Reference Architecture for Dialogue-Based Sustainability Reporting

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Abstract
Sustainability reporting is the integrated communication of economic, ecologic and social impacts. Nowadays, most reports are web-based. However, small and medium enterprises are by far less active in this field than large companies due to a lack of resources. In this paper a reference architecture and its concrete implementation is presented which will provide a free software system to reduce the cost of sustainability reporting. In order to demonstrate the flexibility of this architecture, ongoing research especially in terms of dialogue-orientation, interactivity and web 2.0 will be included to provide companies and other organisations a freely available tool to report on sustainability issues.

1. Introduction
Sustainability reporting is the integrated communication of an organisation’s economic, ecologic and social impacts. In large companies, sustainability reporting nowadays is no longer a matter whether “if” to report at all, but more a matter of “how” to report (Marshall and Brown 2003). In a ranking from 2007 none of the 30 biggest German companies (DAX30) were listed as “non-reporter” any more (Gebauer and Westermann 2007). However, small and medium companies (SMEs) are still largely lagging behind, not having the means to publish comprehensive reports.

In a market study of 2008 nine software systems for sustainability reporting have been analysed (Stammel 2008). Only one of them is available for free. One conclusion was that software support for the creation of sustainability reports is focusing mainly on larger companies and oftentimes too expensive for SMEs. The free system, though, was based on open source software and developed within a student project at the University Oldenburg, Germany, named cerebral (Corporate Environmental REporting for Business Related Affiliates).

This project, despite technical difficulties with the underlying framework (Apache Cocoon), successfully demonstrated the flexibility of XML pipelines, which were used to take a single source and transform these data easily into various output formats like HTML, XML or PDF (Marx Gómez et al. 2007). Furthermore, content could be presented to each visitor in an individualised way, allowing them to customise their reports. Besides the output of sustainability reports, a report editor was given, based on a GRI 3 schema, the de-facto global standard (GRI 2006).

However, the cerebral software had some limitations: The report schema was “hardwired” in XML; the cocoon framework proved to have technical difficulties and underwent a major revision, changing the underlying code structure and thus making further development difficult.

In the meantime, new research on sustainability reporting has taken place. An overview of new trends will be given in the second chapter, introducing the concepts of dialogue-based sustainability reporting. Other trends regarding internet-based reporting can be found e.g. in (Isenmann 2007). They demonstrate that
sustainability reporting is an ever developing field, with new topics needing steady consideration. Cerebral, while providing a free implementation, will hardly be able to cover such topics with its architecture. In order to provide a modern, freely available platform for sustainability reporting, emphasis has been put on developing a reference architecture demonstrating the requirements from a company point of view as well as from an IT view. This reference architecture will be presented in the third chapter. In the final chapter, an outlook will be given on the ongoing development towards a reference implementation, providing a freely available, modern platform for dialogue-based sustainability reporting.

2. Dialogue-based sustainability reporting

In this paper, a new approach for a free sustainability reporting software is presented. Two goals have been the focal point of this redevelopment: a) considering the requirements of SMEs, as those are under-represented in sustainability reporting compared to large companies (Coope 2004) and b) developing a modern and extensible platform, providing a modern, web 2.0-based interface, as described e.g. in (Süpke et al. 2009).

Taking into account the heterogeneous architectures of SMEs, a reference architecture will be presented and an outlook towards ongoing implementation of this architecture given. In order to demonstrate the flexibility of the chosen architecture, a short introduction to research on dialogue-based sustainability reporting will be given in the following section, which is followed by its adaption in the architecture. In the last years, there have been many developments regarding sustainability reporting. Since the release of cerebral, there have been new trends emerging, such as dialogue-based sustainability reporting (see e.g. Süpke et al. 2009), which is the focus of this paper. However, there have been significant other contributions, which will be summarised in the following. In order to give an overview on relevant trends, a morphological box of sustainability reporting is suggested, which may be extended to cover further aspects (which are, however, not in the focus of this paper). A number of attributes along with their possible characteristics describe the status of a sustainability reporting system for any given organisation. These attributes are classified regarding structure, type and presentation of a report (Table 1).

Table 1: Morphological box of sustainability reporting

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Characteristic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Structure</td>
<td>Standard based</td>
</tr>
<tr>
<td>Standards</td>
<td>Individual</td>
</tr>
<tr>
<td>Periodicity</td>
<td>Irregular</td>
</tr>
<tr>
<td>Boundaries</td>
<td>Single company</td>
</tr>
<tr>
<td>Form</td>
<td>Print</td>
</tr>
<tr>
<td>Data format</td>
<td>Print</td>
</tr>
<tr>
<td>User modelling</td>
<td>Stereotyped</td>
</tr>
<tr>
<td>System adaption</td>
<td>Adapted</td>
</tr>
<tr>
<td>Communication</td>
<td>Monologue</td>
</tr>
</tbody>
</table>

Regarding the structure of a report, it can be either based on standards such as G3, or may be an individual type of reporting, as under-resourced companies (typically SMEs) may publish. Reports may be published irregularly, regularly (e.g. in a two-year-rhythm) or even continuously with automatically updated, daily
data. Reporting can be done by, as usual, a single company, including sub companies (see e.g. Nestlé 2009), or along supply chains and company networks (for ongoing research on this see Solsbach et al. 2009).

Regarding the type, a report may either be entirely on print, might additionally have been converted e.g. to PDF or a 1:1 conversion to HTML without any added values from the internet. If they are web-enabled, the focus is still oriented to or coming from print, but has been subsequently enriched with additional web elements. A web-based report is using the potential to its full extend, planning from the beginning to the end, to integrate useful features into the report process. This will be the base for a dialogue-based reporting process, enabling all stakeholders to contribute information and opinions easily. The data format may either be print, web, or even digital i.e. non-human-readable data export, allowing further automated computation of sustainability data. This aspect will be explained in more detail later.

Regarding the presentation of reports, Lenz provided a classification of company reports (Lenz 2003), which can be adapted towards sustainability reporting (e.g. Isenmann et al. 2008). Stereotyped systems don’t make any differences between different user types, providing a one-purpose-serves-all report. Individualised systems distinguish between certain, typical user groups, while personalised systems are designed to give information to unique users. Accordingly, adapted systems only provide a fixed system of information, which has been set once. Users of adaptable systems may change the information they want to retrieve during runtime, while adaptive systems automatically customise the presented information according to information they gather about the user.

Finally, there are different ways of communication reporting can be based upon (see Figure 1). Any number of companies might exchange information with each other and present a unified sustainability report (compare attribute “boundaries”), publishing its sustainability report to be read by stakeholders. The stakeholders might give feedback to the publishing companies, going from simple feedback forms to an entirely dialogue-based process on web-based platforms. Furthermore, they might discuss this information among themselves, on the companies’ web pages or externally.

![Figure 1: Possible directions of communication flow in sustainability reporting](image)

There are numerous ways to improve web-based sustainability reporting, from customisable content to interactive sustainability reporting, or truly dialogue-based forms of communication. All these are based on web platforms and, in good report systems, used by some extent. However, even the award-winning sustainability websites of BASF (Gebauer 2010) are, in terms of dialogue-orientation, not truly going beyond simple contact forms or simple links to social bookmarking sites. A recent survey on research activities was published (Freundlieb and Teuteberg 2010), analyzing stock listed companies worldwide according to their sustainability reporting. The dialogue-features presented in (Süpke 2009) have been considered in this analysis, attesting that there is still high potential for companies to implement such ideas.
Providing more direct means of user communication (as described e.g. in Süpke et al. 2009b) will enable companies to gain valuable feedback from different stakeholders, attract more non-expert-readers and demonstrate transparency and stakeholder involvement, as requested in (KPMG/SustainAbility 2008). However, a number of problems arise when enabling stakeholders to directly communicate on a company’s website, among which are increased effort to moderate and prevent malicious content or facing negative criticism in a transparent way. The reference architecture presented in the next section will consider such problems stemming from a community-enabled form of sustainability reporting.

3. Reference Architecture

Since cerebral provided a free platform, its features should be used as a basis for a new development. There are two main tasks for a sustainability reporting platform: Create reports and then deliver them. Both were realised in cerebral, with the focus on customisable output of reports. The creation of reports was supported by using schemas within the IBM DB2 Express database. However, a schema editor was not provided, which would allow smaller companies to easily introduce tailored report schemas.

One of the issues of SMEs not reporting is found within the lack of resources (Coope 2004, p.21). Also, while there are guides to reporting, the task of especially first-time reporting should not be underestimated and consequently be aided by the software system. Thus, there should be an easy possibility to specify adapted schemas, considering company-specific reporting requirements, as well as deviations from the standard schema where necessary. A schema editor should therefore be included, providing globally and generally accepted accounting principles (e.g. GRI G3), industry based standard (e.g. sector supplements) and company-specific information (adapted from DiPiazza/Eccles 2002).

The output module needs to be flexible, allowing extensions to cover ongoing research and new developments. This will be exemplified by including a module for gathering and administering user feedback. Such a component is useful when a continuous user dialog is enabled, as the employee responsible for stakeholder communication will have a central interface to efficiently dealing with comments, links, questions etc. A component-based view on such an architecture is given in Figure 2. As common, an admini-
The component view gives a general overview on the different tasks of the sustainability reporting software. The underlying architecture needs to support these tasks, while providing a flexible document structure, like in Cerebral e.g. Figure 3 shows the proposed reference architecture. There are some distinct differences to the architectural structure in Cerebral. First, a persistency layer with an Object Relation Mapper is introduced, in order to ease and secure data storage and retrieval. Furthermore, a Unified Data Access Layer is introduced, serving as standardised wrapper for automatic collection of indicators from external systems. The output format is kept flexible, but differentiated between varying recipients.

While HTML and PDF will be the data formats almost exclusively being asked for by regular readers, digital data exchange for automated computation and retrieval of data should be provided. This will prove useful for connected companies, ministries and other professional users. While an exchange in XML or Microsoft Excel may be suitable in many cases, a more sophisticated option will be the provision of a specialised reporting format, like it is used for financial reporting with XBRL (eXtensible Business Reporting Language). Provided via Web Service, any system can easily retrieve reports digitalised in such manner. Up to now, there is no common XBRL standard for sustainability reporting. There is work in progress done by the GRI itself, and early research e.g. in (Solsbach et al. 2009).

The other way around, Web Services can be easily used to integrate external systems as well, automatically gathering input to provide up-to-date quantitative indicators. Especially in the field of Corporate Environmental Management Information Systems (CEMIS), there are a large number of specific solutions, without a high degree of integration or standard. However, CEMIS may provide valuable data for environmental and sustainability reports. By providing standardised wrappers i.e. access methods to specific indicators, a company-specific information system can easily contribute data without being changed structurally.

Extended functionality which may prove critical for companies (see sec. 2) is provided in form of modules. These are optional and can be activated step by step, as the company gathers experience. In this way,
critical functionalities concerning employee time e.g., costs or critical feedback are not mandatory and leave the decision whether to use them up to the companies.

4. Conclusion and Outlook

The proposed architecture allows a large number of specific architectures to be used and thus can be implemented in different IT-environments. However, the effectiveness of this architecture needs to be demonstrated by its implementation, and the advantages of a modern, dialogue-based sustainability reporting system need to be evaluated.

In an interdisciplinary project, two student project groups were organised to work on these topics. One group is focusing on defining a university standard for sustainability reporting and retrieving necessary data, while the other group is developing a general-purpose reporting software as a reference implementation for the suggested reference architecture. This reference implementation is based on grails, combining the benefits of J2EE systems with the modern MVC-approach of ruby on rails (see Figure 4). The definition of required components and the modular structure, the creation and usage of suitable functionalities can be easily implemented. The results will be evaluated and published in a subsequent publication, linked to the excepted impacts described here.

5. Acknowledgement

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6. Literature

Apache Cocoon: http://cocoon.apache.org/ last access: 2010-04-29
KPMG Sustainability B.V., SustainAbility Ltd. (Bartels W, Iansen-Rogers J, Kuszewski J) (2008): Count me in - The readers’ take on sustainability reporting