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Research Note

Augmented Sustainability Reports: A Design Science Approach

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Abstract

Sustainability reports provide stakeholders with information about a company's efforts to balance its economic, ecological and social goals. Because of their influence on a company's image as well as on the customers' buying and shareholders' investment decisions, sustainability reports are an integral part of today's corporate online communication.

Following a design science research approach, this paper describes the design, prototypical implementation and evaluation of augmented sustainability reports. In contrast to traditional PDF- or print media-based sustainability reports, augmented sustainability reports contain multimedia contextual information that is displayed depending on the user's gaze position. In our prototype the gaze position is simulated using mouse tracking. The comparative evaluation of the prototype was conducted via a quantitative questionnaire based on the technology acceptance model (TAM). Additionally, qualitative feedback was gathered during the course of the evaluation. Traditional and augmented sustainability reports were compared on the basis of the questionnaire results which reveal room for improvement of the prototype as well as possible starting points for future research.

Overall, the evaluation results indicate that our test users had a strong preference for the augmented sustainability report compared to the PDF-based report even though both alternatives had identical content.

Keywords: Design science, sustainability reports, augmented browsing, experiment, environmental, technical innovation, adoption, acceptance factors

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INTRODUCTION

Sustainability reports (SRs) provide stakeholders with information about a company's efforts to balance its economic, ecological and social goals, the so-called triple bottom line (Elkington, 1998). In this context, sustainability can be defined as "meeting the needs of the present without compromising the ability of future generations to meet their own needs" (Brundtland Commission, 1987). Studies indicate that SRs bear the potential to improve a company's image and to influence consumers' buying decisions as well as shareholders' investment decisions (Bartels et al., 2008; Townsend et al., 2010). Hence, companies that provide their stakeholders with state-of-the-art SRs can benefit from potential competitive advantages. In this way, sustainability reporting has become an integral part of today's corporate online communication.

Although IS researchers have identified a trend towards online sustainability reporting, they also concede that the technical possibilities online reports offer in comparison to traditional PDF- or print media-based reports have not yet been utilized to the fullest extent (Isenmann et al., 2007; Isenmann et al., 2011; Rikhardsson et al., 2002). Accordingly, Melville suggests that the IS community needs to further investigate how information systems influence beliefs about the natural environment and environmental sustainability, and how these systems should be designed (Melville, 2010).

Following this suggestion, we propose an innovative way to extend existing reporting practices by utilizing a design science research approach. In our suggested concept, multimedia information is no longer statically embedded into the report, but displayed on-demand based on the reader's gaze position, which dramatically changes the way users interact with the SR. In our prototype the gaze position is simulated using mouse tracking. The contextual information is not only provided by the reporting company, but also by third parties such as Wikipedia, Google and social networks. Our study investigated whether test users preferred augmented sustainability reports over traditional PDF-based sustainability reports.

We first review the relevant literature in section 2. In section 3, we describe our general research approach, the design and implementation of the augmented sustainability report (ASR) prototype, and the quantitative and qualitative evaluation results. Section 4 contains a discussion of the results, and section 5 outlines limitations and starting points for future work. The contributions to theory and practice are summarized in section 6.

BACKGROUND

A growing number of SRs are published in the form of websites and online portals instead of PDF documents or print media (Rikhardsson et al., 2002). In the course of this development, researchers have suggested concepts and solutions that utilize the multimedia potential of online SRs, enable custom-tailored sustainability reporting for different stakeholder groups and facilitate a dialogue between the reporting companies and their stakeholders (Isenmann, 2004; Isenmann et al., 2007, 2011). Nevertheless, researchers still criticize online SRs, asserting that the technical possibilities available are not utilized to the fullest extent and that companies are hesitating to replace static reporting formats (Isenmann et al., 2011).

In the IS community, the term 'augmented' has been used in the field of augmented browsing. Augmented browsing is "dynamically adding supplementary information to a webpage without having users navigate away from the page" (Dai et al., 2011). Augmented browsing has been successfully applied in other use contexts, such as the management of a museum collection (Cunliffe et al., 1997). Pafilis et al. (2009) implement augmented browsing by tagging gene, protein and small-molecule names in websites and opening popups with additional information from popular life sciences databases and websites (see also O'Donoghue et al., 2010). Dai et al. (2011) used augmented browsing to categorize search results in the PubMed database on biomedical literature and to provide additional information on gene and gene products.

The previous applications of augmented browsing have in common that a specialized vocabulary is used within the application domain, which on the one hand eases the tagging process and on the other hand increases the need to provide additional background information to novice users. This also applies to sustainability reporting since SRs contain many chemical and technical terms as well as key performance indicators that may not be understandable to the everyday website visitor. The previously mentioned papers all share a strong focus on the technical implementation of augmented browsing. Only O'Donoghue et al. (2010) mention some qualitative feedback from their users. This paper takes a different approach by focusing on the evaluation of the implemented prototype and investigating how the augmentation influences user acceptance of a SR.

Our research transfers the term augmented to the domain of SR. An ASR contains multimedia contextual information that is displayed depending on the user's gaze position which is simulated using mouse tracking in our prototype. The contextual information is not only provided by the reporting company, but also by external third parties. Thus, our research aims to combine the technologies of augmented browsing and eye tracking.

Eye tracking has been applied to the domain of human-computer interaction as both a usability evaluation tool as well as an input device (Poole and Ball, 2005). Previous applications of eye tracking as an input device include hands-free user interfaces for disabled users (e.g. Bonino et al., 2011) as well as controlling virtual reality environments or games (e.g. Nacke et al., 2011).

Researchers have found eye tracking to be a convenient and natural addition to user interfaces (Sibert and Jacob, 2000; Zander et al., 2010). For example, Sibert and Jacob (2000) found that eye tracking outperformed using a mouse regarding speed for selecting items. However, using eye tracking as an input device also raises new problems such as unintentional fixations and sporadic dwellings that trigger unwanted interactions with the system. Dwell-time based solutions have been successfully applied in the past to overcome this obstacle, however, choosing a dwell time is always a trade-off between speed and accuracy (Zander et al., 2010).

RESEARCH METHODOLOGY

The problem discussed in recent literature that the technical possibilities offered by traditional online SR are not utilized to the full extent requires distinct research activities and solutions. The solution in this paper is presented by means of an artifact. In the IS research field the creation of artifacts is usually associated with design science research (Hevner, 2007; Hevner et al., 2004; March and Smith, 1995). We have taken the design science approach in our work because of its detailed and methodologically sound research process for creating an artifact.

Research Approach

Following the design science research approach this paper describes the design, prototypical implementation and evaluation of an ASR. The research approach is illustrated in Figure 1.

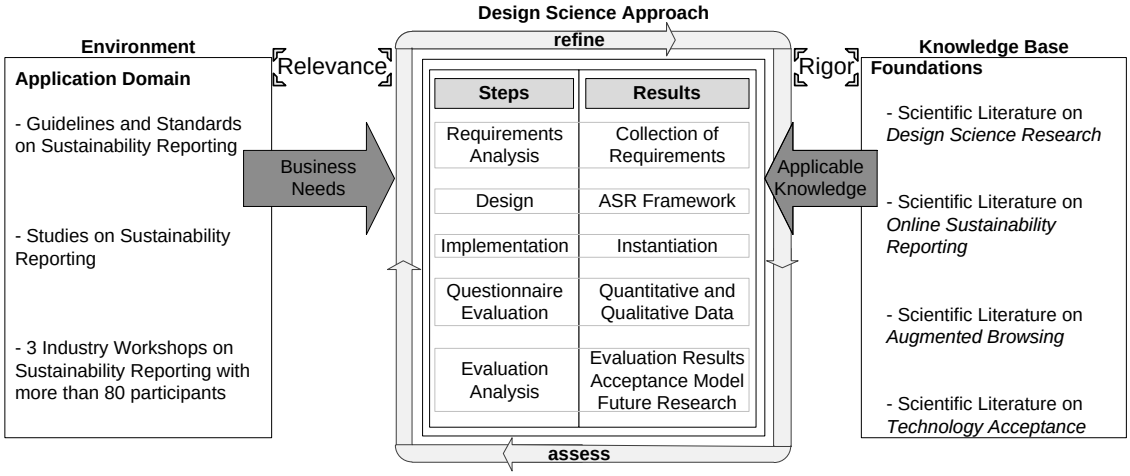


Figure 1: Research Approach (Hevner, 2007; Hevner et al., 2004)

The business needs for ASR are derived from existing standards and guidelines as well as studies on sustainability reporting. Prior to the research outlined in this paper, three industry workshops with more than 80 participants from science and practice were recruited, and 13 experts were interviewed to directly collect current challenges and requirements in the field of sustainability reporting within a third-party funded project. The extensive results of the requirement analysis can be found in (Gräuler et al., 2013).

Research on design science, online sustainability reporting, augmented browsing and technology acceptance contribute to the knowledge base that can be applied to our research approach. By using the design science approach described in Hevner et al. (2004) to address both the business needs and the applicable scientific knowledge, the paper intends to achieve both a rigorous scientific foundation and a relevant contribution to the application domain

The research approach can be subdivided into five steps: 1) Following the requirements analysis, a framework for ASR was designed; 2) During the implementation, the suggested framework was prototypically implemented resulting in an instantiation of the IT-artifact; 3) To gather both quantitative and qualitative data, a questionnaire evaluation of the prototype was performed; 4) During the evaluation, the ASR prototype was compared to a traditional PDF-based SR on the basis of acceptance factors; and 5) The evaluation tested whether the augmentation of a SR had a positive effect on a user's acceptance of the report, and established a number of starting points for future research. Moreover, these analyses provide information that can drive further improvement of the concept and implementation of an identified ASR. In preparation of this paper, two cycles of this research approach have been conducted.

Table 1 contains 7 guidelines on design science research (Oesterle and Otto, 2010) and indicates how these apply to this paper.

Table 1: Guidelines on Design Science Research (Oesterle and Otto, 2010)

Guideline	Description	Instantiation in ASR Research Design
1	Design as an Artifact	An instantiation is a typical design artifact (March and Smith, 1995).
2	Problem Relevance	By influencing a company's image, consumers' buying as well as shareholders' investment decisions (Bartels et al., 2008; Townsend et al., 2010), SRs offer a potential competitive advantage to the reporting companies. Since sustainability reporting is increasingly performed online (Isenmann et al., 2007, 2011; Rikhardsson et al., 2002), it is a relevant research domain for the IS community.
3	Design Evaluation	The designed IT artifact was evaluated utilizing a questionnaire on factors of technology acceptance which were adopted from existing scientific literature. In addition to this quantitative data, qualitative feedback was collected as well.
4	Research Contributions	This paper builds on current research on online sustainability reporting and extends the existing knowledge base by proposing the innovative concept of augmented sustainability reporting, which was designed, prototypically implemented, and evaluated following a design science research approach. Additionally, implications for practice and future research were derived. Possible directions for future research and further improvements of the proposed concept were generated qualitatively during the evaluation of the prototype.
5	Research Rigor	The research approach followed established guidelines on design science research. It was based on existing literature regarding online sustainability reporting, technology acceptance and augmented browsing.
6	Design as a Search Process	In preparation of this paper, two cycles of the research approach were conducted. In each cycle, room for further improvement of the concept and the prototypical implementation were identified.
7	Communication of Research	By means of the present paper, the results are being communicated to the scientific community. To disseminate the results to practitioners as well, the results were presented to the members of the IT-for-Green project (www.it-for-green.eu) and the Ertemis corporate network (www.ertemis.eu).

Design

To determine current challenges and requirements, three workshops with more than 80 participants from the academic community and industry were conducted preceding this paper. During the first two workshops which occurred in January and March 2010, a creativity technique called World Café (Brown et al., 2007) was applied. First, the participants were divided into groups of 4 to 10 people who discussed requirements and issues from their companies' perspective. A moderator guided the discussion and documented the results for later reference and analysis. Then, people could switch to another group to contribute the findings and ideas of their previous group to a different discussion. In addition to the workshops results, requirements were determined within the course of 13 expert interviews between November 2009 and March 2010. Finally, a literature review was performed in June 2011 to identify additional requirements.

The process described above resulted in a set of 63 requirements which were categorized and consolidated in a third workshop in July 2011. An empirical survey conducted in August 2011 prioritized the remaining set of 47 political and legal, economic, organizational and technical requirements. The extensive results of the requirement analysis can be found in (Gräuler et al., 2013).

The requirement analysis indicated that a web-based solution with consistent and transparent reports was desired. Stakeholders sought usability, understandability and enjoyment, but discouraged the provision of excess information. Similar requirements are subsumed under the term 'clarity' in the reporting guidelines of the Global Reporting initiative (GRI Global Reporting Initiative, 2011).

Based on these requirements, this paper suggests extending SR by multimedia contextual information that is displayed depending on the users' gaze position which is simulated using mouse tracking within the prototypical implementation. Biedert et al. (2009) propose a similar concept for an eye tracking enabled e-book reader that utilizes pictures and sounds depending on the reader's gaze position in order to enhance the reading experience of fiction. We transfer this concept to the application domain of sustainability reporting, assuming that the users' acceptance as well as, in the long run, the companies' acceptance of SR can be improved by augmenting the contents of the reports. This assumption will be further investigated in the comparative evaluation of an ASR against a traditional SR. Figure 2 illustrates the IT architecture for the implementation of an ASR that was designed following the Text 2.0 Framework (Biedert et al., 2010).

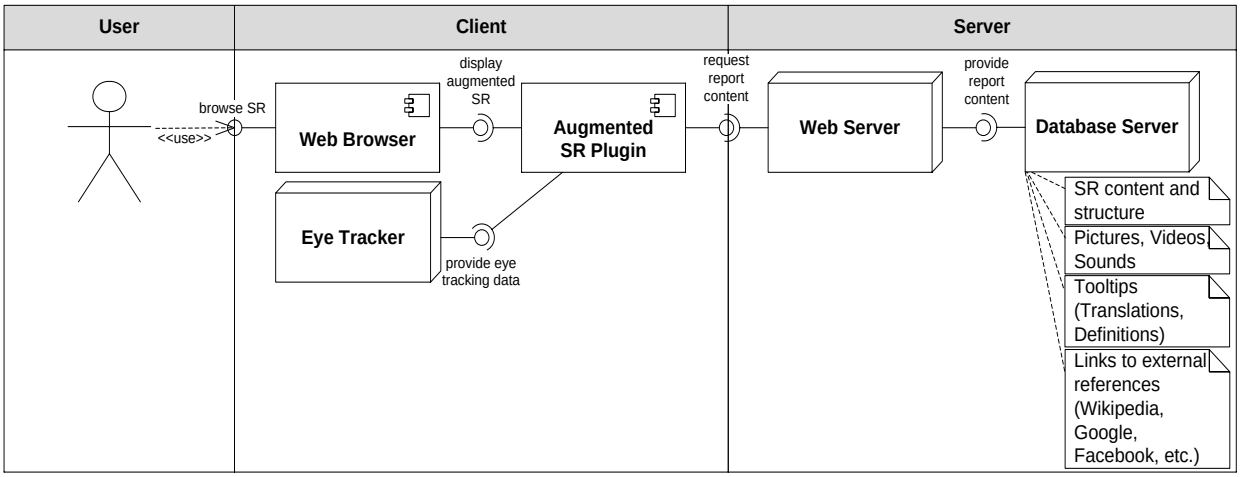


Figure 2: IT Architecture for Augmented Sustainability Reports (Biedert et al., 2010)

The ASR is displayed via the user's web browser which is extended by an augmented SR plugin. The plugin receives the user's gaze data from an eye tracking device and displays multimedia contextual information such as figures and tables as well as relevant external references. For example, if a certain marker within the report is being read by the user, content such as definitions of technical terms by Wikipedia, search results by Google, search results from social networks such as Facebook, LinkedIn or Twitter as well as YouTube videos appear in the web browser. In order to avoid triggering undesired augmentations, we implemented a dwell time of two seconds before an augmentation is triggered. The dwell time was determined in a pretest as a compromise between avoiding undesired interactions with the report and enabling the users to quickly access the augmented content. We selected Wikipedia, Google, Facebook, Twitter, LinkedIn and YouTube as the external websites to augment the report content since they are among the top twelve of the Alexa Top 500 Global Sites list (Alexa, 2012) and are thus popular sources of information on the internet.

The plugin connects to the web server which provides the ASR. Report structure, contents and multimedia contextual information are stored in a separate database server. The proposed framework utilizes standard software such as a web server, a database server and a web browser with which not only the reporting companies, but also the readers are already familiar with. This intends to facilitate acceptance by both parties.

However, besides installing the ASR browser plugin, readers need to have an eye tracking device available. Although today only few of the average computer users have such a device at their disposal, Tobii, one of the main providers of eye tracking devices in the market, envisions that future consumer computers will be equipped accordingly in order to improve the usability (Tobii, 2011). Thus, in the near future, eye tracking devices may become a standard component of PCs or notebooks like webcams are today.

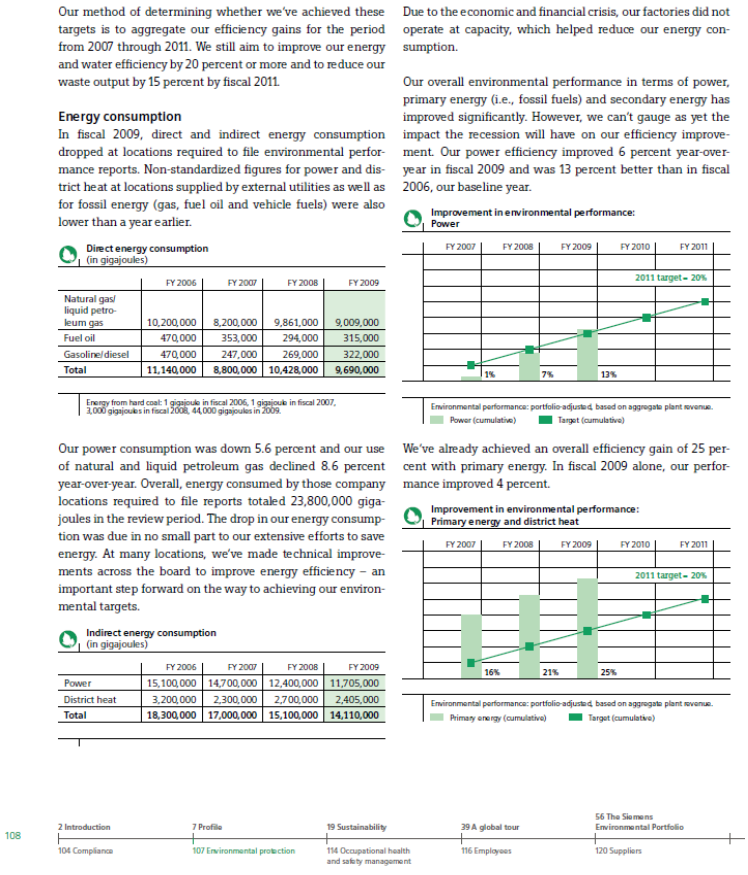
Implementation

In order to allow for the prototypical implementation, first we used a low-cost eye tracking solution. The ITU Gaze Tracker (Agustin et al., 2009) was selected since it is available free of charge and it can operate using standard hardware such as a camcorder or a webcam. Our setup included a Sony DCR-PC4 camcorder, two infrared lights and an infrared filter to implement a remote eye tracking solution. In contrast to head mounted devices, this solution

allowed eye tracking without contact to the user's body and thus created a less invasive environment for the evaluation. A pretest of the chosen setup resulted in an excellent tracking accuracy of 0.6 degrees. However, the accuracy dramatically deteriorated when the lighting conditions slightly changed or the participants moved their heads. Overall, we did not find the setup to be suitable for the evaluation of the prototype and looked for alternatives.
In scientific literature, several researchers found a correlation between mouse position and the user's gaze position (Chen, 2001; Guo and Agichtein, 2010; Huang et al., 2011; Rodden and Fu, 2007). To allow for an evaluation without using an eye tracker, the prototype was implemented using mouse tracking. The test users were instructed to use the mouse as a reading aid (Rodden and Fu, 2007).

The prototype was implemented using HTML and JavaScript on the basis of the Siemens SR. The section 'Environmental Protection' from the chapter 'Facts and Figures' was selected for implementation since it contained many tables and figures that could be used to augment the report content. Implementing mouse tracking instead of eye tracking provided the advantage that the prototype could be run on a standard PC with standard hardware. Naturally, this also eliminated the possible issue of unintentional interactions with the prototype resulting from the use of eye tracking as an input device (cf. Section 2).

For the sake of comparison, Figure 3 shows a screenshot of the traditional PDF-based SR by Siemens.



Our method of determining whether we've achieved these targets is to aggregate our efficiency gains for the period from 2007 through 2011. We still aim to improve our energy and water efficiency by 20 percent or more and to reduce our waste output by 15 percent by fiscal 2011.

Energy consumption

In fiscal 2009, direct and indirect energy consumption dropped at locations required to file environmental performance reports. Non-standardized figures for power and district heat at locations supplied by external utilities as well as for fossil energy (gas, fuel oil and vehicle fuels) were also lower than a year earlier.

Direct energy consumption (in gigajoules)

	FY 2006	FY 2007	FY 2008	FY 2009
Natural gas/ liquid petroleum gas	10,200,000	8,200,000	9,861,000	9,009,000
Fuel oil	470,000	353,000	294,000	315,000
Gasoline/diesel	470,000	247,000	269,000	322,000
Total	**11,140,000**	**8,800,000**	**10,428,000**	**9,690,000**

Energy from hard coal: 1 gigajoule in fiscal 2006, 1 gigajoule in fiscal 2007, 3,000 gigajoules in fiscal 2008, 44,000 gigajoules in 2009.

Our power consumption was down 5.6 percent and our use of natural and liquid petroleum gas declined 8.6 percent year-over-year. Overall, energy consumed by those company locations required to file reports totaled 23,800,000 gigajoules in the review period. The drop in our energy consumption was due in no small part to our extensive efforts to save energy. At many locations, we've made technical improvements across the board to improve energy efficiency – an important step forward on the way to achieving our environmental targets.

Indirect energy consumption (in gigajoules)

	FY 2006	FY 2007	FY 2008	FY 2009
Power	15,100,000	14,700,000	12,400,000	11,705,000
District heat	3,200,000	2,300,000	2,700,000	2,405,000
Total	**18,300,000**	**17,000,000**	**15,100,000**	**14,110,000**

Due to the economic and financial crisis, our factories did not operate at capacity, which helped reduce our energy consumption.

Our overall environmental performance in terms of power, primary energy (i.e., fossil fuels) and secondary energy has improved significantly. However, we can't gauge as yet the impact the recession will have on our efficiency improvement. Our power efficiency improved 6 percent year-over-year in fiscal 2009 and was 13 percent better than in fiscal 2006, our baseline year.

Improvement in environmental performance: Power

We've already achieved an overall efficiency gain of 25 percent with primary energy. In fiscal 2009 alone, our performance improved 4 percent.

Improvement in environmental performance: Primary energy and district heat

Figure 3: Traditional Sustainability Report

Figure 4 shows a screenshot of the implemented prototype. In contrast to the traditional SR, multimedia contents are not statically embedded into the report content, but automatically displayed depending on the users' mouse position. Moreover, the report does not only include information that was issued by the reporting company, but also external related content. The keywords that trigger the multimedia contextual information are highlighted in green. The symbol following the keyword indicates what type of contextual information will be displayed when the keyword is being read.

In Figure 4 all possible types of contextual information are displayed simultaneously in order to demonstrate the bandwidth of possible augmentations. The windows displaying the augmented content remain open until the user decides to close them by clicking on the "x" icon. Thus, users can avoid information overload by closing augmented content that is no longer needed.

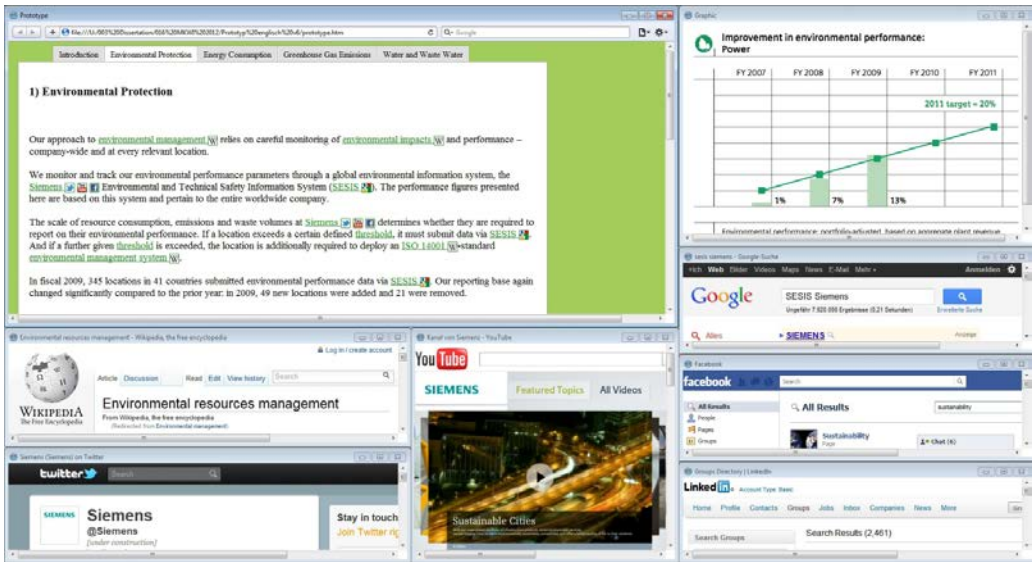


Figure 4: Augmented Sustainability Report

Evaluation

Acceptance Factors

In order to evaluate the prototype, a set of acceptance factors was selected from scientific literature and a corresponding questionnaire (see Appendix) was adapted. The goal was not to design 'yet another technology acceptance model' (TAM), but to identify acceptance factors and corresponding questions that allow for an evaluation of the ASR prototype in comparison to the traditional PDF-based report. Correspondingly, the utilized acceptance factors are based on existing scientific literature, namely the technology acceptance model (TAM) by Davis (1989) and its widely recognized acceptance factors Perceived Usefulness (PU), Perceived Ease of Use (PEOU) and Intention to Use (IU). Because the prototype was evaluated in a laboratory environment, we investigated the Intention to Use (IU) rather than actual use.

In a meta-study on TAM papers, Lee et al. (2003) analyzed which acceptance factors were frequently used in 101 scientific publications between 1989 and 2003. On the basis of these frequently used variables and the results of our requirements analysis, we added Result Demonstrability (RD), Output Quality (OQ), Computer Anxiety (CA) and Subjective Norm (SN) to our acceptance model because these variables have been applied successfully to related IT artifacts such as websites or e-shops. Table 2 gives an overview of the variables, their definitions (which were slightly modified to fit SR), and the original source that introduced the variable.

Table 2: Summary of Variables (Lee et al., 2003)

Variable	Definition	Origin
Output Quality (OQ)	The perception how well the report supports tasks that match with the individual's goals.	(Venkatesh and Davis, 2000)
Result Demon-strability (RD)	The degree to which the results of using the report are observable and communicable to others.	(Rogers, 1962)
Computer Anxiety (CA)	An individual's apprehension, or even fear, when she/he is faced with using computers.	(Simonson et al., 1987)
Perceived Enjoyment (PE)	The extent to which using the report is perceived to be enjoyable in its own right.	(Davis et al., 1992)
Perceived Usefulness (PU)	The degree to which a person believes that using a report would enhance his or her job/task performance.	(Davis, 1989)
Perceived Ease of Use (PEOU)	The degree to which a person believes that using the report is free of effort.	(Davis, 1989)
Subjective Norm (SN)	The individual's perception that most people who are important to her/him think she/he should or should not use the report.	(Fishbein and Ajzen, 1975)
Intention to Use (IU)	The individual's intention to use the report in the future.	(Davis, 1989)

Experimental Design, Task Description and Participants

Because TAM 3 (Venkatesh and Bala, 2008) includes the most frequently used acceptance factors described in Table 2, we used TAM 3 questionnaires for these variables and slightly modified them to fit SR. The participants assessed the items on a 7-point Likert scale ('strong disagree' to 'strong agree') directly after reading each of the report alternatives. The test users were not asked to solve concrete tasks (e.g., retrieve certain information from the report), but were instructed to read the excerpt from the Siemens SR as if they wanted to gain a general impression of the reporting company.

After using each of the report alternatives, the participants filled out the questionnaire, which was identical for both report alternatives. Having completed both questionnaires, the participants were interviewed about what they liked or disliked about both report alternatives to identify room for further improvement of the prototype as well as starting points for future research. Figure 5 depicts the course of the experiment and states the approximate duration of each step in minutes. Please note that the two alternatives were presented to the participants in different orders to avoid bias from sequence effects.

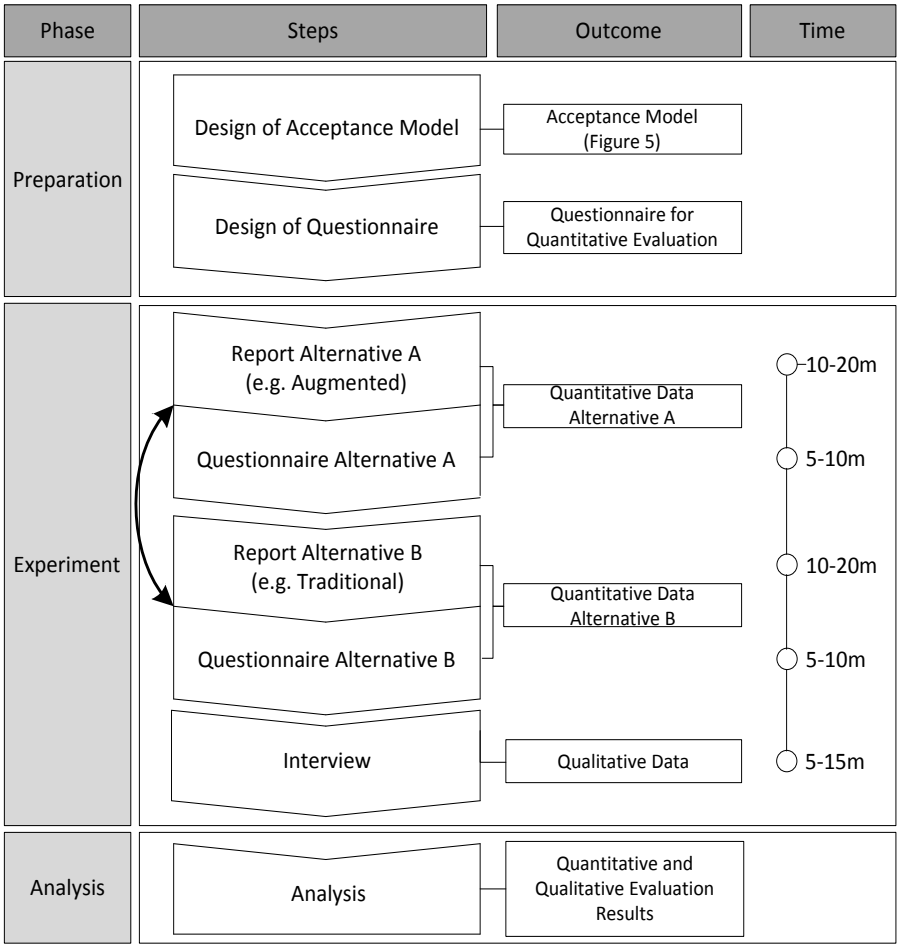


Figure 5: Course of the Experiment

The evaluation was carried out in two steps, representing two cycles of the research approach. In the first step, an evaluation was conducted among 24 participants. Five of these participants were masters students and 19 were employees of a medium-size corporation. In the second step, an evaluation was conducted among 19 research assistants of the University of Osnabrueck. About half of the 43 total participants were from industry (employees) and the other half from academia (research assistants and masters students), allowing us to capture the evaluation of not one but two representative user populations for SRs. One participant completed the questionnaires inconsistently and has consequently been excluded from the evaluation.

Figure 6 gives an overview of the participant demographics.

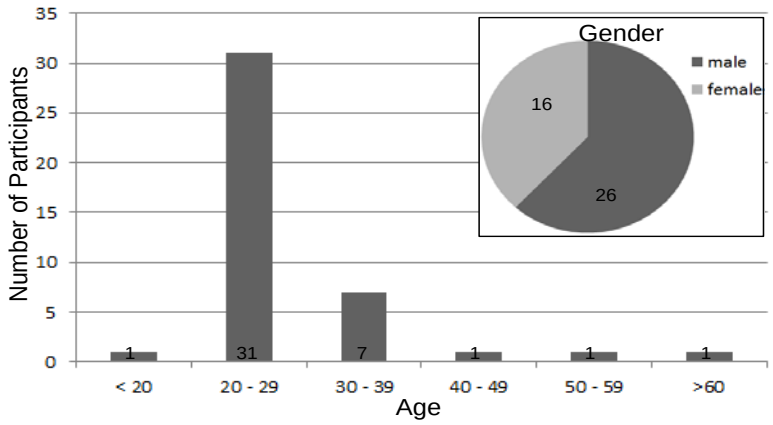


Figure 6: Participant Demographics

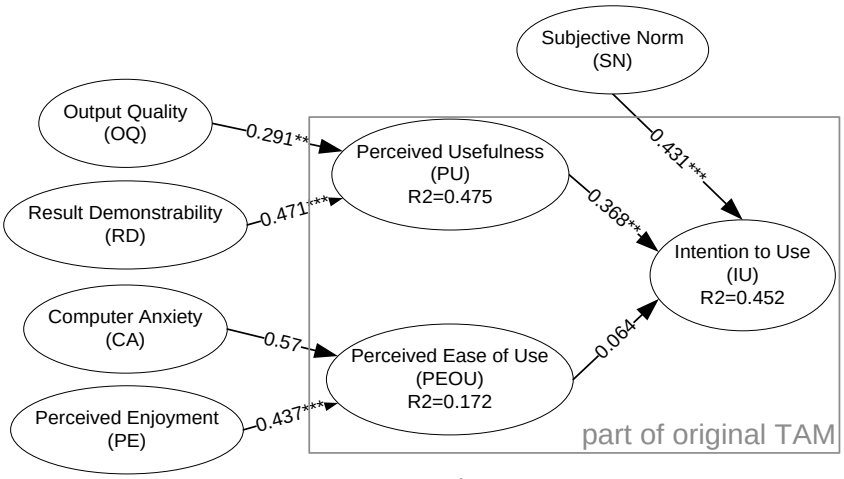
The group consisted of 26 male (62%) and 16 female participants. Most participants were between 20 and 29 years of age. Accordingly, the group's mean Computer Anxiety was very low (*M* = 1.2, *SD* = 0.52). Since the Computer Anxiety of a participant was identical for both report alternatives, it was excluded from the following evaluation results. Nevertheless, it should be kept in mind when reading the results.

Evaluation Results

As mentioned earlier, we selected those items from the TAM3 that were applicable to our application domain and prototype. Hence, only a subset of the TAM3 items was used to measure user acceptance of the prototypes in our study. There were 2 items in each questionnaire except for PU and PEOU, which had 3 and 4 items respectively.

Reliability estimates (Cronbach's Alpha) were above 0.8 for RD, CA, PU, PEOU and SN which indicates good internal consistency. The alphas for OQ (0.76), PE (0.74) and IU (0.69) indicated acceptable internal consistency.

To confirm that these variables were appropriate for testing improvement in user acceptance of the prototypes in our study, we performed a regression analysis to test whether these variables had an impact on willingness to use the SRs that were developed for our study. Figure 7, which illustrates the results of this analysis, shows that variables OQ, RD, PE, and SN, either directly or indirectly (through PU and PEOU) influenced acceptance. Variable CA, however, did not seem to affect acceptance behavior of our participants. The results are also in line with previous acceptance research. In a meta-analysis of 101 TAM papers, Lee et al. (2003) found that 88% of studies investigating the relationship of PU and BI found a significant influence of PU on BI, whereas only 71% found a significant influence of PEOU on BI. Our results show a significant relationship between PU and BI but not between PEOU and BI. These results together indicate that OQ, RD, PE, and SN (but not CA) appear in this sample to be appropriate factors for evaluating the improvements in acceptance of an ASR compared to a traditional SR.



Numbers on the arrows indicate β-weights, R2 = adjusted R^2
*** = significant at the p < 0.001 level, ** = significant at the p < 0.01 level

Figure 7: Evaluation of Acceptance Factors

Next, we compared the variables for augmented and traditional reports to test possible differences in user acceptance of the prototypes. For the augmented report, all variables showed a mean that was at least 1.17 points higher than for the traditional report. In particular the mean for Intention to Use the augmented report (4.54) was significantly higher than the mean for the traditional report (3.27) (t=5.17, p<.001). These results suggest that augmentation had a strong positive effect on the acceptance of the report even though the two alternatives were identical regarding contents. Table 3 illustrates the evaluation results (SD: standard deviation; SEM: standard error of the mean).

Table 3: Evaluation Results

	Report Type	N	Mean	SD	SEM	Diff. Mean	T-Test
IU	augmented	42	4.54	1.12	0.17	1.26	5.17***
	traditional	42	3.27	1.12	0.17		
SN	augmented	40	4.00	1.71	0.27	1.23	3.53**
	traditional	40	2.78	1.37	0.22		
PU	augmented	42	5.25	0.75	0.12	1.21	6.68***
	traditional	42	4.04	0.91	0.14		
PEOU	augmented	42	5.36	0.67	0.10	1.17	4.83***
	traditional	42	4.18	1.42	0.22		
OQ	augmented	42	5.32	0.99	0.15	1.18	5.02***
	traditional	42	4.14	1.16	0.18		
RD	augmented	42	5.11	0.95	0.15	1.69	6.62***
	traditional	42	3.42	1.35	0.21		
PE	augmented	42	4.54	1.12	0.17	1.40	4.83***
	traditional	42	3.27	1.12	0.17		

*** = significant at the p < 0.001 level, ** = significant at the p < 0.01 level

Figure 8 illustrates the quantitative evaluation results in the form of box and whisker plots. Overall, the ASR (white box-plots) was considered to be superior to the PDF-based SR (grey box-plots) in all variables.

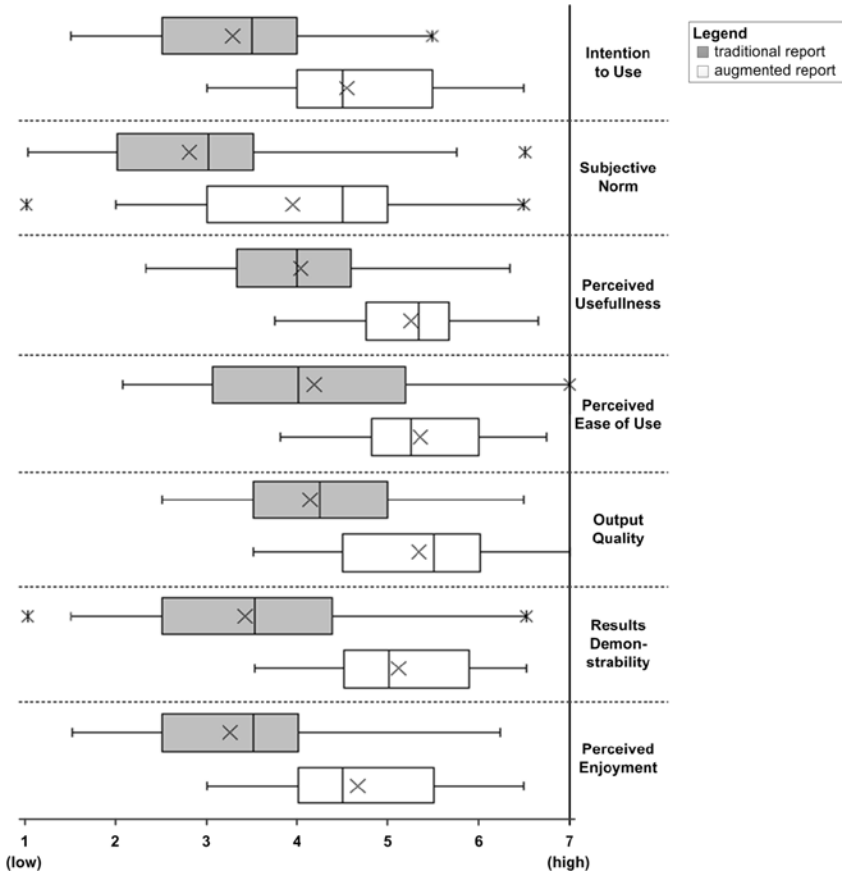


Figure 8: Box and Whisker Plots of the Evaluation Results

In addition to the quantitative evaluation based on the TAM questionnaire, we conducted a qualitative evaluation of the prototype. After participants had used both report alternatives and filled out the quantitative questionnaire, we asked them what they liked and disliked about the reports invited them to suggest improvements for the next prototype version. We categorized the given feedback into feedback on certain types of medial extensions, general usability feedback and suggestions for improvement. The numbers in brackets behind statements indicate how many participants made similar statements. Table 4 gives an overview of feedback regarding the definitions and background information from Wikipedia and Google.

Table 4: Comments about Wikipedia and Google

Positive Feedback	Negative Feedback
• Definitions and background information are missing in the traditional report (8) • Definitions and background information are helpful, especially for novices in the field of sustainability (5) • External information improves the comprehensibility of key performance indicators (1) • The inclusion of external resources makes the report appear to be more trustworthy because the information seems to be more complete (1)	• Google search results are sometimes not relevant (4) • Some additional definitions would be desirable in the augmented report (3)

The qualitative results show that the majority of our participants appreciated the integration of definitions and background information from Wikipedia and Google into the augmented report: After using both report alternatives, our test users criticized the traditional report for lacking definitions and background information. However, some participants criticized the Google search results for sometimes lacking relevance. Some users even reported a desire for additional augmentations.

Table 5 gives an overview of the feedback regarding tables and figures as medial extensions.

Table 5: Comments about Tables and Figures

Positive Feedback	Negative Feedback
• In the augmented report, the link between text and the corresponding tables and figures is more obvious (2) • When using the traditional report, one tends to overlook the tables and figures instead of reading the report fully (1)	• I prefer tables and figures to be directly integrated into the text (1)

Feedback regarding tables and figures was mixed. Some users stated that in the augmented report the link between text and the corresponding tables and figures is more obvious because they are automatically displayed when reading the related text. However, one user also reported a preference for tables and figures to be directly integrated into the text.

Table 6 gives an overview of the feedback regarding social networks and YouTube.

Table 6: Comments about Social Networks and YouTube

Positive Feedback	Negative Feedback
	• Social networks are superfluous (10) • YouTube does not add value to the report content (3) • It is annoying that some of the social networks require user accounts (2) • Movement in the YouTube-Window is distracting (1)

Surprisingly, not a single user made a positive comment about social networks. The following quotes indicate why our participants found social networks to be superfluous:

> *"Twitter, YouTube and Facebook are superfluous since they do not facilitate the understandability of the report."*
>
> *"Social networks mainly contain marketing information and are thus not a reliable source of information. I prefer independent external information via Wikipedia or Google."*
>
> *"Twitter and YouTube are not reliable sources of information."*

In addition, some users criticized the use of social network content because they needed a user account for the corresponding social network to access the external information.
Table 7 gives an overview of the feedback regarding usability.

Table 7: Comments about Usability

Positive Feedback	Negative Feedback
• The number of clicks to acquire background information is reduced (2) • The subdivision of the report content into tabs is intuitively understandable (2) • The presentation of the report is visually appealing (1)	• Multiple links to the same medial extension should be avoided (9) • Windows for medial extensions are too small (5) • The readability of the report suffers if multiple augmentations are available for a single keyword (3) • If no augmentations are displayed, part of the screen is unused (1)

The given feedback indicates that the participants found the presentation of the report to be visually appealing and intuitively understandable, whereas the augmentation made the acquisition of external background information more comfortable. However, the users strongly criticized the inclusion of multiple links to identical medial extensions in our prototype, and reported that some of the windows were too small for the augmented content. Additionally, part of the screen remained unused if no augmentation was being displayed. The symbols indicating the different types of augmentations were found to deteriorate the readability when a multitude of augmentations were used for a single keyword. This criticism is also reflected in the following suggestions for improvement made by our test users:
Introduce a distinct symbol for tables and figures (5). Note: In the prototype, tables and figures were indicated by a highlighted keyword, but not by a symbol following the keyword. This left some test users in doubt about what kind of augmentation would be displayed.

Augmentations should not be opened in separate windows, but as an overlay to the report content (2).
Excessive use of augmentations should be avoided to prevent information overload (2).

DISCUSSION

Our quantitative evaluation results show that the ASR was considered to be superior to the traditional PDF-based report by our test users, especially regarding the acceptance factors Perceived Enjoyment and Result Demonstrability. Accordingly, participants found the augmented report more enjoyable to use. In addition, the participants felt more capable of demonstrating the advantages of using the ASR to others.

Subjective norm was more difficult to capture than other variables. Subjective norm had a relatively higher standard deviation and standard error of the mean compared to other variables. Fewer participants responded to the two items representing that construct. This may have been because of the laboratory setting in our study. In a real-life environment, it would certainly be more meaningful for the participants to judge on whether or not people who are important to them think that they should use the corresponding report.

Overall, our results indicate that the factors used in our study are applicable to evaluating the acceptance of SRs, and hence the applied quantitative questionnaire is a suitable instrument for comparing the evaluation of the two report alternatives.

Our qualitative results indicated that especially novices in the field of sustainability could benefit from the information provided by Wikipedia and Google. The external information improves the comprehensibility of key performance indicators and makes the report appear more trustworthy because the information is perceived to be more complete. The issue that some of the Google search results were not relevant to the report content should be addressed in the next prototype version by defining tighter search strings.

The dependency between the users' mouse position and the augmentation being displayed made it easier for the users to make the connection between text and figures in comparison to the PDF-based report. However, the amount of augmentation was discussed controversially in the qualitative evaluation. While some users found the given amount of augmentations confusing, others desired even more augmented content. To address this inconsistency in a future prototype version, the different types of augmentation could be made configurable so that the user is free to decide what information should be presented in the traditional way and what information should be augmented. Possibly, some users just need more experience with ASR.

We were surprised by the lack of positive feedback regarding social networks within the qualitative evaluation since previous research suggests that users desire SR that facilitate a dialogue between the user and the reporting

company (Isenmann et al., 2011). It should be noted that the results might have been different if our participants had been interested in a long-term relationship with the reporting company (e.g. in form of a supply-chain partnership). Accordingly, our results do not falsify the results of previous research, but they indicate that some readers might not be interested in a dialogue with the reporting company.

Although the quantitative evaluation results indicated that our test users strongly preferred the augmented report, the qualitative evaluation also revealed some criticism as well as suggestions for improvement. In line with our general research approach, we intend to address these issues in the next prototype version.

LIMITATIONS AND FUTURE WORK

Naturally, the applied research approach has some limitations. First, only an excerpt from a real-life SR was prototypically implemented and evaluated in a laboratory environment. Accordingly, the evaluation results may have been influenced by the artificial experimental setting. The participants were rather young and had a high affinity for computers.

Future research could address the limitations of our research approach by implementing a complete ASR and evaluating it in a more natural environment. Also, future evaluations could be conducted with a more diverse set of participants.

The necessary selection process of external websites for the augmented content was another limitation of our research approach. Selecting different websites for the augmented content may have led to different results, especially in the qualitative evaluation results regarding social networks and YouTube. However, by choosing the websites from the Alexa Top 500 Global Sites list (Alexa, 2012), we implemented a transparent process that resulted in a selection of popular websites that almost every internet user should be familiar with. Accordingly, we were surprised by the negative feedback regarding the augmented content from some of these websites. Although previous research indicates that stakeholders desire possibilities for engagement with the reporting companies, our test users stated that the information provided via social networks was not useful to them. However, the evaluation results might have been different if our test users had been interested in a long-term relationship with the reporting company. We conclude that further research on the stakeholder-specific needs in sustainability reporting and the custom-tailoring of SRs according to these needs is required.

The same applies to the level of augmentation. In our prototype, we provided the same number of augmentations to every user. However, novice users may require more background information than expert users. Users interested in a supply-chain partnership with the reporting company may appreciate links to social networks more than those who merely want to gain a general impression of a company from which they are buying products. Accordingly, the types and amount of augmentation should be made configurable by the user in the next prototype version. This is also indicated by the qualitative evaluation results; while some users stated that additional augmentation was desired, others suggested avoiding excessive use of augmentation to avoid information overload.

In our paper, we used TAM factors and questions to compare the augmented report with the traditional one. Although designing and evaluating an acceptance model that specifically meets the needs of SR was not one of our research goals, a logical next step could be the development and evaluation of an acceptance model that is designed to fit SR. There is also a need for future research about augmentation itself. There is a need for standards regarding highlighting augmented content by using certain colors and/or symbols. For implementation, algorithms that automatically annotate the report content with multimedia external information are required.

As suggested by our general research approach, the next step of our research will be the design, implementation and evaluation of the next prototype version that addresses the criticism and suggestions for improvement identified in this paper.

Once a sufficiently ‘good’ prototype has been implemented, the underlying implications for design theory (Gregor and Jones, 2007) can be investigated.

CONTRIBUTIONS

Practical Contributions

In this study, a concept for ASR was developed, prototypically implemented and evaluated. Our evaluation results indicate that our participants had a strong preference for the ASR compared to the traditional report.

The quantitative evaluation indicates that the augmentation of a report had a positive impact on the acceptance of the SR. The inclusion of external definitions and background information via Wikipedia and Google was especially valued by our test users. Not only could novice users' understanding of the report contents be improved, perceptions of credibility could also be facilitated. Thus, companies could benefit from augmenting their report content with external information.

While our qualitative evaluation confirmed the quantitative evaluation results, it also revealed room for further improvement. The test users' criticisms and suggestions for improvement may also be useful for companies' traditional sustainability reporting.

Our evaluation results show that TAM factors and corresponding questionnaires can serve as a suitable scientific foundation for a practical evaluation.

Theoretical Contributions

Instead of utilizing TAM-based questionnaires to evaluate a research model, we applied the questionnaire to evaluate a concrete IT artifact within a design research paradigm. This approach extends TAM's applicability to a new practical domain. In contrast to existing literature on augmented browsing, our paper does not focus on the technical implementation, but rather on the evaluation of an IT artifact. Accordingly, our paper contributes to the knowledge about how augmentation affects the users and their acceptance of this emerging technology. Moreover, our research has identified sustainability reporting as another application domain that benefits from the application of augmented browsing.

Because the augmentation provided a significant contribution to the acceptance of SR, our study provides a rationale for transferring the concept of augmentation to related application domains such as websites or e-shops.

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REFERENCES

Agustin, J. S., H. Skovsgaard, J. P. Hansen, and D. W. Hansen (2009) "Low-Cost Gaze Interaction : Ready to Deliver the Promises," in *Proceedings of the 27th International Conference Extended Abstracts on Human Factors in Computing Systems* (pp. 4453-4458). New York: ACM.

Alexa. (n.d.). Top 500 Global Sites. Retrieved May 31, 2012, from http://www.alexa.com/topsites

Bartels, W., J. Iansen-Rogers, and J. Kuszewski (2008) *Count Me In - The Readers' Take on Sustainability Reporting*. KPMG.

Biedert, R., G. Buscher, and A. Dengel (2009) "The eyeBook – Using Eye Tracking to Enhance the Reading Experience," *Informatik-Spektrum 33* (3), pp. 272-281. doi:10.1007/s00287-009-0381-2

Biedert, R., G. Buscher, S. Schwarz, M. Möller, A. Dengel, and T. Lottermann (2010) "The Text 2.0 Framework," in *2nd Workshop on Eye Gaze in Intelligent Human Machine Interaction*. Stanford University, Palo Alto.

Bonino, D., E. Castellina, F. Corno, and L. De Russis (2011) "DOGeye: Controlling your Home with Eye Interaction," *Interacting with Computers 23* (5), pp. 484-498. doi:10.1016/j.intcom.2011.06.002

Brown, J., K. Homer, and D. Isaacs (2007) "The World Café", in Holman, P., T. Devane, and S. Cady (Eds.), *The Change Handbook: The Definitive Resource on Today's Best Methods for Engaging Whole Systems*. San Francisco: Berrett-Koehler, pp. 179-194.

Brundtland Commission. (1987) "*Our Common Future*," in G. H. Brundtland, Ed.). Oxford: Oxford University Press.

Chen, M. (2001) "What Can a Mouse Cursor Tell Us More? Correlation of Eye/Mouse Movements on Web Browsing," in *Proceedings of the ACM Conference on Human Factors in Computing Systems* (pp. 281-282).

Cunliffe, D., C. Taylor, and D. Tudhope (1997) "Query-based Navigation in Semantically Indexed Hypermedia," in *Proceedings of the Eighth ACM Conference on Hypertext*, pp. 87-95.

Dai, H., W. Tsai, R. T. Tsai,, and W. Hsu (2011) "Enhancing Search Results with Semantic Annotation Using Augmented Browsing," in *Proceedings of the Twenty-Second International Joint Conference on Artificial Intelligence*, pp. 2418-2423.

Davis, F. D. (1989) "Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology," *MIS Quarterly 13* (3), pp. 319-340. doi:10.2307/249008

Davis, F. D., R. P. Bagozzi, and P. R. Warshaw (1992) "Extrinsic and Intrinsic Motivation to Use Computers in the Workplace," *Journal of Applied Social Psychology 22* (14), pp. 1111-1132. doi:10.1111/j.1559-1816.1992.tb00945.x

Elkington, J. (1998) "Partnerships from Cannibals with Forks – The Triple Bottom Line of 21st-century Business," *Environmental Quality Management 8* (1), pp. 37-51.

Fishbein, M. and I. Ajzen (1975) *Belief, Attitude, Intention, and Behavior: An Introduction to Theory and Research*. Reading: Addison-Wesley.

GRI Global Reporting Initiative. (2011) *Sustainability Reporting Guidelines 3.1*. Global Reporting Initiative.

Gregor, S. and D. Jones (2007) "The Anatomy of a Design Theory," *Journal of the Association for Information Systems 8* (5), pp. 312-335.

Gräuler, M., F. Teuteberg, T. Mahmoud, and J. Marx Gómez (2013) "Requirements Prioritization and Design Considerations for the Next Generation of Corporate Environmental Management Information Systems - A Foundation for Innovation," *International Journal of Information Technology and the Systems Approach (accepted for publication).*

Guo, Q. and E. Agichtein (2010) "Towards Predicting Web Searcher Gaze Position from Mouse Movements," in *Proceedings of the ACM Conference on Human Factors in Computing Systems* (pp. 3601-3606). New York, New York, USA: ACM Press.

Hevner, A. R. (2007) "A Three Cycle View of Design Science Research," *Scandinavian Journal of Information Systems 19* (2), pp. 87-92.

Hevner, A. R., S. T. March, J. Park, and S. Ram (2004) "Design Science in Information Systems Research," *MIS Quarterly 28* (1), pp. 75-105.

Huang, J., R. W. White, and S. Dumais (2011) "No Clicks, No Problem: Using Cursor Movements to Understand and Improve Search," in *Proceedings of the ACM Conference on Human Factors in Computing Systems*.

Isenmann, R. (2004) "Internet-based Sustainability Reporting," *International Journal of Environment and Sustainable Development 3* (2), pp. 145-167. doi:10.1504/IJESD.2004.004700

Isenmann, R., C. Be, and M. Welter (2007) "Online Reporting For Sustainability Issues," *Business Strategy and the Environment 16*, pp. 487-501.

Isenmann, R., J. Marx Gómez, and D. Süpke (2011) "Making Stakeholder Dialogue For Sustainability Issues Happen – Benefits, Reference Architecture and Pilot Implementation for Automated Sustainability Reporting à la Carte," in *Proceedings of the 44th Hawaii International Conference on System Sciences*. IEEE Computer Society.

Lee, Y., K. A. Kozar, and K. R. T. Larsen (2003) "The Technology Acceptance Model: Past, Present and Future," *Communications of the Association for Information Systems 12*, pp. 752-780.

March, S. T. and G. F. Smith (1995) "Design and Natural Science Research on Information Technology," *Decision Support Systems 15* (4), pp. 251-266. doi:10.1016/0167-9236(94)00041-2

Melville, N. P. (2010) "Information Systems Innovation for Environmental Sustainability," *MIS Quarterly 34* (1), pp. 1-21.

Nacke, L. E., S. Stellmach, D. Sasse, J. Niesenhaus, and R. Dachselt (2011) "LAIF: A Logging and Interaction Framework for Gaze-based Interfaces in Virtual Entertainment Environments," *Entertainment Computing*, *2* (4), pp. 265-273. doi:10.1016/j.entcom.2010.09.004

Oesterle, H. and B. Otto (2010) "Consortium Research," *Business & Information Systems Engineering 2* (5), pp. 283-293. Retrieved from http://www.springerlink.com/index/10.1007/s12599-010-0119-3

O'Donoghue, S. I., H. Horn, E. Pafilis, S. Haag, M. Kuhn., V. P. Satagopam, R. Schneider, and L. J. Jensen (2010) "Reflect: A Practical Approach to Web Semantics," *Web Semantics: Science, Services and Agents on the World Wide Web 8* (2-3), pp. 182-189. doi:10.1016/j.websem.2010.03.003

Pafilis, E., S. I. O'Donoghue, L. J. Jensen, H. Horn, M. Kuhn, N. P. Brown, and R. Schneider (2009) "Reflect: Augmented Browsing for the Life Scientist," *Nature biotechnology 27* (6), pp. 508-510. doi:10.1038/nbt0609-508

Poole, A. and L. J. Ball (2005) "Eye Tracking in Human-Computer Interaction and Usability Research: Current Status and Future Prospects," in C. Ghaoui (Ed.), *Encyclopedia of Human Computer Interaction*. Hershey: Idea Group Reference.

Rikhardsson, P., A. J. R. Andersen, and H. Bang (2002) "Sustainability Reporting on the Internet," *Greener Management International 40 (2)*, pp. 57-75.

Rodden, K. and X. Fu (2007) "Exploring How Mouse Movements Relate to Eye Movements on Web Search Results Pages," in *SIGIR 2007 Workshop Web-Information Seeking and Interaction* (pp. 29-32).

Rogers, E. M. (1962) *Diffusion of Innovations*. New York: Free Press.

Sibert, L. E. and R. J. K. Jacob (2000) "Evaluation of Eye Gaze Interaction," in *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems - CHI '00*, pp. 281-288. doi:10.1145/332040.332445

Simonson, M. R., M. Maurer, M. Montag-Torardi, and M. Whitaker (1987) "Development of a Standardized Test of Computer Literacy and a Computer Anxiety Index," *Journal of Educational Computing Research 3* (2), pp. 231-247.

Tobii. (2011) Integrated Eye Control in Consumer Computers. Retrieved January 23, 2012, from http://www.tobii.com/eye-tracking-integration/global/industry-applications/consumer-computers/

Townsend, S., W. Bartels, and J. P. Renaut (2010) *Reporting Change: Readers & Reporters Survey 2010*. *Change*. Futerra Sustainability Communications.

Venkatesh, V. and H. Bala (2008) "Technology Acceptance Model 3 and A Research Agenda On Interventions," *Decision Sciences 39* (2), pp. 273-315.

Venkatesh, V. and F. D. Davis (2000) "A Theoretical Extension of the Technology Acceptance Model: Four Longitudinal Field Studies," *Management Science 46* (2), pp.186-204.

Zander, T. O., M. Gaertner, C. Kothe, and R. Vilimek (2010) "Combining Eye Gaze Input With a Brain-Computer Interface for Touchless Human-Computer Interaction," *International Journal of Human-Computer Interaction 27* (1), pp. 38-51. doi:10.1080/10447318.2011.535752

APPENDIX

General Questions

No	Factor	Question	strongly disagree						strongly agree
1	AGE	How old are you?							
2	GENDER	Are you male or female?	o male					female o	
3	CANX1	I am not afraid of dealing with computers.	o	o	o	o	o	o	o
4	CANX2	Working with computers does not make me nervous.	o	o	o	o	o	o	o

Questions evaluating user acceptance of the conventional / augmented report

No	Factor	Question	strongly disagree						strongly agree
1	PU1	Using the report improves my research on sustainability.	o	o	o	o	o	o	o
2	PU2	The report is useful for the research on sustainability.	o	o	o	o	o	o	o
3	PU3	Using the report makes sense.	o	o	o	o	o	o	o
4	PEOU1	The handling of the report is clear and understandable.	o	o	o	o	o	o	o
5	PEOU2	Using the report does not require a lot of my mental effort.	o	o	o	o	o	o	o
6	PEOU3	I find it easy to read the report.	o	o	o	o	o	o	o
7	PEOU4	The operation of the report meets my expectations.	o	o	o	o	o	o	o
8	SN1	People who influence my behavior think I should read the report.	o	o	o	o	o	o	o
9	SN2	People who are important to me think I should read the report.	o	o	o	o	o	o	o
10	OUT1	The quality of the information contained in the report is high.	o	o	o	o	o	o	o
11	OUT2	I have no problems with the information contained in the report.	o	o	o	o	o	o	o
12	DEMO1	I am in a position to explain the benefits of this report to others.	o	o	o	o	o	o	o
13	DEMO2	I have difficulties in explaining the contents of this report to others.	o	o	o	o	o	o	o
14	ENJ1	I find using the report to be enjoyable.	o	o	o	o	o	o	o
15	ENJ2	I enjoy reading the report.	o	o	o	o	o	o	o
16	BI1	Provided that the report is available, I would also read it in future.	o	o	o	o	o	o	o
17	BI2	I will try to use this kind of reporting also in future.	o	o	o	o	o	o	o

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Frank Teuteberg is head of the subject area Accounting and Information Systems, which is part of the Institute of Information Management and Corporate Governance at the University of Osnabrueck, Germany. Prof. Teuteberg is founder of the innovation network ertemis (www.ertemis.eu) which is supported by the European Fund for Regional Development (EFRE) and the State of Lower Saxony. In total, the network has received more than 2 million Euros of funding over three and a half years (funding period: April 2011 - October 2014; www.it-for-green.eu). The innovation network ertemis aims at facilitating knowledge transfer between research and practice and at advancing interdisciplinary research on special fields of Green IT, Sustainable Cloud Computing, Green Logistics, Sustainability Reporting and Energy Efficiency. Prof. Teuteberg has published more than 150 scientific papers which have appeared in leading German and international scientific journals. His main research interests are Green IT/IS, Sustainable Supply Chain Management, and Cloud Computing.

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