of the content and design capabilities that are already realised to a certain extent.

The technical benefit of **internet-based environmental reporting is a powerful vehicle** which supports the workflow of environmental reporting generally, from preparation and administration to distribution and presentation of CERs. Sensing that traditional environmental reporting might be limited, companies are considering how to improve CERs and environmental reporting in general. With this in mind, one **challenge** for reporting companies seems to be the utilization of the Internet and internet-based CERs. Internet-based environmental reporting will change the workflow of environmental reporting as well as the content and form of CERs.

## 8 Framework for internet-based environmental reporting

The third level includes a look to an **IT-application** for internet-based environmental reporting, now turning from the basics, IT-challenges and technical benefit to consequences for companies in practice. Thereby, a fundamental framework for internet-based environmental reporting is illustrated. This framework for internet-based environmental reporting is based on three related parts (fig. 5).
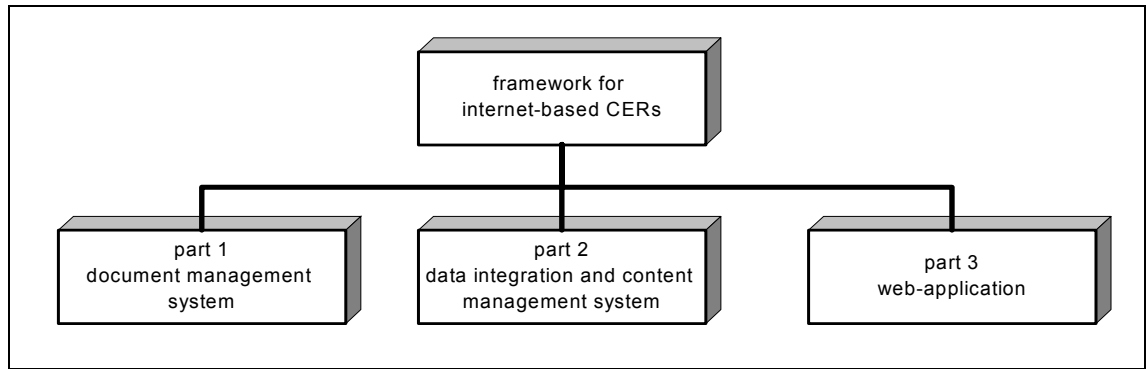
*Figure 5: Framework for internet-based environmental reporting (Isenmann, & Busch, 2000)*

- **Part 1**: A document management system based on Internet-technologies represents the IT-specific fundament for the efficient production and administration of internet-based CERs. This document management system should ensure the necessary preparation of the documents with regard to structure, content and format for machine processing.

- **Part 2**: Based on a document management system there is a system for data integration and content management. This system provides both (i) cooperative production and administration and (ii) interactive and customised distribution and presentation of internet-based CERs.

- **Part 3**: The data integration and content management system is linked with the web-application. The web-application represents an interactive interface enabling the stakeholders (i) to specify and submit their information needs and (ii) to enter their individual user profiles. The interface also provides the presentation of the CERs.

The three parts illustrated above construct a rough, but fundamental framework of internet-based environmental reporting.

**9 Architecture of IT-implementation**

Building on the framework for internet-based CERs, a basic architecture of an IT-implementation is explained, in order to exploit the technical benefit of Internet-technologies and Internet-services. The architecture is based on a **three-layer web-**

**application** (Goldfarb, & Prescod, 1999, 76), using descriptive markup languages like XML (Extensible Markup Language) - or perhaps in future EML (Environmental Markup Language) – for data modelling and creating document type definitions (DTD). The aim of such a basic architecture is to support the workflow of environmental reporting in general, including preparation, administration, distribution and presentation of CERs (fig. 6).
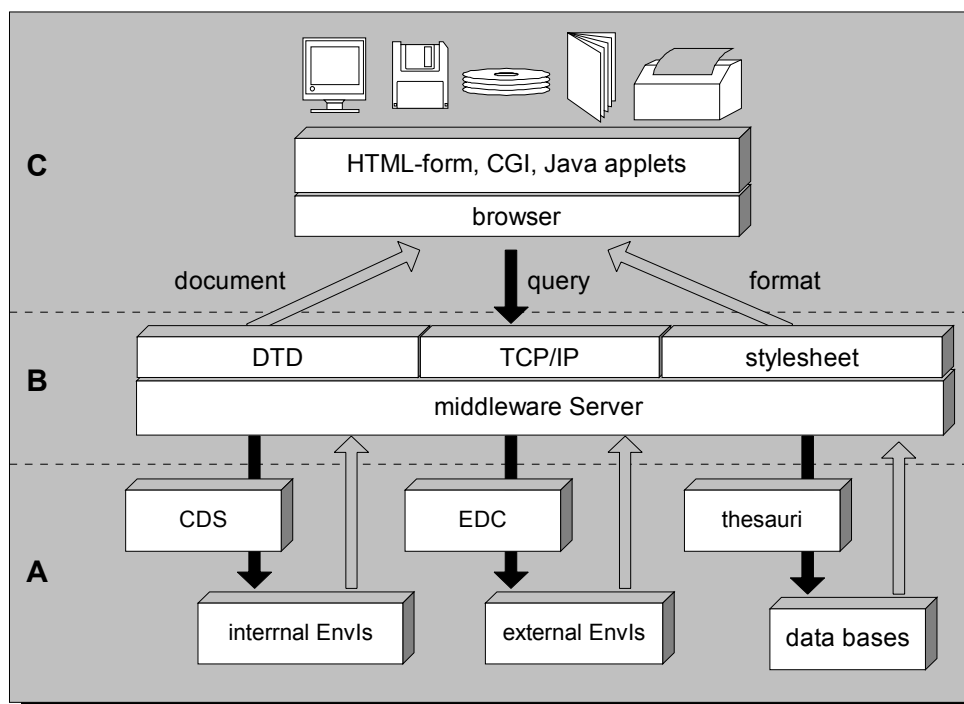


*Figure 6: Three-layer web-application for internet-based environmental reporting*

From an information management perspective, CERs are representing documents. These documents consist of components such as preface, description of the company, description of environmental management system, input output inventory etc. (Schraml, 1997, 191; e.g. for environmental statements according EMAS: Steven, & Letmathe, 1998). The components likewise are sequenced logically and grouped into a hierarchical structure. **XML** is a recent descriptive markup language, representing an Internet-derivative of SGML (Standard General Markup Language). XML enables the encoding of documents for machine processing by designing DTDs with descriptors. Descriptors - so called tags - determine the components, the logical sequence and hierarchical structure of the

documents. By tagging CERs, the components can be distinguished and identified easily. Machine processing is possible. With XML encoded documents any number of different data viewing specifications and styles can be applied as needed. CERs can be routinely published cross-media, e.g. printed on paper, pressed on CD-ROM or put on the Internet from the same databases.

The three-layer web-application allows the publishing of customised CERs despite heterogeneous data bases and different data sources: The first basic **data layer** (A) contains the environmental information systems (EnvIS) and data bases, including the necessary metadata like e.g. environmental data catalogue (EDC), catalogue of data sources (CDS), and other thesauri. The second **middleware layer** (B) is used as a data integrator responsible for performing the content management of CERs. On this layer the users query is structured into the necessary environmental data in order to generate a CER by machine processing. The environmental data are located, accumulated, and consolidated in a compound document according to a DTD. The third **application layer** (C) represents the interactive user interface. The interface is used either for submitting the users information needs or for presenting the published CERs on the Internet. The application layer provides easy access via a standard browser on the Internet.

- **Data layer (A)**: By using XML coded CERs, the desired environmental data from EnvIS could be made available and shareable for authorised users on computer-based networks like on the Internet. EDC, CDS and other thesauri contain the **metadata** in order to enable indexing and search functions for comfortable retrieval. The metadata store data about data and allow the identification of the desired environmental data. For example, the metadata specifically provide up to date data of content, data source, location, data format, data access etc. Currently a Resource Description Framework (RDF), which represents a standard for Internet-metadata, is going to be developed (W3C 1999; Tolksdorf 1999, 419).

- **Middleware layer (B)**: A so-called middleware server receives the users query including their information needs and other preferences with regards to channel, media for presentation, preferred document format and layout. Transforming the users query, the server locates the desired environmental data by using the metadata. Then, the environmental data are **mastered modularly** in a compound document. DTDs provide the

grammar for CERs, ensuring the logical structure of the components of CERs. Processing and presentation including layout and format is determined separately by stylesheets. Both, CERs and stylesheets are distributed via Internet.

- **Application layer (C)**: Graphical user interfaces (GUI) such as the browsers „Netscape Navigator" and „Microsoft Internet Explorer" already allow the use of XML, respectively XML-parser are currently under development. The user interface provides either an **interactive dialog medium** incorporating hyperlinks and automatic HTML forms or a hypermedia featured medium of presentation. The user is able to select e.g. profoundness, depth, breadth, time and presentation of CER from a menu.

**Summarising**: The three-layer web-application enables the publishing of customised, or personal CERs. The users preferences and information needs are submitted via browser. A middleware server interprets and transforms the queries, generates the CERs from the consulted data sources and pass it on to the browser together with a stylesheet. The efficient preparation and administration is supported by the modularity enabled by XML. The rapid distribution can be realised by computer-based networks like the Internet. Internet-services like the www provide hypermedia featured presentation of CERs.

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**Note**

The website addresses listed above throughout this paper were correct and checked at the time of submitting, but may have been changed or updated subsequently.

**11 Authors**

**Corresponding author**: *Ralf Isenmann*, Master of Industrial Engineering and Management, Research Fellow at the Department of Business Information Systems and Operations Research (Prof. Dr. *Heiner Müller-Merbach*). Postal address: University of Kaiserslautern, P.O. Box 3049, Germany, 67653 Kaiserslautern, phone: +49-631-205-2936, fax: +49-631-205-3381; e-mail: isenmann@sozwi.uni-kl.de, Internet: http://www-bior.sozwi.uni-kl.de;

**Co-author**: *Nicolas Warkotsch*, Master of Industrial Engineering and Management, Consultant, CON MOTO Strategy & Implementation Consulting Group. Postal address: Dolomitenstr. 5, Germany, 81547 München, phone: +49-89-64282444, fax: 0180 505254-659550, e-mail: warkotsch@hotmail.com

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**Bestelladresse**: Universität Kaiserslautern, Lehrstuhl für Betriebsinformatik und Operations Research (BIOR), z.Hd. Herrn *Ralf Isenmann*, Gottlieb-Daimler-Straße, 67653 Kaiserslautern, **Tel.**: 0631 205 2936, **Fax**: 0631-205 3381, **E-Mail**: isenmann@sozwi.uni-kl.de; **Internet**: http://www-bior.sozwi.uni-kl.de