Topic:

Counting what Counts:
Applying Business Intelligence to Support Corporate Sustainable Development

Masterthesis

in the subject Business Intelligence

at the Chair for Information Systems and Informationmanagement

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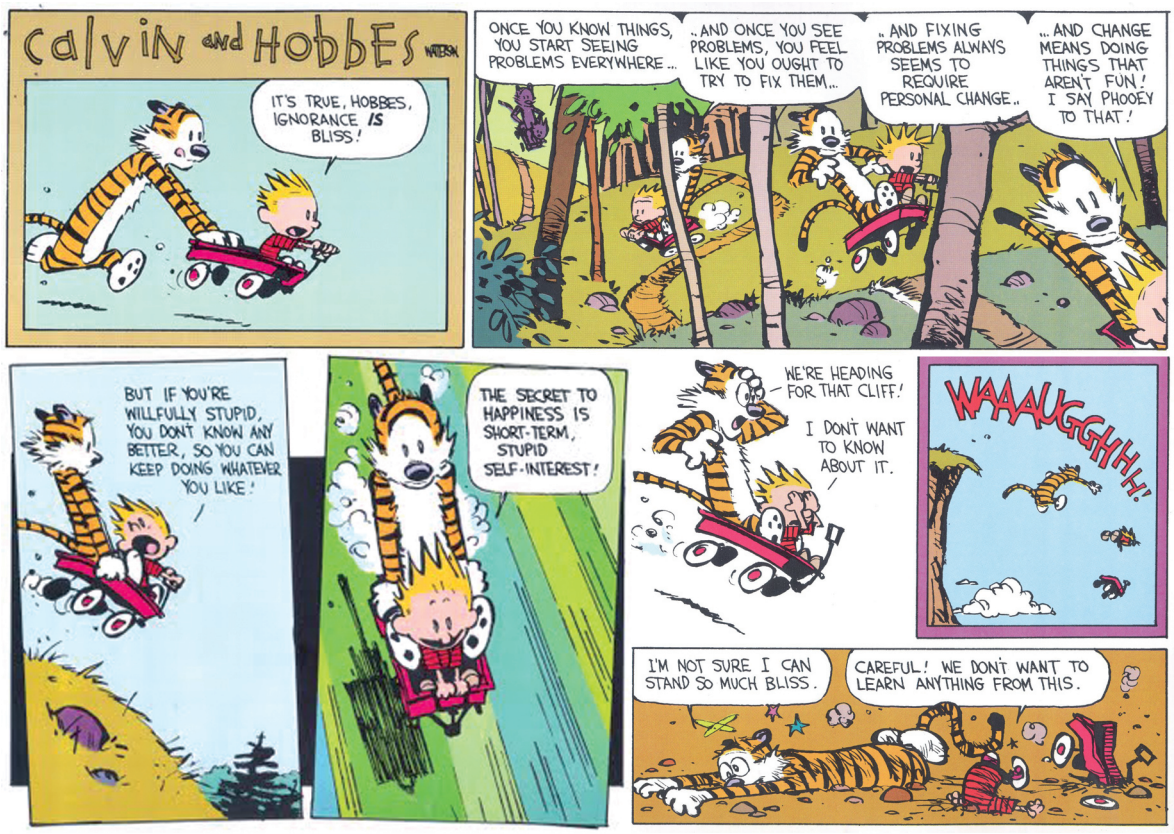
Abbreviations

BI	Business Intelligence
BS	Business & Society
BSC	Balanced Scorecard
BSE	Business Strategy and the Environment
CC	Corporate Citizenship
CPM	Corporate Performance Management
CS	Corporate Sustainability
CSR	Corporate Social Responsibily
DSS	Decision Support System
DWH	Data Warehouse
EIS	Executive Information System
GRI	Global Reporting Initiative
ICT	Information and Communcation Technology
IO	Information and Organization
IS	Information Systems
JASIST	Journal of the American Society for Information Science and Technology
JBE	Journal of Business Ethics
JCP	Journal of Cleaner Production
JSIS	Journal of Strategic Information Systems
KPI	Key Performance Indicator
MDX	Multidimensional Expressions
MIS	Management Information System
MISQ	Management Information Systems Quarterly
MSS	Management Support System
OLAP	Online Analytical Processing
PMS	Performance Management System
SBSC	Sustainability Balanced Scorecard
SPM	Sustainability Performance Measurement and Management
SQL	Structured Query Language



(Watterson, 1992)

The following is an extract from the latest report on climate change published by the INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE (2007, p.11) with very high or high confidence statements about the projected regional impacts for Europe:

- Climate change is expected to magnify regional differences in Europe's natural resources and assets. Negative impacts will include increased risk of inland flash floods and more frequent coastal flooding and increased erosion (due to storminess and sea level rise).

- Mountainous areas will face glacier retreat, reduced snow cover and winter tourism, and extensive specieslosses (in some areas up to 60% under high emissions scenarios by 2080).

- In southern Europe, climate change is projected to worsen conditions (high temperatures and drought) in a region already vulnerable to climate variability, and to reduce water availability, hydropower potential, summer tourism and, in general, crop productivity.

- Climate change is also projected to increase the health risks due to heat waves and the frequency of wildfires.

1 Introduction

> The world has never faced greater challenges: over-consumption of finite natural resources, climate change, and the need to provide clean water, food and a better standard of living for a growing global population. Decisions taken in tackling these issues need to be based on clear and comprehensive information; but, as The Prince of Wales has said, we are at present "battling to meet 21st century challenges with, at best, 20th century decision making and reporting systems."
>
> (UN Global Compact, 2010)

As society and various stakeholder groups impose increasing expectations, many companies incorporate environmental and social aspects into their vision, mission and goals. Although already many organizations include social responsibility and sustainability into strategic considerations, most of the time, they are not integrated into operative business management practices (Petrini and Pozzebon, 2009, p.119).

The aim of this thesis is to study the potential of Information Systems to support companies in their endeavors to advance Corporate Sustainability (CS) and to close the gap between strategic and operational sustainability considerations. The focus in this thesis is on Business Intelligence (BI) systems, a specific type of IS with the aim to transform operational data into high-level business information, which ultimately leads to better informed decisions. In the context of corporate sustainability, BI systems could have a big potential to support corporate management with information about economic, social and environmental aspects in an integrated way. Thereby, BI could enable firms to discover opportunities for improvement and to monitor impacts of operational sustainability initiatives.

In academic research, a central role is attributed to Information Systems (IS) in the quest for advanced corporate sustainability, as IS have been the greatest force for productivity improvement in the last half century (Elliot, 2011, p.222; Melville, 2010, p.14; Watson et al., 2010, p.24). Nevertheless, research in this field is sparse. Current approaches to develop research agendas (Jenkin et al., 2010; Chowdhury, 2011; Elliot, 2011; Melville, 2010; Watson et al., 2010), suggest that this field of research is up-and-coming and the IS academic community starts facing their responsibility to contribute to the challenge of sustainable development.

JOHN HOLDREN, president of the American Association for the Advancement of Science and current advisor for science and technology of Barack Obama, once appealed to the scientific community:

> I would urge every scientist and engineer with an interest in the intersection of Science & Technology (S&T) with sustainable well-being to read more and think more about relevant fields outside your normal area of specialization, as well as about the interconnections of your specialty to these other domains and to the practical problems of improving the human condition. [...] If as a substantial fraction of the world's scientists and engineers devoted 10% of their professional time and effort to working in these and other ways to increase the benefits of S&T for the human condition and to decrease liabilities, the acceleration of progress toward sustainable well-being for all of Earth's inhabitants would surprise us all.
>
> (Holdren, 2008)

Following this call, in this Masterthesis, I want to contribute to the area of sustainable development by exploring the intersection of sustainable well-being with my special field of interest, "Business Intelligence" at the intersection point of "Corporate Sustainability".

The goal of this thesis, is more specifically, to identify possible applications of Business Intelligence methods to support corporate sustainability initiatives and to derive additional requirements for a BI System, which explicitly integrates sustainability aspects. The questions are answered, based on a systematic matching of existing concepts in the two main areas of knowledge, Business Intelligence and Corporate Sustainability.

The concrete research questions addressed in this thesis and according expected results are stated in Table 1.1.

	Research Question	Expected Result
RQ1	How can Business Intelligence systems be applied to support corporate sustainable development?	A framework illustrating the relation between BI and CS
RQ1.1.	How do organizations manage and implement corporate sustainability?	Illustration of sustainability management concepts and instruments
RQ1.2	Which methods and applications does BI provide to support businesses?	Portfolio of BI applications and methods
RQ2	Which additional requirements are posed against BI systems, which integrate sustainability aspects?	A structured list of requirements to be met by BI systems supporting corporate sustainable development

Tab. 1.1: Research Questions and Expected Results

The thesis has been organized in the following way (see Figure 1.1). The *second chapter* briefly reviews the history and presents the current state of research in the field of Information Systems related to Corporate Sustainability. In the following two chapters the two core topics of the thesis "Corporate Sustainability" and "Business Intelligence" are first analyzed separately in order to be combined in the subsequent chapter.

In the *third chapter*, the business perspective is illuminated, by exploring both the motivations of firms to incorporate social and environmental aspects into corporate actions and the way companies can actually implement corporate sustainable development.

The *fourth chapter* elaborates on the concept of Business Intelligence. After discussing the fundamental functions of BI, the ways how BI can support business are examined, structured and summarized in a BI portfolio.

The *fifth chapter* combines the two central concepts, clarifies intersection points and eventually presents a model, highlighting the potential of BI to support corporate sustainable development. Based on this model, requirements for a BI System providing the potential to accelerate corporate sustainable development are derived in the *sixth chapter*.

The *last chapter* briefly summarizes the main findings, points out opportunities for further enhancement of the study and suggest a possible way of evaluating the proposed models.[1]

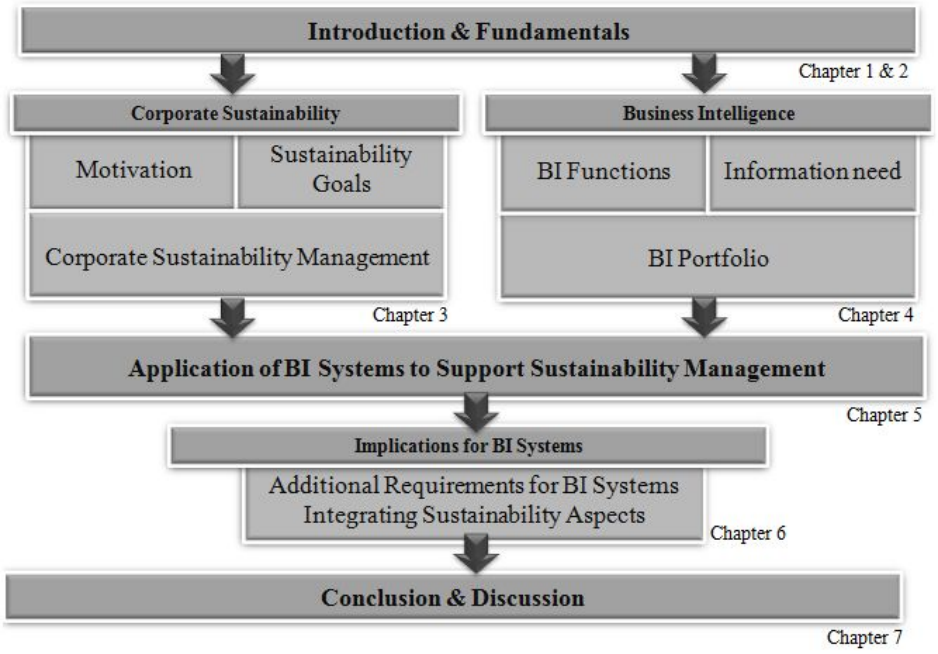


Fig. 1.1: Structure of the Thesis

[1] General Remark: All citations referring to literature in German language, have been translated by the author.

2 Information Systems Support for Corporate Sustainability

This chapter provides an overview about the evolution of the idea to use Information Technology and Information Systems to respond to challenges related to sustainability. Moreover, a literature review provides an insight into the current state of research in the field of Business Intelligence as a tool to support corporate sustainability.

2.1 A Brief Review of History

> Over the years, the use of IT has exploded in several areas, improving our lives and work and offering convenience along with several other benefits. Computers and other IT infrastructure consume significant amounts of electricity, placing a heavy burden on our electric grids and contributing to greenhouse gas emissions.
>
> (Murugesan, 2008, p.24)

With increasing use of Information Technology, energy consumption through operation and production of Information and Communcation Technology (ICT) equipment raised dramatically. As awareness of this fact increased, the industry reacted and offered new products and software to increase the energy efficiency of ICT hardware. Power management software, server virtualization, intelligent data center design are some of the methods aiming to reduce the energy consumption of IT hardware, summarized under the label "Green IT". Moreover, eco-labels evolved which certify computers and other equipment with high energy efficiency, e.g. Energy Star (Murugesan, 2008, p.26).

Therefore, information technology and systems contribute to the problem of climate change, due to the related greenhouse gas emission caused by energy consumption. Recently, the focus changed, information technology and particularly information systems are no longer seen to be only part of the problem but also a key factor to its solution. information technology and systems have a large potential to increase energy efficiency, but not only of its own products, but, according to projections of the GLOBAL E-SUSTAINABILITY INITIATIVE (2008), their largest influence will be by enabling energy efficiencies in other sectors, which could deliver carbon savings five times larger than the total emissions from the entire ICT sector in 2020, e.g. by optimizing supply chains and thereby reducing emissions caused by means of transportation.

Consequently, academics argue that an exclusive focus on information technologies is too narrow and should be extended to information systems, which is defined as an integrated and cooperating set of people, processes, software, and information technologies to support

individual, organizational, or societal goals. The commonly used "Green IT" expression, was extended to the more encompassing "Green IS", which incorporates a greater variety of possible initiatives to support sustainable business processes. This also means, that Green IS includes Green IT (see Watson et al., 2010, p.24).

The shift of the focus from Green IT to Green IS implied two changes. Firstly, instead of improving environmental aspects of information technology itself, Green IS seeks opportunities to make business processes more environmentally compatible through the application of IT. Secondly, the terminology changed from *energy-efficient*, to the more inclusive *environmental-sustainable* or even *sustainable* in general, which expands the scope even further and examines social, economic and environmental aspects in an integrated way.

As Green IS examines the interplay of people, processes and IT, business considerations gained in importance. The business domain developed similar concepts dealing with the corporate responsibility of companies, for example Corporate Social Responsibility, Corporate Citizenship or Corporate Sustainability. With emergence of these concepts, next to environmental considerations also social and economic aspects became more important.

This leads to the assumption that the Green IS term has to be expanded once more to comprise also social and economic aspects, leading to the need for "Sustainable IS". However, this field is still developing and research in this field is sparse, as illustrated by the following literature review.

2.2 Literature Review

The aim of this thesis is to explore how Business Intelligence can serve as a tool to support companies increasing their corporate sustainability. Obviously, this tasks is based on two fields of knowledge: Business Intelligence and Corporate Sustainability. Therefore, a research for related literature has to include both domains.

The goal of this literature review is to discover similar research endeavors focusing on the relationship between Business Intelligence and Corporate Sustainability. The identification of previous research work in this field, should help to integrate the thesis at hand within the context of current research.

The literature search process will follow the process model suggested by VOM BROCKE ET AL. (2009, p.9), which consists of three main phases (see Figure 2.1). In the first phase, the journals providing articles relevant for the particular research topic, are identified. The task in the second phase is to find according databases, which provide access to these journals

and electronic search functionality. The last phase is the most critical phase, as keywords have to be defined, which best match the requested topic. The selection of keywords can significantly influence the results.

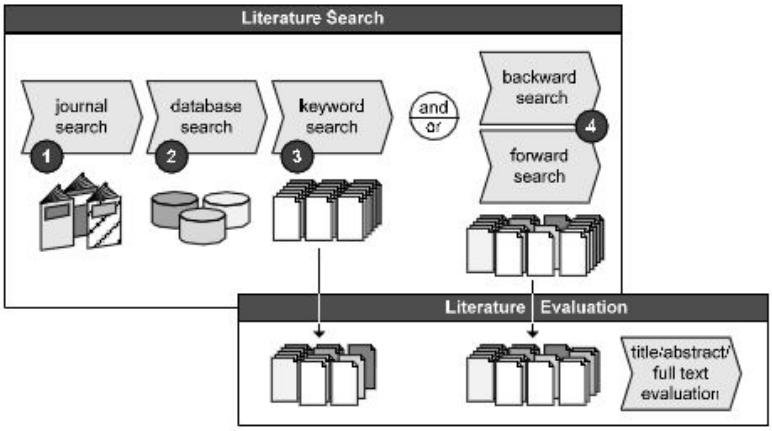


Fig. 2.1: The Literature Search Process (Vom Brocke et al., 2009, p.9)

In order to find relevant literature for the purpose of this study, it seems appropriate to search in a crosswise manner. This means, that BI journals are scanned for articles relating to the concept of "Corporate Sustainability" and journals, publishing articles about sustainability in the business context, are searched for articles referencing to "Business Intelligence" systems.

As there is no broadly accepted list of ranked BI Journals, this study will refer to the research work of JOURDAN ET AL. (2008, p.124), who analyzed existing BI literature and compiled a list of the top ten IS Journals ranked by the percentage of published articles about BI (see Figure 2.2).

Journal Name	*BI*	*Articles/Year*	*Years*	*Total*	*%*
European Journal of Information Systems	18	20	10	200	9.00
MIS Quarterly	17	20	10	200	8.50
Information & Management	21	32	10	320	6.56
Communications of the ACM	51	84	10	840	6.07
Information Systems Research	10	24	10	240	4.17
Journal of Management Information Systems	12	44	10	440	2.73
Journal of the ACM	5	30	10	300	1.67
Management Science	19	120	10	1200	1.58
Harvard Business Review	10	90	10	900	1.11
IEEE Transactions on Software Engineering	4	48	10	480	0.83

Fig. 2.2: IS Journals Ranked According to Rate of BI Articles (Jourdan et al., 2008, p.124)

All listed journals which published more than ten articles about BI in the analyzed period (1997–2007), will be included into this literature review. Furthermore, journals containing the term "Business Intelligence" within their title are added.[2] As the term "Business Intelligence" has only recently become popular to be used within academic journals, also the related terms, "Management Information System", "Management Support Systems", "Decision Support System", "Corporate Performance Measurement" are taken into account. The resulting list of thirteen journals can be found in Table 2.1.

In the field of corporate sustainability, the selection of journals is based on the journal ranking "JOURQAL" which has been published by the association of German professors for economy. All journals which have been ranked in the categories Business Ethics and Environmental management are included.[3] The resulting list of 25 journals is presented in Table 2.2.

In the next step, databases have to be identified, which provide the functionality to search within these journals. The selected database for each journal can be viewed in Table A.1 (in appendix A.1). In this step eight journals had to be excluded as these were not available or could not be accessed in any database (see Table A.1 for a list of the excluded journals and exclusion criteria).

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2 For the search of journals by title, the electronic journal library of the University library in Regensburg (http://ezb.uni-regensburg.de) has been used

3 The ranking is available online: http://vhbonline.org/service/jourqual/. The categories can be found in the edition of 2008.

Journal title	Abbreviation
European Journal of Information Systems	EJIS
MIS Quarterly	MISQ
Information & Management	IM
Communications of the ACM	CACM
Journal of Management Information Systems	JMIS
Management Science	MS
Business Intelligence Journal	BIJ
International Journal of Business Intelligence Research	IJBIR
Decision Support Systems	DSS
ACM Transactions on Management Information Systems	TMIS

Tab. 2.1: List of Included Journals Publishing Articles About Business Intelligence

Journal title	Abbreviation
Accounting, Organizations and Society	AOS
Ecological Economics	EE
Journal of Cleaner Production	JCP
Journal of Environmental Economics and Management	JEEM
Business & Society	BS
Business Ethics - A European Review	BE
Business Ethics Quarterly	BEQ
Greener Management International: The Journal of Corporate Environmental Strategy and Practice	GMI
Journal of industrial ecology	JIE
Socio-Economic Review	SER
Business Strategy and the Environment	BSE
Corporate Social Responsibility and Environmental Management	CSREM
Journal of Business Ethics	JBE
Ökologisches Wirtschaften	ÖW
Umweltwirtschaftsforum	UWF
Zeitschrift für Wirtschafts- und Unternehmensethik	ZWU
Accounting Auditing Accountability Journal	AAAJ
Society and Business Review	SBR
Social and Environmental Accountability Journal	SEAJ
Forum Wirtschaftsethik	FW
International Journal of Business Environment	IJBE
International Journal of Innovation and Sustainable Development	IJISD
Zeitschrift für angewandte Umweltforschung	ZAU
Zeitschrift für Umweltpolitik und Umweltrecht	ZUU
GAIA - Ökologische Perspektiven in Natur-, Geistes- und Wirtschaftswissenschaften	WW

Tab. 2.2: List of Included Journals Publishing Articles About Corporate Sustainability

In this review, special attention has to be paid to the selection of keywords, as both terms "Business Intelligence" and "Corporate Sustainability" are rather new concepts. In both cases, a number of frequently used related terms exist, which are often used as synonyms. Therefore for both domains, a number of similar terms is used for querying, so as to be able to identify all potentially relevant papers.

The terms selected as keywords, similar to "Business Intelligence" are: "Management Information System", "Management Support System", "Decision Support System", "Executive Information System" (all used in singular and plural form). During the search process, the more general term "Information System" combined with "Sustainability" or "IT support" combined with "Sustainability" were added to broaden the selection to any kind of information system support.[4]

For the reverse case, the terms "Corporate Social Responsibility", "Corporate Responsibility" and "Corporate Citizenship" are used in addition to the term "Sustainability", in order to be used for querying IS and BI Journals.

The use of various different keywords led to a high number of search results. Therefore, for each resulting paper, the titles and abstracts have been analyzed in order to single out the papers which focus on the use of Information Systems or Information Technology for supporting environmental or social initiatives in companies.

By applying the described search strategy, in total seven papers could be found. However, none of them focuses on the relationship between "Business Intelligence" and sustainability. Therefore, the search was extended to query not only the listed journals, but the whole databases EBSCOhost (Academic and Business Premier), SciDirect and Wiley Online Library.[5] In this way, four more relevant papers could be identified, including one which explicitly studies the role of "Business Intelligence" to support sustainability initiatives. The complete list of papers is presented in Table 2.3.

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[4] Whenever possible, the terms "Business Intelligence" and the pairs "Information System"+"Sustainability" and "IT Support"+"Sustainability" were used to query the full text, all other terms have been used to query abstracts, titles and keywords.

[5] According to the expansion of the search pool the terms had to be defined in a more concrete way to limit results: "Business Intelligence"+"Sustainability", "Information technology"+"Sustainability", "Green Business Intelligence", "Green Information Systems" were used in abstracts, titles and keywords.

Title	Author	Year	Journal	Summary	CS dimension			IS/IT aspect	Contribution type
					Eco.	Env.	Soc.		
Internet use for corporate environmental reporting: current challenges - technical benefits - practical guidance	Isenmann and Lenz	2002	BSE	Analyze technical benefits using the Internet for corporate environmental reporting		x		Web, IS	Development of theory, based on literature
Management Information System - A Tool for Corporate Sustainability	Caldelli and Parmigiani	2004	JBE	Develop a method for assessing how good IS can support sustainability goals	x	x	x	IS	Development of theory, evaluation in an empirical experiment
Managing sustainability with the support of business intelligence: Integrating socio-environmental indicators and organizational context	Petrini and Pozzebon	2009	JSIS	Study the relation of BI and Sustainability, focusing on the Information planning phase	x	x	x	BI, IS	Development of theory, based on empirical experiment
Information systems and environmentally sustainable development: energy informatics and new directions for the IS community	Watson, Boudreau and Chen	2010	MISQ	Develop a research agenda to establish a new subfield of energy informatics, which applies information systems thinking and skills to increase energy efficiency		x		IT, IS	Development of a research agenda
Information systems innovation for environmental sustainability	Melville	2010	MISQ	Develop a conceptual framework and a research agenda to expedite development and adoption of information systems for environmental sustainability	x	x		IS	Development of a research agenda
An approach to assessing sustainability integration in strategic decision systems for product development	Hallstedt, Ny, Robèrt and Broman	2010	JCP	Develop a method for assessing how good sustainability is integrated in a company's strategic decision system; guidelines are given, for improving such decision systems	x	x	x	IS	Development of theory, evaluation in an empirical experiment
An agenda for 'Green' information technology and systems research	Jenkin, Webster and McShane	2010	IO	Develop a research agenda based on a review of existing green information technology and systems literature, and draws from research that addresses environmental sustainability in the management, environmental psychology, and social marketing domains.		x		IT, IS	Development of a research agenda
Information technology as a change actant in sustainability innovation: Insights from Uppsala	Bengtsson and Agerfalk	2010	JSIS	Analyze the consequences of committing to the implementation of a reporting and analysis system for IT-supported sustainability	x	x	x	IT, IS	Development of theory, based on empirical experiment
Building environmentally sustainable information services: A green IS research agenda	Chowdhury	2011	JASIST	Propose a research agenda based on the literature on environmental impacts (especially green house gas emissions) of Information Services	x	x		IS	Development of a research agenda
Green Information Technologies and Systems: Employees' Perceptions of Organizational Practices	Jenkin, McShane and Webster	2011	BS	Analyze how employees currently view IT/S issues in relation to environmental sustainability and if similarities exist between different types of financial institutions.		x		IT, IS	Development of theory, based on empirical experiment
Transdisciplinary perspectives on environmental sustainability: a resource base and framework for IT-enabled business transformation	Elliot	2011	MISQ	Develop a holistic, transdisciplinary, integrative framework for IT-enabled business transformation as a research agenda		x		IT, IS	Development of a research agenda

Tab. 2.3: List of Identified Papers About IS/IT and Sustainability

The fact, that only one paper could be found, addressing the particular topic of Business Intelligence to support sustainability initiatives, shows a lack of a research in this specific area. All other papers, either address the general role of IS and IT systems in relation to sustainability aspects or focus on special IS/IT applications or sustainability aspects.

As illustrated in the column "Contribution Type", the main result in five of the eleven papers was a research agenda. This clearly demonstrates, that there is a research gap, not only in the specific field of BI and sustainability, but also in the whole broader field of IS and sustainability. All of these five papers were published recently (between 2010 and 2011), which indicates, that this research field is currently starting to evolve.

In all listed papers there is common understanding that sustainability (especially environmental sustainability) is an urgent problem to address for our society:

> The quality and future of human existence are directly related to the condition of our natural environment, but we are damaging the environment. Scientific evidence has mounted a compelling case that human behavior is responsible for deterioration in the Earth's natural environment, with the rate of deterioration predicted to increase in the future.
>
> (Elliot, 2011, p.197)

Furthermore, authors acknowledge the "central role of information systems, given its cross-functional view of the entire organization and ability to understand, change and reinvent business processes to better support sustainable practices" (Watson et al., 2010, p.23.f) and also the responsibility of the IS research community to better understand the role of IS in tackling the challenge of sustainability (Elliot, 2011, p.222; Melville, 2010, p.14; Watson et al., 2010, p.24).

Information Systems are seen as "an important but *inadequately understood weapon* in the arsenal of organizations in their quest for environmental sustainability by enabling new practices and processes" (Melville, 2010, p.14). PETRINI AND POZZEBON (2009, p.178) suggest that BI methods and tools have an important *but as yet not well studied role* to play in helping organizations implement and monitor sustainable and socially responsible business practices.

Despite the critical role in the challenge for more sustainability, the IS perspective in research on environmental sustainability is still nascent (Melville, 2010, p.3). "The IS academic community has been slow to acknowledge the problem and take action" (Watson et al., 2010, p.23).

In contrast to the area of IS, which has been treated in a general way, the focus on sustainability has been narrowed down. By definition, sustainability is incorporating three dimensions of aspects, being economic, environmental and social aspects. Interestingly, only four papers view sustainability in this integrated way. Most papers focus on the environmental or combined economic and environmental perspective (also illustrated by Bengtsson and Agerfalk, 2010, p.98). Surprisingly, none of the research agendas was developed under consideration of all three perspectives.

Generally, the term "sustainability" was first associated only with environmental aspects. With the introduction of the "Triple Bottom Line", by ELKINGTON (1998), the conceptual division into the economic, environmental and social dimension became the dominant approach. Although this concept suggests, that all three dimensions are of equal importance, the "Environmental" dimension is often viewed to be superior, as the economy and society depend on a healthy environment.

On a corporate level, however, the economic dimension could be assumed to be the most important one. From a business perspective, the overall goal is to maximize the profit, whereas with regard to environmental and social issues, only minimum requirements have to be met.

However, the other two dimensions became more important, with increasing sustainability awareness of consumers, investors, media, government and many other stakeholders. As these groups can, on the one hand, put pressure on companies (consumer boycott, bad media, governmental regulations) they also offer new opportunities (the ethical consumer, governmental subventions).

It is important to view the environmental and social dimension integrated with the economic, because parallel organizational structures face the danger of being cut back in times when corporate economic performance is under pressure. Sustainability management that is economically sound, will also be practiced in times of crises and not only when firms are successful. Furthermore, holistic corporate sustainable development requires participation and stakeholder involvement, not just with societal stakeholders but also an involvement by conventional managers (Schaltegger and Wagner, 2006, p.683).

Therefore, this paper will view sustainability in the integrated way, by considering all three dimensions. The according concept of "Corporate Sustainability" will be elaborated in detail in the next chapter.

3 Corporate Sustainability

Before suggesting a solution, its inevitable to examine the problem first. For the purpose of studying the potential opportunities to support Corporate Sustainability with Business Intelligence, an understanding of the business perspective of sustainability is essential.

This chapter provides the basis for understanding the concept of sustainability in general and the application of sustainability in the business context. Based on an analysis of the company's' motives towards becoming more sustainable, the goals of corporate sustainability are examined. Finally, the question "How do companies manage sustainability initiatives?" (Research question 1.1.) is answered by providing an overview about the central concepts of Sustainability Performance Management and Measurement.

3.1 Sustainability

The idea of sustainability has a long history. It originated in the field of forestry in Germany in the beginning of the 18th century. The extensive silver mining leaded to a considerable need for wood. As a result, whole forests were cleared. Soon, people recognized the imminent consequences of the exploitation of their forests, the endangerment of the silver mining and their economical development. Consequently the mine captain, Hans Carl von Carlowitz, introduced the principle of sustainable forestry. He demanded that in a particular period of time only as many trees would be cut as could be regrown (see Loew, 2004, p.56).

Despite the long history of the term, the concept of sustainable development first became widely accepted in 1987 after the UN world commission on environment and development published the report "Our common future" (see Boms, 2008, p.83). At that time it became clear, that consequences of globally ongoing processes might endanger the existence of further generations:

> Settled agriculture, the diversion of watercourses, the extraction of minerals, the emission of heat and noxious gases into the atmosphere, commercial forests, and genetic manipulation are all examples of human intervention in natural systems during the course of development. Until recently, such interventions were small in scale and their impact limited. Today's interventions are more drastic in scale and impact, and more threatening to life-support systems both locally and globally. This need not happen. At a minimum, sustainable development must not endanger the natural systems that support life on Earth: the atmosphere, the waters, the soils, and the living beings (Brundtland, 1987, Paragraph I.9).

Thus BRUNDTLAND (1987) suggested the concept of sustainable development in terms as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs". Sustainable development refers to activities to move towards the goal of sustainability. Therefore sustainable development is used to refer to a process, whereas sustainability describes a state. However, it remains unclear, when the state of sustainability is ultimately reached, therefore it can be seen as a moving target to the societal development.[6]

At first, the discussion about sustainability focused on environmental aspects. After the UN-Conference for Environment and Development in 1992, the relations between environmental, social and economic factors were emphasized (see Kraus, 2011, p.60). An important result of this conference was a comprehensive political program, named "Agenda 21". This agenda states the most important goals, projects and tools for an equal development of today's and future generations and represents an action program for the 21st century (see Hagemann and Hauff, 2010, p.10).

Nowadays, there is general consensus that sustainability is based on the three pillars of environmental, social and economic sustainability.

3.1.1 Dimensions of Sustainability

The three pillars (see Figure 3.1) of sustainability are also referred to as "Triple Bottom Line".[7] According to this concept, all dimensions are of equal importance and none of the three dimensions should be examined independently. There can be interdependencies between the dimensions, which can be either complementary or conflicting. Activities or facts can sometimes be assigned to more than one dimension, e.g. a reduction of energy consumption can be assigned to the environmental as well as the economic dimension (see Kraus, 2011, p.61).

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6 See Schaltegger et al. (2006, p.2) who defined corporate sustainability and corporate sustainable development analogously

7 See also (Elkington, 1998), who first coined the expression "Triple Bottom Line"

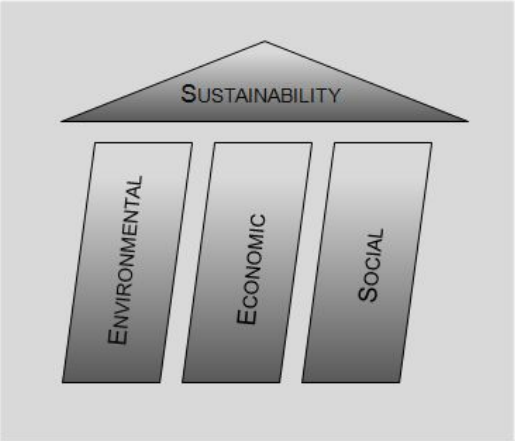

Fig. 3.1: The Three Pillars of Sustainability (see Kirchgeorg and Hermann, 2004, p.604)

The aim of *economic sustainability* is to create and preserve conditions which enable a high level of provisioning. Among related macro-economic goals are a high employment rate, stable price levels, appropriate growth, and a balance in foreign trade (see Loew, 2004, p.60f). In order to achieve economic sustainability it is important to preserve an effective, adaptive, and innovative market system. Furthermore the global sustainable development can be pushed by transfer of technology and by avoidance of distortion of competition (see Boms, 2008, p.91).

The overall goals of the *social dimension* are to ensure health, social stability, and the society's ability to develop and function (see Brugger, 2010, p.19). Further important characteristics of a socially sustainable society are prevailing of equity, equality of opportunities and individual freedom (see Boms, 2008, p.93).

The *environmental dimension* of sustainability is of particular importance, as damage to the environment can be eliminated to only limited extend. Moreover, the production of goods and services, and a stable social society presume an intact ecosystem (see Hagemann and Hauff, 2010, p.11). The main focus of this dimension is on the insurance of the environments capabilities, the conservation of the nature, and on the society's obligation to not over strain the environments capacities (see Boms, 2008, p.91). This means that the depletion of renewable resources should not exceed their regeneration rate (Loew, 2004) and the emission of noxious substances should not exceed the environments capacity to absorb these.

3.1.2 Sustainability in the Business Context

Generally, the concept of sustainable development applies to the society as a whole (Loew, 2004, p.14). At the business level, corporate sustainability can accordingly be defined as "meeting the needs of a firm's direct and indirect stakeholders (such as shareholders, employees, clients, pressure groups, communities etc), without comprising its ability to meet the needs of future stakeholders as well" (Dyllick and Hockerts, 2002, p.131).

Several concepts to integrate economic, social and environmental aspects into corporate actions have been developed. Corporate Social Responsibily (CSR), Corporate Citizenship (CC) or Corporate Sustainability are the most popular examples within a variety of different approaches. The scope and definitions of these concepts are not always clear. In general, corporate sustainability and, CSR refer to company activities demonstrating the inclusion of social and environmental concerns in business operations and in interactions with stakeholders (see Marrewijk, 2003, p.102). Corporate Citizenship highlights the fact that the corporation sees its rightful place in society, next to other "citizens", with whom the corporation forms a community (see Matten et al., 2003, p.111).

Many authors[8] tried to relate and differentiate the similar concepts, with different results. As corporate sustainability is often seen as the broadest term (see Greiling and Ther, 2010, p.45), incorporating the concepts of CSR and CC (see Figure 3.2), throughout this paper the term Corporate Sustainability will be used to refer to corporate actions, simultaneously integrating economic, ecologic and social factors with the aim to preserve resources for future generations (see Quick and Knocinski, 2006, p.616).

Generally, two tasks can be considered to be in the core focus of Corporate Sustainability. The first is to ensure a company's success and existence in the long run (see Hoffmann, 2011, p.33).

> By providing jobs, investing capital, purchasing goods, and doing business every day, corporations have a profound and positive influence on society. The most important thing a corporation can do for society, and for any community, is to contribute to a prosperous economy.
>
> (Porter and Kramer, 2006, p.13)

[8] Marrewijk, 2003; Matten et al., 2003; Loew, 2004; Brugger, 2010; Boms, 2008; Prammer, 2010

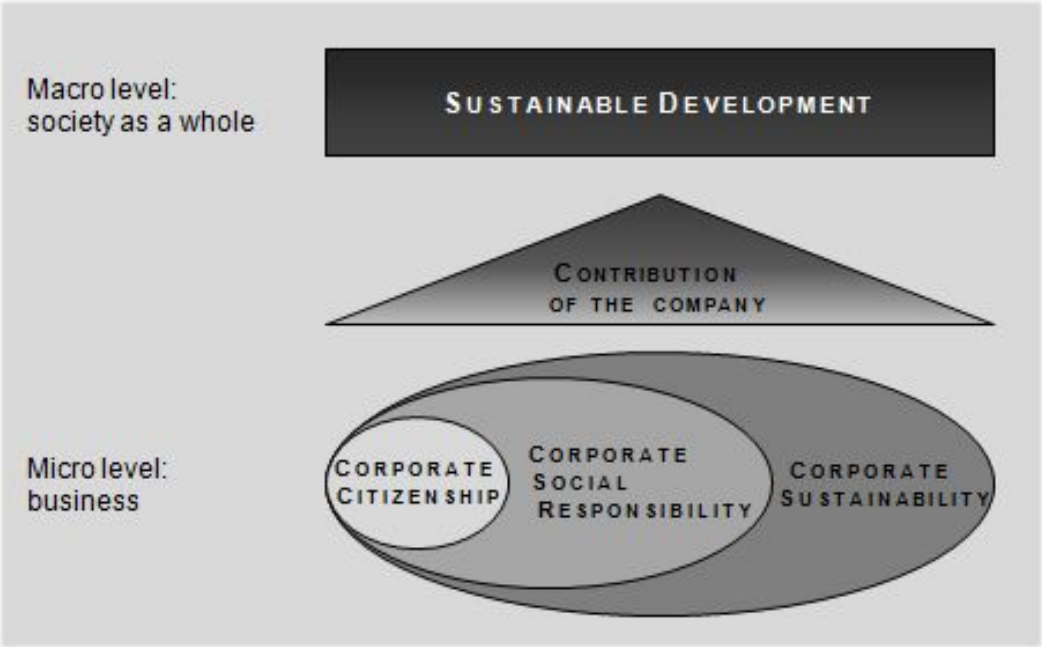

Fig. 3.2: Relation Between the Concepts Corporate Social Responsibility, Corporate Citizenship and Corporate Sustainability

This means, companies in their role as economic players should strive for long-term existence by protecting their position on the market and their resource base.[9]

The second is to contribute to the sustainable development of the society as whole (see Prammer, 2010).

> [...] the proper "social responsibility" of business is to tame the dragon, that is to turn a social problem into economic opportunity and economic benefit, into productive capacity, into human competence, into well-paid jobs, and into wealth.
>
> (Drucker, 1984, p.62)

Corporate sustainability means to incorporate these tasks into a company's strategic planning (see Fischer et al., 2009, p.270).

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[9] From a purely economic perspective, the question arises, if any action other than ensuring the sustainable competitive advantage of a company, is justified on a company's agenda. As, according to FRIEDMAN (2007), the "one and only one social responsibility of business is to use it resources and engage in activities designed to increase its profits so long as it stays within the rules of the game, which is to say, engages in open and free competition without deception or fraud". This question will not be addressed in this paper, instead it will be referred to related literature: JONKER ET AL. (2011, p.25) discuss the role of company's in the society, by opposing the theories of MILTON FRIEDMAN and ROBERT EDWARD FREEMAN. PALAZZO (2009) comments on the responsibility of company's in the society from a neo-liberal and an instrumental position.

With reference to the three dimensions of sustainability, companies face challenges in three different areas:

Economically sustainable companies guarantee at any time cash flow sufficient to ensure liquidity while producing a persistent above average return to their shareholders (see Dyllick and Hockerts, 2002, p.133f). These requirements can be satisfied by companies performing anticipatory economic activity, appropriately managing risks and communicating results transparently to the investors (see Schönborn, 2001, p.V).

Environmental sustainable companies use only natural resources that are consumed at a rate below the natural reproduction, or at a rate below the development of substitutes. They do not cause emissions that accumulate in the environment at a rate beyond the capacity of the natural system to absorb and assimilate these emissions (see Dyllick and Hockerts, 2002, p.133f). General protection of the environment, efficient use of energy, water and other resources as well as avoiding waste and emissions are important tasks of corporate environmental sustainability (see Schönborn, 2001, p.V).

Socially sustainable companies avoid and diminish negative and foster positive social corporate behavior (see Boms, 2008, p.102). Social sustainability generally means to act conscientiously and responsibly towards the society, while not taking advantage of the asymmetrical distribution of power in favor of the company (see Hermann, 2005, p.74). More concretely, to act socially sustainable means, amongst others, to ensure the health and safety of employees and people in the society, to fairly remunerate employees, treat people equally independent of their gender or race, to combat against corruption (see Schönborn, 2001, p.V).

Following these definitions, corporate sustainability supports the aims of the sustainable development on the societal level and thereby ensures the corporate resource base in the long run (see Boms, 2008, p.105). In this way, both tasks of Corporate Sustainability, are connected and support each other. However, activities that support sustainability, especially the economic sustainability of a firm, do not necessarily contribute to the sustainability of the society. In fact, both tasks might be complementary or conflicting. The general idea behind the three dimensional model, is that the three perspectives have to be balanced. This means, a firm should only perform activities which protect the environment, if they do not harm the company with respect to the economic or social dimension.[10]

[10] See also Balik and Frühwald, 2006, p.28f and Figge, 2004, p.5: “Ecologically effective environment protection, which is destroying corporate value, will not find acceptance of the company’s owners. Measures, which increase corporate value, but cause damage to the environment, will have to deal with the pressure of ecologically oriented stakeholders.”

3.2 Motivations of Businesses Towards Becoming More Sustainable

A company's efforts to improve Corporate Sustainability has to fit the company's business strategy.[11]

They are many ways how CS can contribute to a firm's success, which can serve as a motivation to incorporate CS into the business strategy. Generally, factors can be divided into "Push" and "Pull" factors (see Schaltegger et al., 2010, p.35). The pressure of the society, Non-Governmental Organizations and media, as well as governmental regulatory requirements are push factors, as they drive companies to perform corporate sustainability initiatives in order to anticipate further pressure or damage.

The evidence of negative effects of non-sustainable corporate activity can be clearly seen in the case of Nike, which faced an extensive consumer boycott after the New York Times and other newspapers published reports about abusive labor practices at some of its Indonesian suppliers in the early 1990s (see Porter and Kramer, 2006, p.2). Another example is the oil company Shell, which was confronted with Greenpeace protest after it decided to sink the Brent Spar, an obsolete oil rig, in the North Sea in 1995. The result was a profit decline of 30-50% in Germany, as customers and also public institutions declined to buy from gas stations operated by Shell (see Kintzinger, 1995).

Push factors urge companies to increase sustainability, in order to avoid scenarios like these. Pull factors, on the other hand, provide potential advantages for company's and make them pro actively increase corporate sustainability. A classic example is the increasing number of sustainability aware customers as a new target group, who prefer sustainably produced goods or products provided by sustainably operating companies.

The IT company Fujitsu Technology Solutions, for example, introduced a new product line, called "proGreen-Selection", which are produced natural materials and are designed in a way that they consume less energy. As the company also redesigned production processes with the aim to increase sustainability, they were able to save more than 50% of the energy consumption needed to produce a PC and could also decrease their water consumption (Fujitsu Technology Solutions, 2010).

In the 1980s and 1990s, mainly pull factors determined the decision of companies to manage environmental concerns. SCHALTEGGER ET AL. (2010, p.35) carried out a study, in which they interviewed 112 of the 500 biggest companies in Germany about their corporate sustainability activities. The results showed, that push factors are still seen as the factors, which

[11] PORTER AND KRAMER (2006, p.p.1) state that CSR efforts have not been nearly as productive as they could be because companies think of corporate social responsibility in generic ways instead of in the way most appropriate to each firm's strategy.

support corporate sustainability at most, but a high relevance is also ascribed to pull factors, such as customers or competition.

In existing literature, eight different motivations, including both push and pull factors, can be identified (see Table 3.1).

	Heemskerk et al. (2002, p.15)	Boms (2008, p.66)	Kraus (2011, p.73ff)	Hermann (2005, p.68)	Duong Dinh (2011, p.24ff)	Jonker et al. (2011, p.41)	Brugger (2010, p.26ff)	Schaltegger et al. (2010, p.34ff)
1. Enhancing reputation	x	x	x	x	x	x	x	x
1.1 Raise employee awareness/motivation	x		x	x	x		x	
1.2 Attract talented people as potential employees	x				x		x	
2. Risk management	x	x	x	x	x	x	x	x
3. Increase shareholder-value	x	x	x	x	x			x
4. Differentiation		x	x	x	x	x		x
4.1 Influence customers buying decision/preferences					x			x
5. Increase cost efficiency		x	x	x	x		x	
6. Encouraging innovation	x			x		x	x	
7. Comply to governmental regulations		x		x				x
8. Give back to society				x		x		

Tab. 3.1: Reasons for Companies to Strive for Corporate Sustainability

Enhance company reputation

The most popular reasons, stated in each of the reviewed works, deal with the impact of CS on the company's reputation. This relationship can be seen as a push factor, when considering the negative impacts non-sustainably corporate behavior can have, but also as a pull factor, when companies position themselves as sustainably operating company and thereby attract qualified employees and raise employee motivation.

Customer surveys indicate, that companies can enhance their reputation, if they are considered to operate responsively. Many positive effects result from a good reputation. A positive company image improves relations of the company to its stakeholders. In this way it influences trust of customers positively and thereby increases customer loyalty (see Münstermann, 2007, p.32f; Hansen and Schrader, 2005, p.384).

A good reputation can also influence current and prospect employees (see Münstermann, 2007, p.32f; Hansen and Schrader, 2005, p.384). It can increase the motivation, satisfaction and loyalty of current employees and also reduce the cost of sick leave. As a company's reputation constitutes also a deciding factor in a job search, potential new employees tend to prefer company's with a good reputation. This can lead to a competitive advantage for the company, for example, through a better service level, based on the staff's competence level.

Generally, many effects of corporate sustainability are in accordance to effects also attributed to Corporate Branding. For this reason, an own research discipline evolved, named Corporate Sustainability Branding, which focuses on leveraging the positive effects of both approaches combined. This concept is based on the assumption, that the approaches strengthen each other and provide a high synergetic potential (see Hermann, 2005, p.71).

Manage risks

A company can strive for CS, because of its fear of economic losses or of damage to the company's reputation. This motivation can be seen as the complementary "push"-side of the before mentioned factor. In this case, companies implement Corporate Sustainability with the aim to to avoid accidents or protests from NGO or employees. As illustrated by the Shell example stated above, protest and critical media reports can substantially harm company's reputation and also cause significant financial loss.

This motivation is often important for companies with a business profile, which inherently poses risks to society or environment, for example, companies in the chemical industry or companies which's success is mainly based on a high brand value (see Jonker et al., 2011, p.41).

A good reputation, can also proactively contribute to the company's risk management, as the positive attitude towards the company, can result in increased tolerance on the side of the society, in case the company is faced with an accident or negative media (see Duong Dinh, 2011, p.25; Hansen and Schrader, 2005, p.383ff).

Increase shareholder-value, easier access to capital

As a pull factor, corporate sustainability contributes to an improved company rating and therefore to extended financing options (see Münstermann, 2007, p.32f). The raising number of Socially Responsible Investments indicates the increasing importance of sustainability in

the financial market (see Kraus, 2011, p.76). With the introduction of the Dow Jones Sustainability Index, a global, rational Index which measures the performance of investments into sustainably acting companies has been established (see Balik and Frühwald, 2006, p.47).

Differentiate from competitors, access new markets

A further opportunity for companies to "pull" advantages from sustainability is by differentiating from competitors, by product and brand differentiation. Companies can address the demand of customers for environmental-friendly and ethically produced goods[12], by designing products which satisfy the new requirements (see Jonker et al., 2011, p.41). The fact that a company operates environmentally and socially responsible, influences buying decisions of sustainability aware customers, which can be willing to pay more for the increased level of corporate sustainability (see Duong Dinh, 2011, p.27).

Furthermore a positive influence of corporate sustainability to the loyalty of customers could be proofed by empirical studies (see Münstermann, 2007, p.32f; Hansen and Schrader, 2005, p.384)

If customers refuse to buy products or services from companies which act unethically or harm the society and the environment, ethical consumption can also be seen as push factor. Especially after "scandals" or accidents, which damaged the company image, the firm is pushed to invest into corporate sustainability, in order to regain trust of customers.

Increase cost efficiency

As sustainable economic activity is often attended by energy and resource savings, the cost efficiency increases. Again, this factor can be considered as a pull factor, when taking the direct effects of process changes focusing on the reduction of energy, water and other resources but also waste, into account. Studies show that, the implementation of environmental information systems regularly leads to cost reduction based on the reduced material and energy consumption (see Hansen and Schrader, 2005, p.385).

When considering the raising prices for energy and non-renewable resources, this factor can also be viewed as a push factor, as a high dependence on energy or resource prises, poses the risk of not being able to keep competitive prices in the long run.

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[12] also referred to as ethical consumption by Duong Dinh (2011, p.26)

Encouraging innovation

Also the challenges connected to the implementation of corporate sustainability themselves, can be seen as a motivating factor. Companies are forced to apply new and innovative approaches in order to reach sustainability aims, this can lead to groundbreaking new developments and subsequent positive effects (Brugger, 2010, p.28).

The critical reflection on the degree of sustainability of the business raises employee awareness on improvements and thereby fosters an atmosphere of innovation and encourages employees to take an active part in initiatives.[13]

Comply to governmental regulations

This factor can be seen as push as well as a pull factor. On the one hand, companies are pushed to meet governmental requirements in order to avoid penalties and the according negative consequences to the company image. The increasing number of statutory provisions, urge companies to fulfill more and more additional requirements. The anticipative fulfillment of provisions, can be an advantage for companies, which behave proactively sustainable (see Münstermann, 2007, p.32f).

On the other hand, companies can also actively benefit from governmental regulations. Corporate sustainability initiatives can permit companies access to government aid, like financial support for research and development activities or other financial subventions (see Münstermann, 2007, p.32f).

Giving back to society

This motivation is not very often stated in literature, as it - viewed separated from any other motivations - does not directly or indirectly contribute to the business success. Corporate actions taken with the exclusive motivation to "Give back to the society" are therefore against the common understanding of economic corporate behavior. Nevertheless, companies undertake philanthropic activities, mainly following their motivation to help, to preserve environment or to increase the living standard. The engagement can be based upon the founder's or owner's ecologic or social beliefs (see Jonker et al., 2011, p.41).

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[13] Bengtsson and Agerfalk (2010, p.108): "In our study, the initial commitment to use a sustainability reporting system for tracking sustainability indicators had profound implications. Not only was it a commitment to continuous striving for sustainability improvements, it also elevated the issue of educating the employees to enable them to take an active part in the initiative."

3.3 Sustainability Goals

The motivations for companies to strive for corporate sustainability, like the enhancement of the company reputation or the increase of cost-efficiency are possible implications of the integration of sustainability aspects into a company's strategy and business processes.

The particular goals of corporate sustainability are examined by moving the focus from the *implications* to the concept of corporate sustainability itself. HERZIG ET AL. (2007) developed a system of objectives. According to the three dimensions, the goals of CS are the increase of eco-effectiveness, the increase of social-effectiveness and with regard to the economic dimension, the increase of eco-efficiency and social-efficiency. At the same time, the alignment of these three goals and the integration of environmental and social aspects into traditionally economically directed management, constitutes the superior goal and the major challenge for companies. Figure 3.3 illustrates the goals of corporate sustainability as well relations between them.

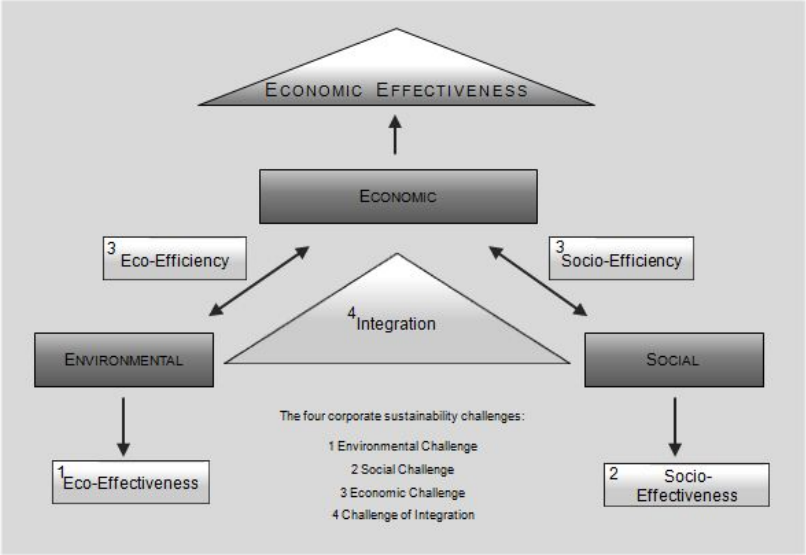

Fig. 3.3: Sustainability Challenges and Objectives (Herzig et al., 2007, p.14)

Generally, an "effectiveness" describes the degree of target achievement. Accordingly, Eco-effectiveness is the relation of the achieved to the targeted degree of environmental compatibility, which is to minimize negative impacts to the environment. Negative environmental impacts are for example, CO_2 emissions, extensive consumption of non-renewable energy or the generation of problematic waste.

Analogously social-effectiveness is, the relation of the achieved to the targeted degree of social compatibility. In the social dimension, the target is to reduce negative and to maximize positive social effects. Health and safety risks, corruption, child labor, and social inequities

are negative effects which have to be reduced and social effects, as for example a positive working atmosphere, fair working conditions, and trainings should be fostered.

The economic challenge for companies, is next to traditional economic aims, like the increase of profits and corporate value, to manage social and environmental aspects as economically as possible. “Efficiencies” describe the relation between desired to undesired effects. Accordingly, the eco-efficiency and the social-efficiency link the social and the environmental dimensions to the economic dimension.

Eco-efficiency is defined as the rate of added value to the amount of environmental impact. Examples are Added Value [EUR] / Emitted CO_2, Added Value / Waste [t], Added Value [EUR] / Consumed Energy [kWh].

Social-efficiency is the relation between the added value and social impact. Examples are Added Value [EUR] / sick leave [days], Added Value [EUR] / accidents at work [Number].

It should be added, that social and environmental impacts are often not easily measurable. If a measurement is possible, the effectiveness of a sustainability initiative can be perceived differently depending on the stakeholders. One stakeholder can attribute high efficiency to an initiative aiming at recycling problematic waste, while another one demands the company to generally avoid the generation of this kind of waste completely.

The overall goal of Corporate Sustainability is to simultaneously fulfill all the individual goals and to integrate them into existing management structures.

3.4 Sustainability Management

In this section, the implementation of corporate sustainable development on an operational business level will be examined. Particularly, the tools and instruments to implement corporate sustainability initiatives will be introduced, which also provides an answer to research question 1.1.

The precondition for corporate sustainable development is the existence of a corporate sustainability strategy, that has the commitment of senior executives and the board of directors. The top management decides about the extent and characteristics of corporate sustainability development of the company. To formulate a successful sustainability strategy, executives have to first identify the issues which have the greatest impact to the company and the society, and prioritize the most important ones to be included into the corporate strategy (see Epstein, 2008, Chapter 1).

Based on the defined strategy and top management commitment, social and environmental impacts have to be integrated into day-to-day management decisions. “Companies must tie the measurement and reporting of these impacts into decision-making processes. Further, these impacts must be measured and reported in financial terms and then integrated into the traditional investment models” (see Epstein, 2008, p.23).

A critical factor for integration of sustainability aspects in existing management is the fulfillment of the new information requirements on sustainability impacts (see Jonker et al., 2011, p.35; Wagner, 2011, p.563). “Information about sustainability impacts and sustainability performance can help managers to incorporate deliberative sustainable thinking into their decision-making, planning, implementation and control activities” (Schaltegger et al., 2006, p.2f).

SCHALTEGGER AND WAGNER (2006) suggest a management framework, which links environmental and social management with the business and competitive strategy and integrates environmental, social and economic business information. Particularly they propose a framework for sustainability performance measurement and management, which links the Sustainability Balanced Scorecard, sustainability accounting and sustainability reporting, which are the central concepts in the context of sustainability implementation. Prior to elaborating on the framework, the next sections briefly describe each of these concepts.

3.4.1 Sustainability Balanced Scorecard

The Sustainability Balanced Scorecard (SBSC) is an extended version of the Balanced Scorecard (BSC) framework, proposed by KAPLAN AND NORTON (1996), which helps to put the corporate strategy into action, by measuring the performance with the help of indicators in four different corporate dimensions. The BSC adds to the traditional financial measures (financial perspective), criteria that measured performance from three additional perspectives (see Figure 3.4), being the customers, internal business processes, and learning and growth (see Kaplan and Norton, 2007, p.150).

The financial perspective indicates whether the transformation of a strategy leads to improved economic success. The customer perspective defines the customer and market segments in which the business competes and addresses the measures related to them, e.g. customer satisfaction. The internal process perspective identifies the internal business processes that enable the company to meet the expectations of customers in the target markets and those of the shareholders. The learning and growth perspective describes the necessary infrastructure for achieving the objectives of the other three perspectives, e.g. qualification, motivation and goal orientation of employees, and information systems (see Figge et al., 2002, p.270).

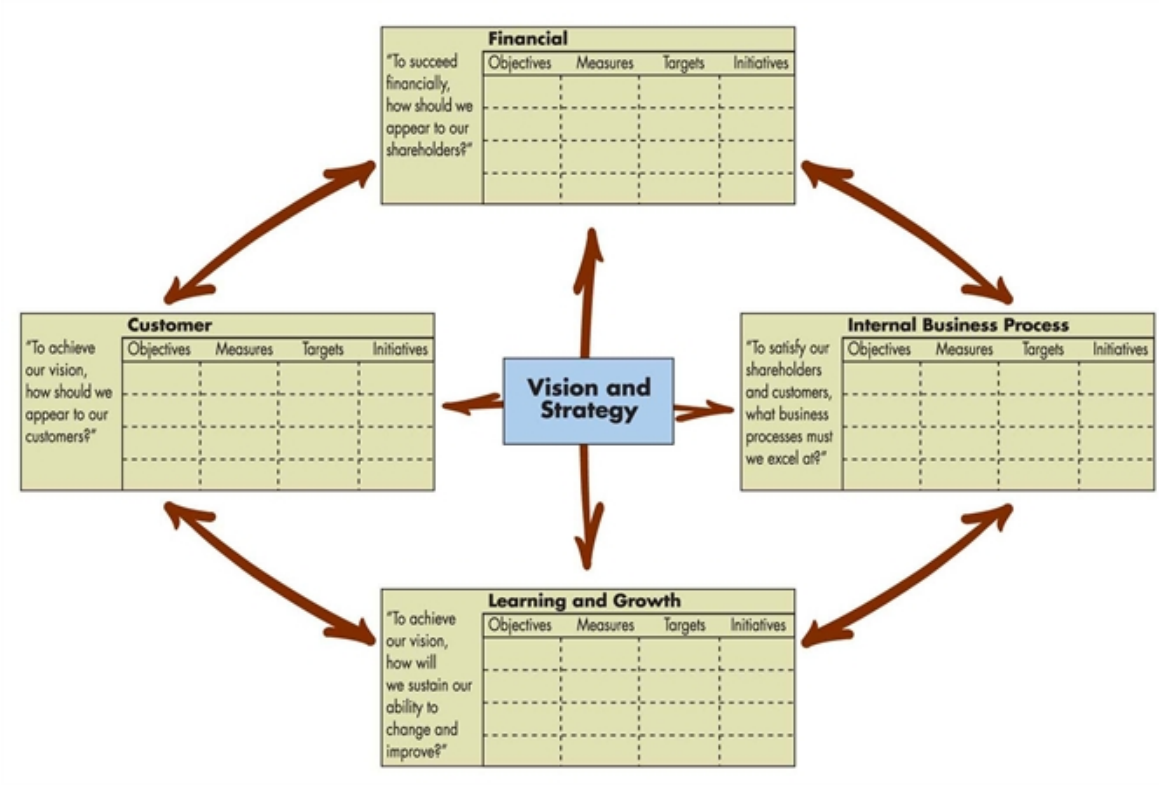

Fig. 3.4: The Balanced Scorecard (Kaplan and Norton, 2007, p.153)

The implementation of the BSC in four steps helps companies to link a company's long-term strategy with its short-term actions. The first step "Translating the vision" helps managers to get a unified understanding of the organization's vision and strategy, by expressing them as an integrated set of objectives and measures, that describe the long-term drivers of success. The second step is referred to as "communicating and linking"-process, in which managers communicate the strategy within the organization and align departmental and individual objectives. "Business Planning" is the third step, which enables companies to integrate their business and financial plans. By using the BSC-goals as a basis for allocating resources and setting priorities, managers can prioritize and coordinate those initiative that move them toward their long-term strategic objectives. In the fourth step "feedback and learning", companies can monitor short-term results from all four perspectives and evaluate their strategy based on the performance, and if necessary also modify the strategy (see Kaplan and Norton, 2007, p.152).

A central aspect of the BSC is the identification and analysis of cause-and-effect relationships between the indicators within and between the different perspectives. "A business strategy can be viewed as a set of hypothesis about cause-and-effect relationships" (Kaplan and Norton, 2007, p.159). Ultimately, all of these cause-and-effect chains end in the financial perspective (see Figge et al., 2002, p.271). With the help of the BSC, these hypotheses

can be evaluated by analyzing the correlation of the different indicators and thereby help to critically reflect on the developed business strategy.

As the BSC has experienced rapid diffusion as a management tool and it is well placed to address efficiently the major challenges of corporate sustainability management (see Schaltegger and Wagner, 2006, p.686). A SBSC is a BSC that incorporates sustainability strategies into its strategic maps, objectives, targets, actions and indicators (see Pozzebon et al., 2010).

There are mainly four different approaches which transform a "conventional" BSC into a SBSC (see Petrini and Pozzebon, 2009, p.182; Figge et al., 2002, pp.273-275):

1. The "partial SBSC", is the simplest form of SBSC, where one or more social or environmental indicators are integrated into one of the four perspectives, e.g. the internal processes perspective. This form constitutes a first step toward sustainability and is basically a pre-stage for the "transversal SBC".

2. In a "transversal SBSC" social or environmental indicators are included in all four perspectives. Environmental and social aspects consequently become an integral part of the conventional scorecard and are automatically integrated in its cause-and-effect links.

3. In the "additive SBSC", an additional dimension is added which includes social and environmental indicators. The introduction of an additional perspective, might be necessary if environmental and social aspects from outside the market system (which is represented in the existing four perspectives) explicitly represent strategic core aspects for the successful execution of the strategy. The aspects within this new dimension are linked to the other dimensions through the cause-and-effect chains, which means that all other dimensions are affected by the "sustainability-dimension".

4. The "derived environmental and social scorecard" is a new scorecard which is derived from the conventional BSC with its four perspectives, but includes only environmental and social aspects. It is important to note that this can be seen exclusively as an extension to one of the before mentioned approaches. The derived societal BSC should not be a separated new scorecard, but should be linked to the conventional BSC through the environmental and social indicators within the four conventional perspectives. In this way, the derived BSC allows coordinated control and view on all strategically relevant environmental/social aspects.

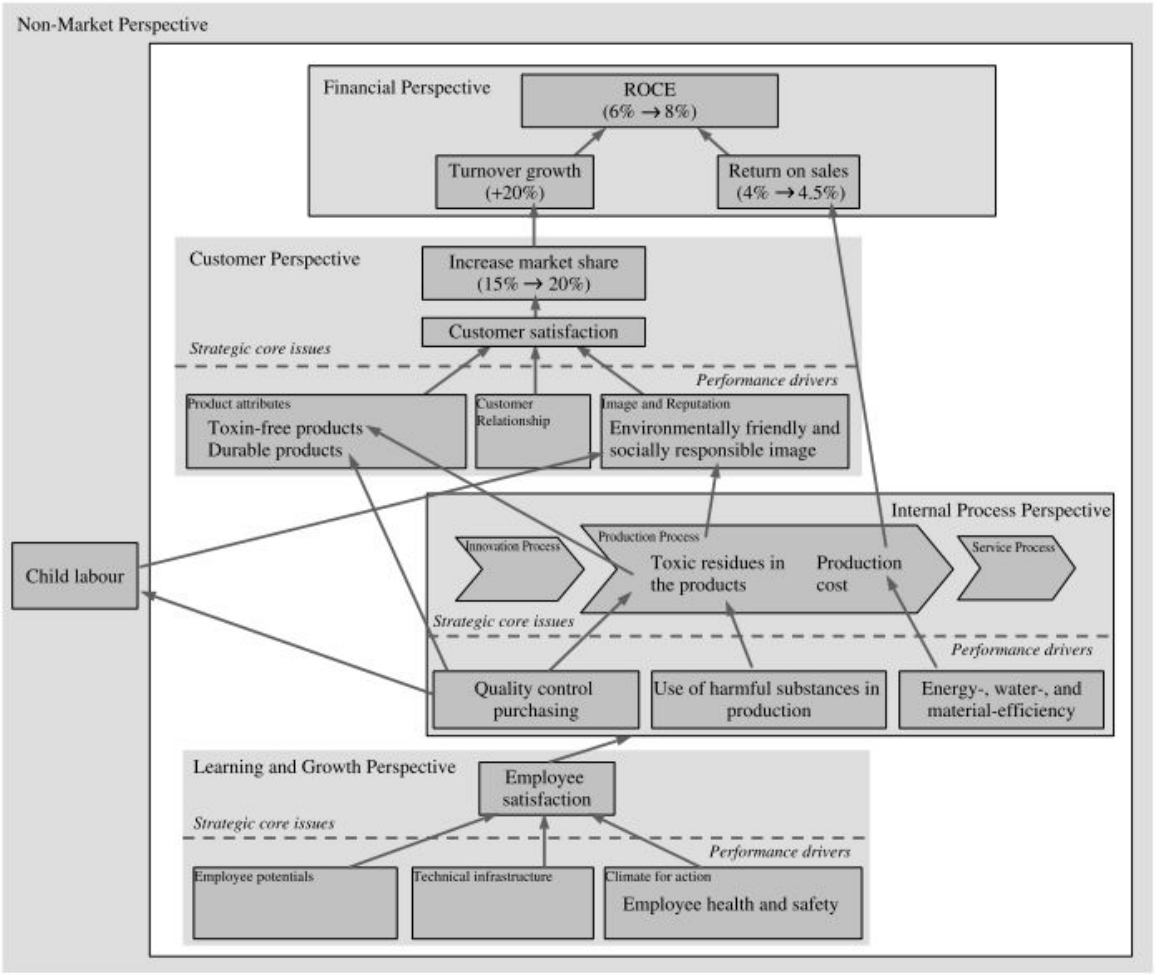

Fig. 3.5: Example of a SBSC Strategy Map (Figge et al., 2002, p.282)

The choice of how environmental and social aspects are integrated into the BSC, depends on the company's strategy. Only if social and environmental aspects represent strategic core aspects and it is not possible to integrate these into the conventional perspectives, a new dimension should be added.

3.4.2 Sustainability Accounting

Sustainability accounting describe new information management and accounting methods that aim to create and provide high quality information to support a corporation in its movement towards sustainability (see Schaltegger et al., 2006, p.15). More specifically, sustainability accounting can be generally seen as the process through which information flows are organized and provided for management decision making. This includes gathering, classifying and accumulating of relevant data and information (see Burritt and Schaltegger, 2010, p.832). However, the concrete understanding of sustainability accounting in a company, depends on the driving force behind the implementation. Basically, two main approaches to

sustainability accounting, can be distinguished, which are the “outside-in” and the “inside-out” approach (see Schaltegger et al., 2006, p.16, Burritt and Schaltegger, 2010, p.832).

The *outside-in* approach focuses on fulfilling stakeholder expectations and serving the information requirements by external parties. Sustainability measurement and management activites are directed towards the demand of external stakeholders. For example, the Global Reporting Initiative offers guidelines for supply of externally published corporate sustainability reports and many companies align their sustainability accounting in a way to fulfill the information requirement defined in these guidelines (Burritt and Schaltegger, 2010, p.832).

The *inside-out* approach, on the other hand, is primarily based on the company’s defined business strategy and analyses of issues that are relevant for the effective implementation of the strategy through sustainability performance measurement, management and reporting. In this approach, sustainability accounting is seen the process for information collection and communication to support internal decision making to implement corporate sustainability (see Schaltegger et al., 2006, p.16; Burritt and Schaltegger, 2010, p.832).

However, these two approaches should not be considered to exclude each other. They rather indicate two different perspectives, which both have their strengths and weaknesses. Any company which is striving for sustainability will need to consider and integrate both approaches to a varying degree depending on its individual situation (see Schaltegger et al., 2006, p.17).

3.4.3 Sustainability Reporting

The motivations of companies to strive for corporate sustainability (as mentioned in Section 3.2) indicate that sustainability issues generally are related to expectations of different stakeholder groups, e.g. ethical consumers, the government, or employees. As a consequence, the company is challenged not only to measure sustainability aspects but also to communicate results to various internal and external stakeholders. Sustainability reporting refers to new formalized means of communication which provide information about corporate sustainability (Herzig and Schaltegger, 2006, p.307f).

Companies disclose information about their sustainabaility aspects in different ways. One opportunity for companies is to publish a specific sustainability report in addition to the financial report. Another way would be to extend business an financial reports and integrate sustainability aspects into the balance sheet or profit loss account, in order to account for the financial importance of environmental and social aspects. Some companies also choose to

produce several different specific reports, e.g. environmental report, social report, corporate responsibility report. Each of this reports deals with a specific challenge of corporate sustainability and addresses different stakeholder groups (Herzig and Schaltegger, 2006, p.307f).

In the field of sustainability reporting, there is an increasing trend towards standardized reporting (Schaltegger and Wagner, 2006, p.692). The most popular sustainability reporting framework was developed by the Global Reporting Initiative (GRI), which is a non-profit organization that promotes economic, environmental and social sustainability. It provides companies and organizations with a comprehensive sustainability reporting framework. The framework includes guidelines for both the process of creating a sustainability report as well as the content of such a report (Global Reporting Initiative, 2011).

3.4.4 Sustainability Performance Measurement and Management

There have been different approaches to measure environmental and social performance, e.g. life cycle assessment or social indicator developments. However, these approaches do not particularly integrate business issues with social and environmental activities, and they do not consider the general economic relevance of corporate societal engagement. Instead these activities result in establishing a parallel organization in the company to deal with non-economic issues of performance (see Schaltegger and Wagner, 2006, p.682).

In contrast, Sustainability Performance Measurement and Management (SPM) is a holistic management approach which links business strategy, sustainability communications and reporting and simultaneously considers all sustainability dimensions. More concretely SPM refers to the definition of goals, evaluation and improvement with regard to corporate sustainability performance (see Boms, 2008, p.150f; Schaltegger and Wagner, 2006, p.682).

The framework proposed by SCHALTEGGER AND WAGNER (2006, pp.683-692) connect the three central concepts of SBSC, sustainability accounting and sustainability reporting and thereby helps to organize the flow of information between its justification, creation and communication.

Figure 3.6 shows the integrated SPM-framework with the central activities in the left column and the core questions to be addressed in the right column.

The SPM-framework can be seen as a sequence from top to the bottom (arrows from top to bottom). In this way, the *inside-out* perspective (as described in Section 3.4.2) is represented. With the help of the SBSC strategic impacts of social and environmental issues are analyzed and incorporated into the business strategy. Based on the developed strategy maps,

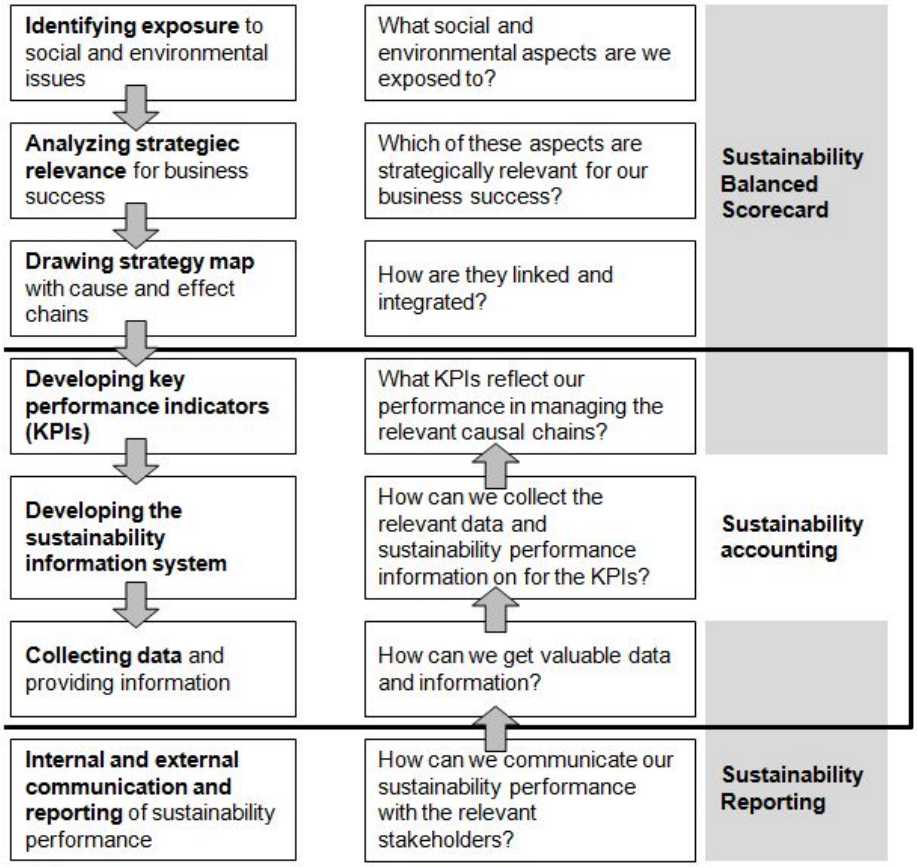

Fig. 3.6: Sustainability Performance Measurement and Management Framework (Schaltegger and Wagner, 2006, p.685)

Key Performance Indicators are defined. The definition of KPI is the connection to sustainability accounting, which focuses on gathering, collecting the data for calculation of KPI. Sustainability accounting again provides the data basis for sustainability reporting, in order to communicate results to stakeholders.

In the outside-in perspective (arrows from bottom to top) sustainability reporting is aligned to stakeholder expectations. According to the individual or standardized information need of stakeholders requirements for data collection and analysis are defined. “The trend towards standardization of reporting indicators and the striving for a core set of broadly applicable metrics, makes it necessary for corporate managers to identify, select and focus on those indicators which relate to and best reflect the core areas of performance” (Schaltegger and Wagner, 2006, p.693). In order to determine which indicators are strategically relevant a systematic approach such as the SBSC is needed.

As mentioned above, also in the SPM-framework both approaches have to be combined in order to lead to a successful SPM-system. Once the strategy and Key Performance Indicator (KPI) have been developed on a conceptual level, the management challenge is to integ-

rate this sustainability performance measurement system with the internal company business information and reporting systems (Schaltegger and Wagner, 2006, p.690).

In this framework, the implementation of a corporate sustainability measurement and management system is depicted. It makes clear, how strategic goals can be operationalized by translating them into KPI. Furthermore, it explicates that these KPI can be measured and calculated by sustainability accounting and communicated by sustainability reporting. However, to answer research question 1.1. ("How do companies implement sustainability initiatives?"), it is inevitable to not only look at the definition, measurement and communication of goals and performance, but also to examine how these goals can be achieved in terms of operational implementation. By moving the focus from the "measurement" to the "management" aspect of Sustainability Performance Measurement and Management, the complementary concept of "Sustainability Controlling" is introduced.

Sustainability Controlling

Derived from the function of the more general term "Controlling", sustainability-oriented controlling is an assisting function of corporate management and operational sustainability management, which aims at supporting managerial decisions in order to increase the degree of achievement of defined targets[14]. The main tasks of sustainability controlling are to support the management to take decisions by providing, preparing and analyzing information, coordination of decision processes, support of communication of sustainability-oriented decisions and critical supervision of decision processes (see Jänicke, 2011, p.164f).

Figure 3.7, shows the controlling cycle, which illustrates the functions of controlling in a more detailed way. In a first step, the definition of goals are defined by the management supported by a controller in a collaborative manner. In a next step a plan is created, on how to achieve these goals, followed by the definition of concrete measures. In step four, achieved results are compared to the targeted goals and derivations are analyzed. In the next step, results of this analysis are reported and finally, corrective actions are initiated or goals are adjusted, which again leads to the definition of goals, and closes the loop of the controlling cycle (see Tschandl, 2012, p.16).

Furthermore this controlling cycle can be integrated with the introduced concepts of the SPM-framework. Translated strategic goals from the SBSC serve as input for the definition of goals, to ensure strategic alignment of operational actions. Sustainability accounting delivers information needed for monitoring impacts of taken measures. The selection of

[14] For definitions of controlling see (Jung, 2011, p.5)

relevant information for communication, prevents management and other stakeholders from information overload, and constitutes the interface to sustainability reporting.

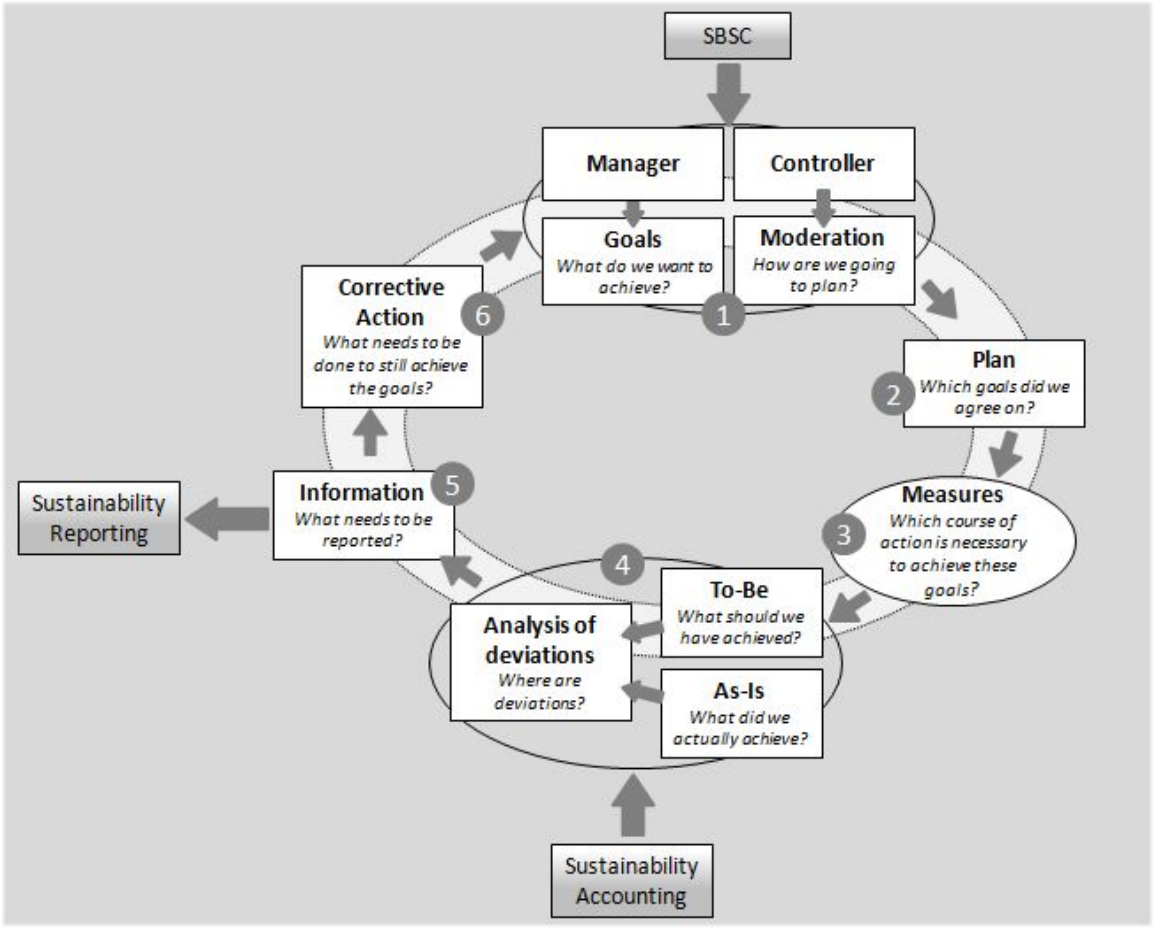

Fig. 3.7: Controlling Cycle Tschandl, 2012

The sustainability controlling perspective links the rather measurement-oriented SPM-framework with the complementary sustainability controlling which focuses on operational management support.

Managerial decision-support through sustainability controlling is primarily based on the application of controlling instruments, e.g. Benchmarking, ABC-Analysis or Eco-budgeting, which provide methods and information to all phases of the controlling cycle. It is task of the sustainability controlling function to select the appropriate tools, depending on the problem, the general corporate sustainability approach, and requirements specific to the individual area of responsibility (Jänicke, 2011, p.192).

Relation Between Sustainability Controlling, Management and the SPM-Framework

According to the discussions above, the relations between the different concepts are summarized in Figure 3.8, which shows how controlling and traditional management are integrated into the SPM-framework.

The figure gives an overview about how sustainability initiatives are implemented in companies on both a strategic and a more operational level and thus provides an answer to research question 1.1.

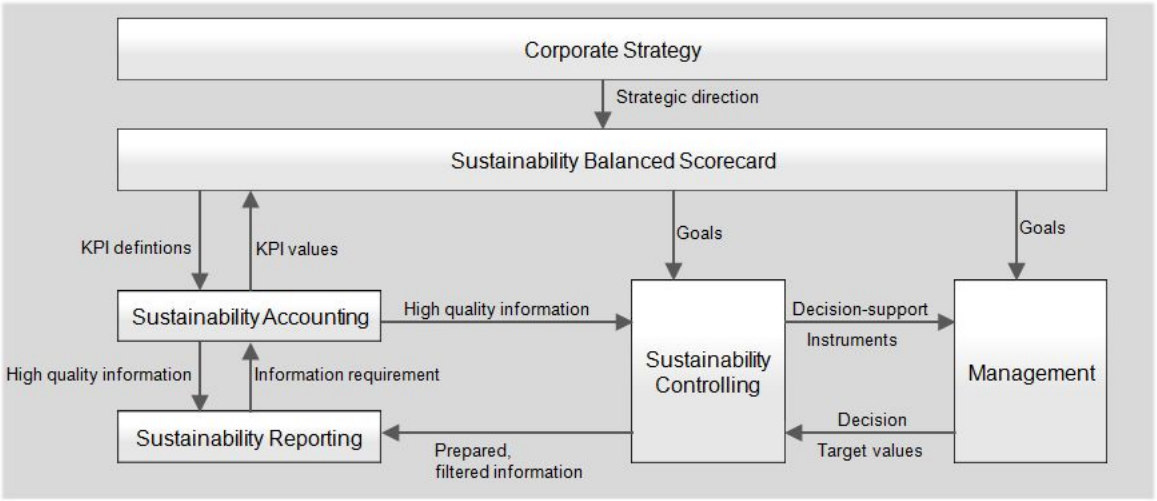

Fig. 3.8: Integration of Sustainability Controlling and Management into the SPM-framework

4 Business Intelligence

In order to explore the potential of Business Intelligence to support sustainability management, it is essential to have a clear picture about the concept of Business Intelligence in general and about possible application scenarios in the business context.

This chapter will elaborate on the background and history of Business Intelligence. After introducing the main functions of a Business Intelligence System, the question "Which methods and applications does BI provide to support businesses?" (Research question 1.2) is addressed. The resulting BI portfolio will serve as a basis for the linking BI and CS in the next chapter.

4.1 A Brief Review of History

Generally, Business Intelligence is an IT-based approach to support managerial decision-making.

Systems aiming to support managerial decision-making, have a long history. Since the 1960s, different systems and approaches evolved with quite similar functionality, but under different captions, e.g. Management Information System (MIS), Decision Support System (DSS), Executive Information System (EIS), Management Support System (MSS), Data Warehouse (DWH) and eventually BI solutions (see Humm and Wietek, 2005, p.3).

The term "Business Intelligence", first became popular within the last 15 years. When querying two important literature databases (ebscohost[15] and IEEE xplore) it becomes obvious that the number of papers containing the term "Business Intelligence" within the title or abstract increased rapidly since 1997 (see Figure 4.1).

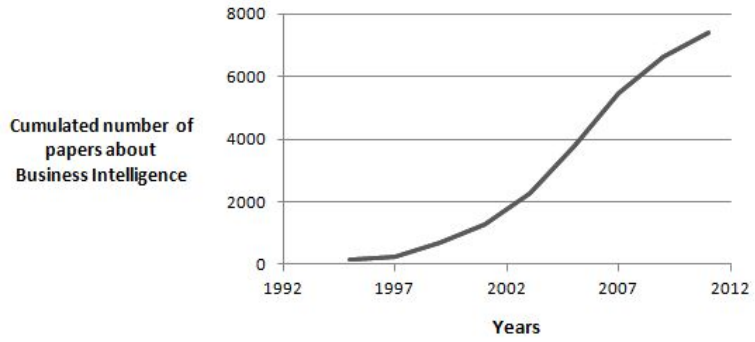

Fig. 4.1: Increased Dissemination of the Term "Business Intelligence" Since 1997

[15] Databases included in the search: Business Source Premier, Academic Search Premier, EconLit with Full Text, eBook Collection (EBSCOhost)

Despite the recent popularity of the term, it has a surprisingly long history. The term "Business Intelligence" was first used by Luhn already in 1958:

> In this paper, business is a collection of activities carried on for whatever purpose, be it science, technology, commerce, industry, law, government, defense, et cetera. The communication facility serving the conduct of a business (in the broad sense) may be referred to as an intelligence system. The notion of intelligence is also defined here, in a more general sense, as "the ability to apprehend the interrelationships of presented facts in such a way as to guide action towards a desired goal."
>
> (Luhn, 1958, p.314)

Today, more than fifty years later, the general idea behind "Business Intelligence" is still the same. However, concrete definitions and the context in which the term has been used, varied over time.

Many authors name Howard Dresner, a researcher from the Gartner Group, as the founder of the BI term[16], who defined it in 1996 as a category for data analysis, reporting, and query tools which help business users to synthesize valuable information from data (see Anandarajan, 2004, p.18f).

At that time, the emergence of comprehensive transaction systems in companies created the need for applications enabling the management to overview the accumulated loads of information (see Gluchowski et al., 2008, p.55) and to eventually derive business value from the thereby acquired knowledge. Clearly, this perspective of BI as a category of IT-tools, moved the focus to the technical aspects of the problem.

In the following years, the term was mainly used by IT consultancies and software development companies, therefore many different interpretations, mostly marketing-oriented, evolved (see Gluchowski and Kemper, 2006, p.12). In 2002, MERTENS (2002, p.67) identified seven different meanings of the term BI, for example, BI as a synonym for a data warehouse, BI as a filter for information in a company or BI as a rapid alert-system.

As it became clear that technic-centric tools do not lead to economic benefit (see Gluchowski and Kemper, 2006, p. 19) and "a number of BI projects fail because they are taken as merely 'technical' projects" (Petrini and Pozzebon, 2009, p.189), the need for an integrated approach emerged.

This paper will use the definition first suggested by KEMPER ET AL. (2010, p.9) who saw

[16] See Kemper et al., 2010, p.2; Strauch and Winter, 2002, p.439; Quaing, 2010, p.12

it as an integrated, company-specific, IT-based, holistic approach for support of managerial decision-making. The main difference to other definitions is the “integrated, holistic” aspect, which means BI is explicitly tackled neither as a solely technical nor as a solely organizational topic, but as a combined organizational and technical problem. The focus is no longer only on the transformation of data into knowledge but also on the application of this knowledge.

According to this understanding, KEMPER ET AL. (2010) define the exclusive purpose of acquirable BI-tools as their utilization for the development of BI applications. This means the actual use of the tool and the integration into the business context gained in importance.

In a more practice-oriented view, this corresponds to the definition given by WILLIAMS AND WILLIAMS (2007) who defined BI as “business information and business analyses within the context of key business processes that lead to decisions and actions and that result in improved business performance. In particular, BI means leveraging information assets within key business processes to achieve improved business performance”. This second definition highlights again that it is not enough to only posses high tech data processing and analysis tools but the important aspect is to leverage the resulting information to take intelligent decisions and actions.

4.2 Main Functions of Business Intelligence

Following the definitions discussed above, Business Intelligence comprises all steps which are necessary in order to transform information about operative processes into high level business decisions and actions.

Figure 4.2 illustrates the general function of an integrated BI approach. By means of information gathered about operational business processes and information about the external environment, the management is enabled to take well-informed decisions to control business processes and to monitor changes and effects of taken measures (see Kemper et al., 2010, p.9f).

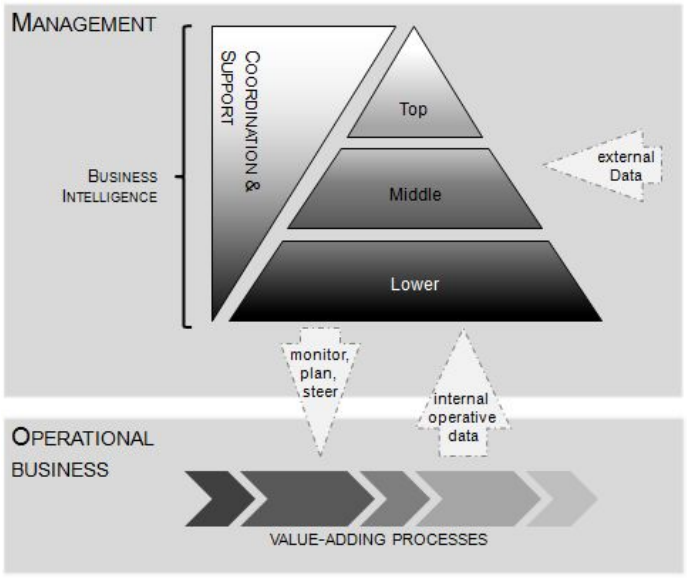

Fig. 4.2: BI Application System (Kemper et al., 2010, p.9)

In existing literature the functions of BI are usually grouped into three major categories or layers, namely “Data provision”, “Data analysis” and “Presentation” (see Table 4.1).

Kemper et al. (2010, p.11)	Gluchowski et al. (2008, p.109)	Grothe and Gentsch (2000, p.21)	Haneke et al. (2010, p.19)	Quaing (2010, p.17)	Knobloch (2004, p.18)
Information access	Presentation	Communication	Front-End Layer	Access / Presentation / Distribution	Data Presentation
Information generation	Analysis / Data processing	Discovery	Output-Layer	Analysis / Processing	Data Analysis
Data provision	Data provision	Data provision	Interpretation & Storage Layer	Data provision	Data processing
					Data extraction

Tab. 4.1: Layers of Business Intelligence in Existing Literature

Data provision typically describes the process of extracting data from operational or external sources and loading it into a common data storage, referred to as data warehouse.

Data analysis modules provide the functionality to analyze and process the data. Common data analysis functions include aggregation, filtering or the discovery of common patterns within the data.

Presentation refers to the interface between the user and the data analysis modules. This layer receives user inquiries and transmits them to the analysis units subsequently. Analysis results in form of reports are in turn presented to the user.

Clearly, the three typical layers described above cover the main functions of technical BI-tools. If Business Intelligence is considered as an integrated approach, which ideally results in actions leading to improved business performance, its scope has to go beyond the presentation of the information to the user.

Williams and Williams highlight the importance of the transfer of the extracted information into operational actions:

> It is common for BI vendor value propositions to emphasize business benefits such as agility, responsiveness, customer intimacy, information sharing, flexibility, and collaboration. But investing in BI to achieve such business benefits may actually destroy business value unless those attributes can be defined in operational terms and realized through business processes that affect revenues or costs.
>
> (Williams and Williams, 2007, Section 1.5)

Today there is general consensus that IT by itself can not create business value, but the effective design of business processes is seen as the driver to business success, although with IT-support playing a key factor (see Kemper et al., 2010, p.163). Figure 4.3 demonstrates the interdependencies between IT-investments and business success.

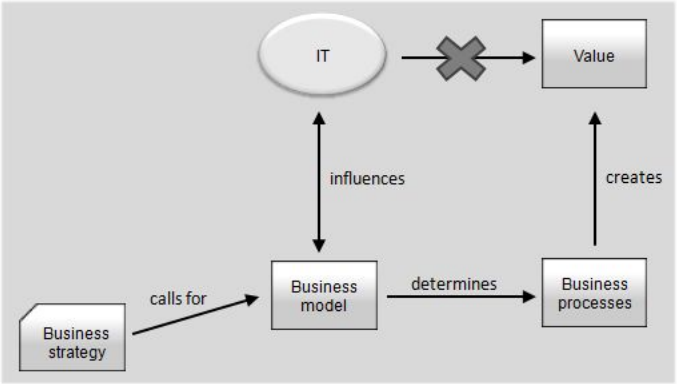

Fig. 4.3: Interdependencies Between IT and Business Success in (Krcmar, 2005, p.520) based on (Wigand et al., 1997, p.158f)

Generally, the business strategy determines the business model, although it can be influenced by IT innovations. For example, e-Commerce business models could only evolve based on the improvement of Internet and web-technologies. On the other hand, the development of new business models can pose new requirements against IT systems. (see Kemper et al., 2010, p.164)

Following this argumentation, an extended layer model will be proposed in this paper. This model is based on the above mentioned three layer model. According to the stated definitions, three further layers are added on top, accounting for the importance of the actual use of the information which have been attained through the support of technical BI-tools.

The layer **"Distribution"** refers to the distribution and communication of analysis results. Even if the data is properly analyzed and well presented, the benefit will be limited if results are not taken into account by the people responsible for taking decisions. The distributed information provides the basis for an intelligent, well-informed **"Decision"**. In the ideal case, a decision leads to an **"Action"**, altering operational business in a way which increases business performance.

This model will be used as a frame to elaborate on the different functions of Business Intelligence in more detail.

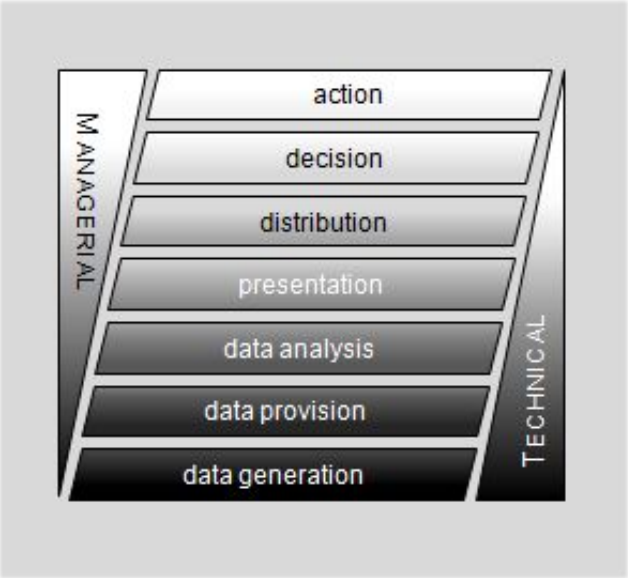

Fig. 4.4: Extended BI Layer Model

4.2.1 Data generation

As the whole concept behind Business Intelligence is based on the idea of leveraging data in a company, obviously the generation of data constitutes an essential part. Nowadays, usually the generation of data is not a critical factor. In fact, companies face the challenge of managing loads of accumulated data in order to get an overview and derive information from it (See Krcmar, 2005, p.54f; Gluchowski et al., 2008, p.32).

The data constituting the basis of all BI Systems can be categorized into two groups: internal and external data.

Internal data is typically generated and processed by internal operative systems, e.g. administration, disposition or billing systems (see Kemper et al., 2010, p.15). With increasing sales and market orientation, the need for external information rises. External information are for example economical, juristic, or social information as well as general information about market sections and competitors. These data is typically imported by accessing external data sources or online services. Data from the World Wide Web can be collected using automated text mining techniques (see Gluchowski et al., 2008, p.110).

A remarkable challenge for any system operating on these different internal or external data sources, are possible different data formats and data quality, creating the need for a unified, harmonized data base.

4.2.2 Data provision

The task of the layer "Data provision" is to provide a consistent, unified data basis for all superordinate applications. This task is achieved by integrating the relevant data of all internal and external data sources into one common data base, referred to as Data Warehouse (DWH).

"A DWH is a subject-oriented, integrated, time-variant, non-volatile collection of data in support of the management's decision-making process" (Inmon, 2005, p.31).

This means a DWH is organized focused around a company's core areas, e.g. products or customers whereas operational data stores are rather organized according to transactions or processes (see Gluchowski et al., 2008, p.119). Data is often stored in different formats depending on the data source. In an integrated DWH, the data must be represented in only one consistent format, which requires the adjustment of data prior loading. A DWH typically provides "read-only" access to superordinate applications. The data in the DWH is refreshed in regular time periods, which means new data from operational data sources is extracted, tranformed and loaded (commonly referred to as ETL-Process). During the first step data is loaded from the different external source systems, in the second step the data is cleaned and both the data as well as the data structure are transformed into a common format. As the data stored in the DWH constitutes the basis for all analyses and reports, it is important that a high level of data quality is ensured. In the last step, the transformed data is loaded into the target system, the data warehouse.

A DWH typically keeps data generated over a long period of time, enabling analysis over expansive time frames. As the DWH keeps also the history of data fields, changes in master data can be tracked.

An important related concept are “Data Marts”. A data mart is a small section of a DWH, providing data for a specific user group, application or task and represent interfaces between the DWH and constitutive applications (see Kemper et al., 2010, p.41).

Even if this layer seems to be rather technic-centric, the input of the business side is essential for the construction of an efficient DWH. Data which is only of importance for execution of transactions or processes but not helpful for managerial decision making is not loaded into the DWH. Generally only data is stored in the DWH which is of importance for required analysis (see Gluchowski et al., 2008, p.119). Defining the information requirement as well as underlying data is a complex task and requires close collaboration between business users and IT experts.

4.2.3 Data analysis

While the previous layer focused primarily on the storage of data, this layer aims at the analysis of the data.

GLUCHOWSKI ET AL. (2008, p.143f) suggests a classification of concepts in this area according to the intended purpose: verification of hypotheses and generation of hypotheses.

Hypothesis Verification

In the context of hypotheses verification the validity of hypotheses on statements, relations or developments with regard to the business are analyzed. In this scenario the user verifies the proposed hypothesis directly on the system. Although supported by analysis tools, the user takes over the active role in order to verify the assumption (Gluchowski et al., 2008).

The most popular BI-concept in this area is Online Analytical Processing (OLAP).

OLAP-Systems aim at providing fast, direct and interactive access to consistent and relevant information to a large number of business users. In order to support business users taking decisions, these applications have to align to the users’ perspectives on the organization. Multidimensional perspectives on quantitative data inventories proofed to enable users flexible and intuitive access to the demanded data (see Gluchowski et al., 2008, p.143f). In a more technical sense, this means data is stored in specific logical structures, which can be

pictured like cubes (see fig. 4.5). Every cube consists of multiple dimensions, representing important business concepts, e.g. customers, products, regions or the time line. Every dimension consists of different elements. Germany, Austria and Switzerland could be elements of the dimension region. Elements can be arranged in hierarchies, e.g. northern Germany and southern Germany could be subordinate elements of Germany. "Facts" are the central parts in the cube, which constitute the relations of the dimensions to each other. A fact could be for example a bill for the sale of a product to a specific customer, in a specific region, at a certain point of time.

A variety of operations can be performed on such cubes enabling extensive analysis of the stored data.

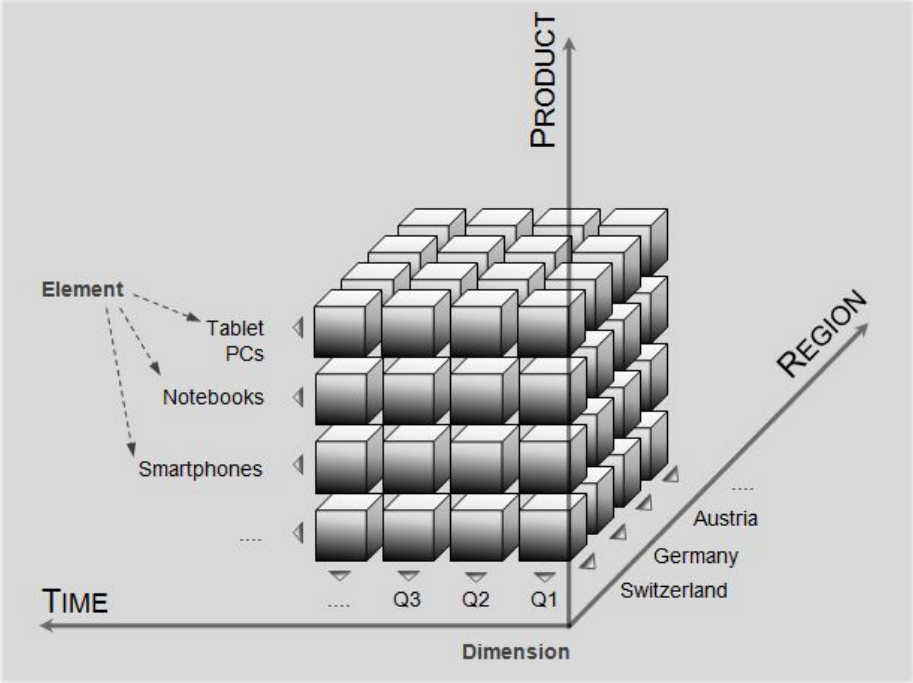

Fig. 4.5: Architectural Overview of an OLAP-Cube

Another approach to verify hypothesis is to request data or calculations from the DWH by directly querying the database, through queries defined in specific data query languages, e.g. Structured Query Language (SQL) for relational databases or Multidimensional Expressions (MDX) for multidimensional databases (see Kemper et al., 2010, p.96). As the process of defining these queries is complex and time-consuming, these form of analysis is generally not suitable for managerial use.

Hypothesis Generation

In contrast to hypothesis verification, in this category, the system takes over the active role, as it uncovers and documents relations between business objects, and thereby makes them transparent for users (see Gluchowski et al., 2008, p.143).

Techniques to generate hypotheses are referred to as “Data Mining”.

“Data mining is the process of discovering and interpreting previously unknown patterns in databases.” (see Nemati and Barko, 2004, Chapter 1) In order to uncover these patterns methods from various research disciplines are applied, e.g. simple visualization techniques, statistical methods or methods from the field of artificial intelligence (see Quaing, 2010, p.299).

Typical applications of data mining tools are classification, clustering and the discovery of interdependencies.

In *classification*, one information object is assigned to a predefined group. A typical use case for classification is the assessment of credit-worthiness in bank institutions. In *clustering*, similar information objects are grouped into segments, but in this case, the groups are not predefined. In fact, the similarity between objects is measured and objects with a high similarity are combined into homogeneous groups. Market segmentation is an example for an application field of this method, where customers are addressed differently depending on the cluster they have been assigned to. Another application is the *discovery of interdependencies*, where significant correlations between different data attributes are extracted. A possible application scenario can be found in insurance companies, where the structure of claims is analyzed in order to design more applicable insurance policies (see Gluchowski et al., 2008, p.194).

Whereas Data mining aims at uncovering unknown patterns primarily in structured data, text, multimedia and web mining are related techniques operating on semi-structured data.

Analogous to data mining, text mining seeks to extract useful information through the identification and exploration of interesting patterns. In text mining, the data sources are document collections, and interesting patterns are found not among formalized database records but in the semi-structured textual data in the documents in these collections (see Feldman and Sanger, 2007, Chapter 1).

Analogously, multimedia mining refers to mining techniques performed on audio and video files, and web mining is applied to extract information from web pages. Web usage mining,

a subdiscipline of web mining is useful for finding patterns in website access logs in order to provide personalized content on web pages. A classic example for web usage mining, is the presentation of customer specific products in a web-shop after analysis of their navigation paths (see Grothe and Gentsch, 2000, p.233).

4.2.4 Presentation

The central task of the presentation layer is to provide relevant content in an appropriate form specific to the user and the particular decision problem (see Gluchowski et al., 2008, p.114). This layer plays an important role in the BI context, as lacking quality of visualizations and deficient orientation of the design to either the user or to the problem, can distort the interpretation, highlight wrong relations and thereby lead to wrong decisions (see Daum and Steinle, 2007, p.520).

In visualization theory, the Cognitive Fit Model is used to explain the effectiveness of the problem solving process. The core idea behind this model is that the problem representation has to fit the problem solving task, in order to achieve a realization of a preferable mental representation of the problem, which results in improved speed and accuracy of the problem-solving process (see Dull and Tegarden, 2004, p.153).

As both the target user group as well as addressed problems are heterogeneous, manifold presentation forms have to be provided. Solutions in this layer provide various forms of visualization of analysis results and a different degree of interaction.

With regard to the visual presentation of analysis results, tables, diagrams and text descriptions are useful means. Especially visualization of information, in form of diagrams, like pie and bar charts or point diagrams, can influence the decision making process. BASSLER (2010) analyzed the impact of information visualization of data in controlling in an empirical experiment. She found that test persons took better decisions based on information presented in a combined form of tables and graphical illustrations compared to test persons exclusively deciding based on information presented in tables. Visualizations of information can highlight existing relations and facts, therefore important or relevant parts can be understood better and faster. But this advantage, comes with the risk of not highlighted data being ignored or too little observed (see Bassler, 2010, p.43). Generally spoken, the visualization of analysis results is a key function and when designing diagrams, one's attention has to be turned especially on both the decision problem and the addressed user group.

Different user groups impose different demands, not only in terms of visualization techniques

but also in terms of the degree of interaction. GLUCHOWSKI ET AL. (2008, p.115f) identifies three typical user types:

Information consumers prefer static reports showing predefined analyses in a defined visualization form.

Analysts focus primarily on the functions offered by navigation-oriented analysis systems in order to navigate through the data without restraints. If leading to transparent, comprehensible results, the typical analyst also uses simple analysis and presentation methods.

Specialists operate with method-oriented functions in order to execute complex analyses. The specialist does not rely on user friendly analysis and output tools, but accepts more complex user interfaces for extensive functionality.

Different presentation concepts are aiming at meeting the needs of all user groups. The most popular approaches in this context are reports, management-dashboards and BI-portals.

Reports

Reports are documents containing information in form of text, graphics and tables. Different types of reports can be distinguished: Standard reports, Exception reports and Ad-hoc reports (see Gleich and Michel, 2008, p.21).

Standard reports are generated in defined fixed time periods. Content and form of the report are defined once, future instances of the report are generated according to these definitions. The generation of **exeption reports** is triggered if particular values exceed predefined reference values. Exception reports draw the receivers attention onto remarkable facts. **Ad-hoc reports** are triggered by individual users. These reports are not generated periodically, but on user request, they can pose an inquiry to the system in order to receive a report containing data satisfying their individual information requirement. The user can create an inquiry in an interactive reporting-platform. The reporting-platform provides a draft view of the report and items can be added by drag-and-dropping them onto the report draft. In this way, also end-users can create own reports intuitively. Figure 4.6 shows an example for an interactive report tool.

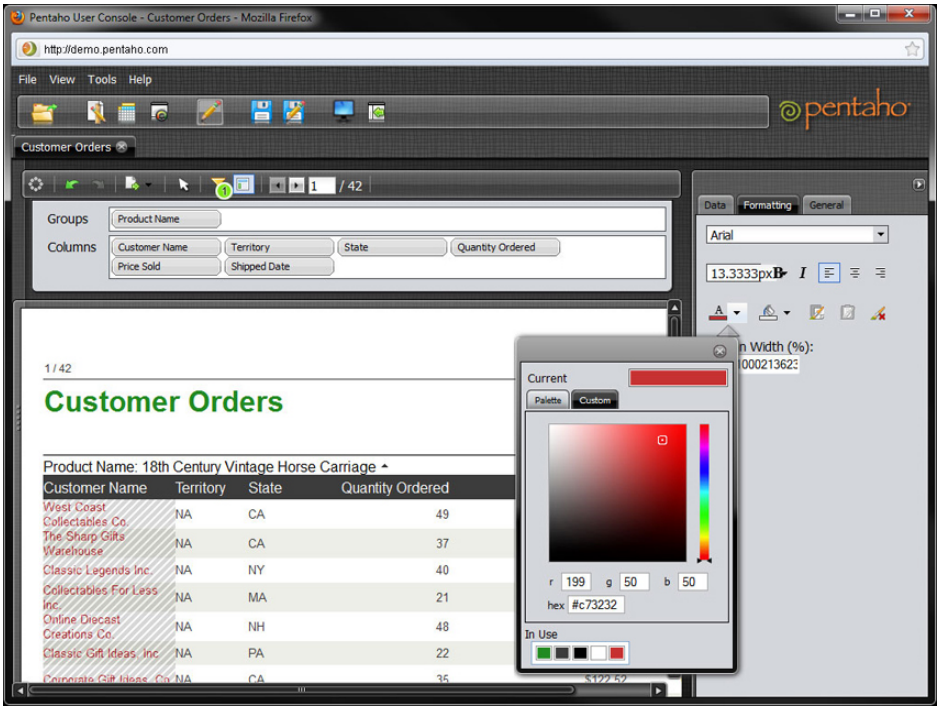

Fig. 4.6: Example of an Interactive Reporting Tool (Pentaho Corporation, 2011)

Management Dashboards

The aim of management dashboards is to provide a summary of relevant, central facts on a few screen pages. In this way the user can get an overview about central business issues at first glance. Dashboards are customized according to the information needs of a specific user or user group. Only information which is essentially relevant to the addressed user is displayed in the compressed presentation form. The information is prepared using appropriate visualization techniques, facilitating managers to understand complex structures and relations quickly. A popular example for management dashboards are management cockpits (see Figure 4.7). As the name lets assume, in this presentation form, analogous to a cockpit in an airplane, different kind of tachometers are used to display the statuses of important key performance indicators (see Gluchowski et al., 2008, p.217).

The individual presentation forms address different of the above described user groups. Whereas standard reports, as well as exception reports and dashboards primarily serve the need of the user group “Information consumers”, Ad-hoc reports are well suited for Analysts. Specialists typically operate directly on the Analysis layer, either by querying the data warehouse or OLAP cubes directly in a technical language (see Section 4.2.3) or by using specific data analysis tools.

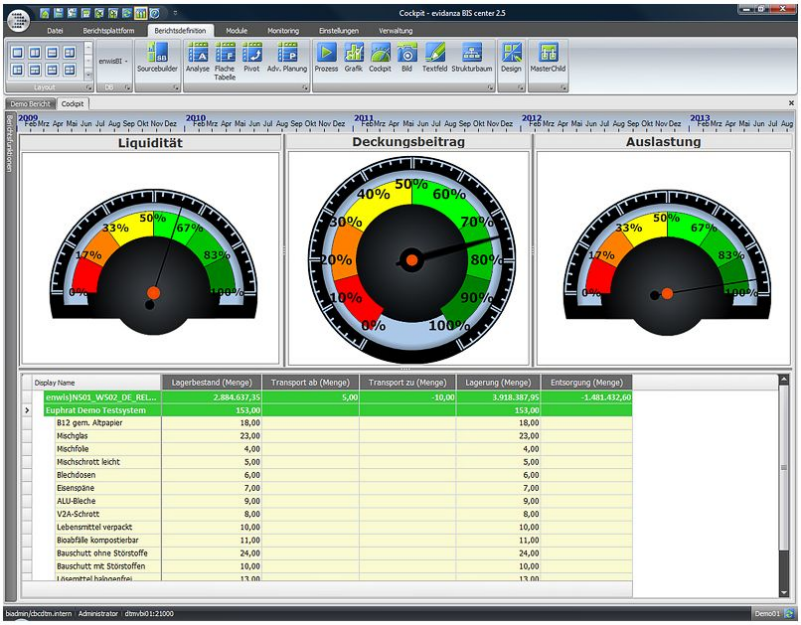

Fig. 4.7: Example of a BI-Cockpit (tegos GmbH Dortmund, 2010)

4.2.5 Distribution

Information generated within BI-systems can reach the user through several channels. There are basically three ways: The user can pull the information from a BI System, the BI system can push the information to the user, or other systems integrate information generated from the BI system, which are accessed by the user.

User Triggered Information-Pull

The expectation of users actively using the BI system inevitably presumes the users' acceptance. This is a critical point within the whole BI context as "the benefit and the success of BI-Systems and BI-applications depends ultimately on the acceptance of users to productively use the system and thus on the user friendliness" (Haneke et al., 2010, p.30).

QUAING (2010, p.221) carried out a study in which he analyzed the benefit of applying BI in organizations. He identified the "benefit for the individual user" as well as the "user satisfaction" as central influencing determinants. The study illustrates that high benefit for the individual BI-user and high level of user satisfaction lead to a high overall benefit for the organization.

Business Intelligence portals aim at giving users a well organized, useful, easily understood place to find the tools and information they need (see Kimball, 2008, Chapter 11). BI portals are applications which provide users a unique access point for all BI applications. Portals

structure, filter and prepare the available information supply. Thereby they avoid information overload and reduce the time for the user to find the required information (see Gluchowski et al., 2008, p.217). Typically portals integrate information from different applications, each of which is represented in an own portlet. A portlet is one building brick of a portal which provides information to one topic or access to one specific application. Hence the portal is a collection of different portlets. A further important characteristic is the content-personalization. Depending on the users' role, portals present the content which is relevant for their business area and function. Furthermore a BI portal can be explicitly customized by the user or implicitly adapted, according to the users usage and navigation behavior (see Kemper et al., 2010, p.156).

Generally, a BI portal has to be comfortable and user friendly, as these attributes strongly impact user's acceptance and thereby the success of the whole BI-approach (see Quaing, 2010, p.302).

Figure 4.8 shows an example of a BI portal.

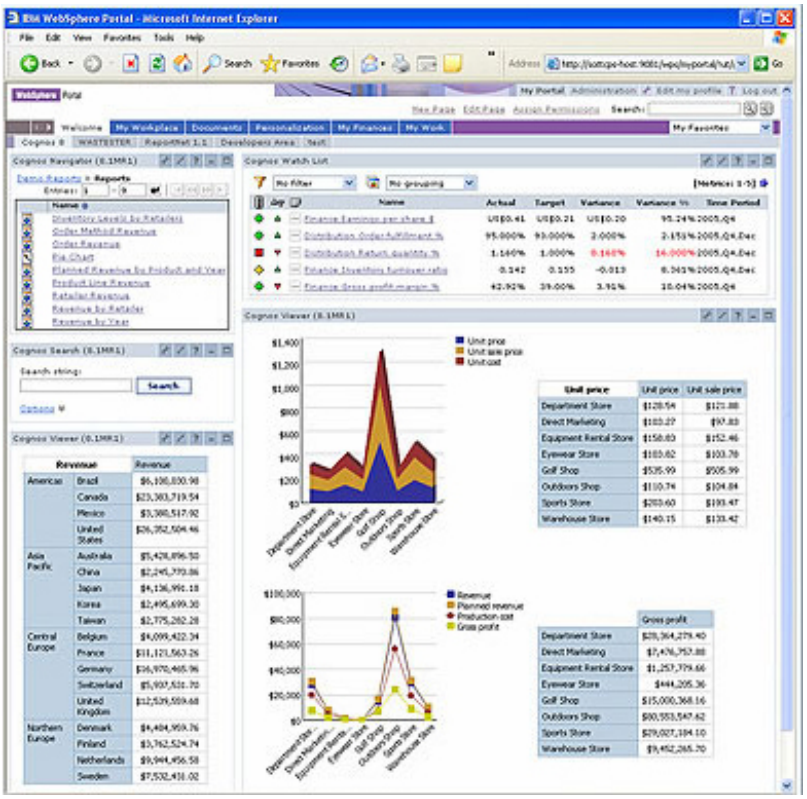

Fig. 4.8: Example of a BI-Portal (IBM Corporation, 2011)

The information displayed in a BI portal is typically optimized to be viewed on a computer screen. With the emergence of tablet pcs and smart phones the development of mobile BI applications was pushed, providing users the opportunity to access BI portals and applications also on mobile devices.

System Triggered Information-Push

In contrast to the previous approach, BI systems can also play the active role in the information distribution process. In this case, the system delivers information to defined receivers, according to predefined rules and settings.

A classical example are exception reports (see Section 4.2.4). If certain values exceed defined thresholds, a report is generated and delivered to the defined recipient, e.g. per E-mail or as an alert in the BI Platform.

A newer form are BI desktop widgets, which display report content in a small desktop display on the user's computer screen. As the information in source files changes, the widget on the desktop is automatically updated, providing the user with the newest information (see Business Objects, 2008, p.8).

Intermediate Systems Distribute Information

Users can also access information originating in the BI system, with other applications playing the role of an intermediary. These applications can request information from the BI system or be delivered with information by the BI system.

Many BI systems provide automated access to information and functionality through web services. A web service provides a defined interface to other applications which can call a particular function of the system. The system in turn delivers resulting data based on the call of particular functions and parameters.

The BI system can also deliver updated information in form of feeds to other applications. In this case the BI system is triggering the interaction.

Using web services or feeds, other applications such as content management systems of company websites or other portals can integrate data from BI systems.

4.2.6 Decision

Even if people can access information, even if they understand and possess the information, what they do with this information is the critical factor, as GROTHE AND GENTSCH (2000, p.123) state:

> Undoubtedly we live in a rapidly evolving information society, mainly driven

> by the key factor “Information”. But is it really the information, which changes the world or are it rather the people possessing information which orient their actions accordingly? The one who is informed, can change the world. [...] The availability of contemporary information and the ability, of wisely handling it, is becoming a crucial competitive factor in the era of increasing globalisation, product cycles becoming shorter, increasing cost pressure and individual customer requirements. The one who has access to information and knows how to leverage it, makes a change; the passive observer will be relegated to the fringe and drop out of the game.

Thus for the success of Business Intelligence, it is essential that discovered knowledge is used in or leads to decisions.

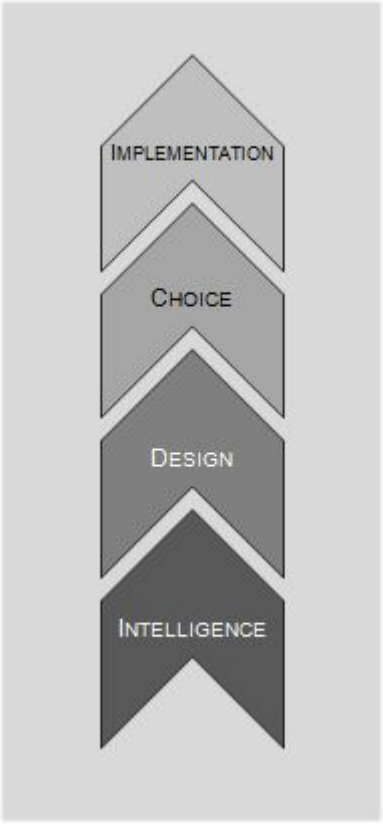

Fig. 4.9: Phases of the Decision Process (Turban et al., 2007, p.15)

TURBAN ET AL. (2007, p.15) describe decision making as a process involving four phases[17] (see Figure 4.9). The decision-making process starts with the intelligence phase. In this phase, the decision maker examines reality and identifies and defines the problem. In the second phase, the design phase, different possible alternative courses of action are examined. In the third phase, the “Choice” phase, one of the available courses is selected. The last

[17] based on the model of SIMON (1977)

phase, the “Implementation” phase, involves adapting the selected course of action to the decision situation.

As BI supports the decision process, the decision process can be mapped to the BI layer model (see Figure 4.10). In the BI-context, the first phase, the intelligence phase, is covered by previous layers. The reality is analyzed based on the data available in the data warehouse using analysis techniques (“Data analysis” - layer). Users can either request information from the system or be informed by the system about conditions that call for actions (“Presentation” and “Distribution” layer).

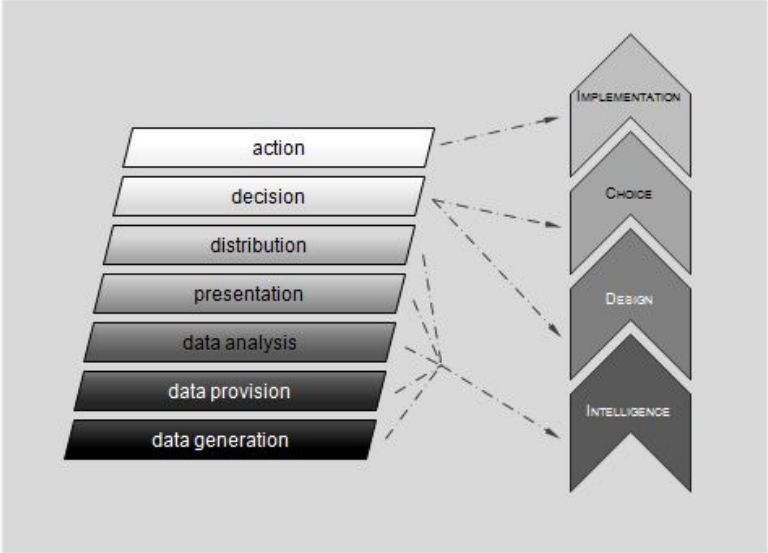

Fig. 4.10: Mapping the Decision Process to the BI Layer Model

The design and choice phase are addressed in this layer. As this topic is hardy covered in existing BI literature, apparently it is assumed that these phases are performed outside a BI solution. In that case, managers learn about the need for action based on the information gained from the BI system, but alternative courses of action are developed using other methods or tools. In this scenario, the focus of BI is to make sure that the right information reaches the right people in the right point of time.

In the second scenario, the development of different courses of action and a possibility to compare these is supported by BI. Although this scenario, is not covered extensively in existing academic BI literature, the fact that many vendors[18] of BI solutions offer planning modules to support exactly these activities, suggests that the support of BI decision support goes beyond the assumed extent.

[18] e.g. SAP with the SAP BI Integrated Planning module, Oracle with the Advanced Planning Center, the IBM Cognos Planning module and Jedox Palo provides planning functions within the main component

Different specified functions exist, e.g. for scenario planning, budget planning or cash-flow planning. Technically speaking, planning components write-back information into OLAP-cubes or data warehouses. This is opposed to the previous dominant concept that DWH and OLAP-cubes are "read-only" data stores. However, by means of write-back functionality, users of BI applications are now able to perform bottom-up and top-down analyses, by entering data at different levels of aggregation. The data is automatically apportioned based on patterns or business rules, providing enterprises the possibility to create and analyze what-if scenarios (see Politan, 2003).

Technical BI tools can support managerial decision making to different degrees. In any case, a critical factor is the consequent implementation of these decisions.

4.2.7 Action

> Only those companies, which manage to turn information into value creation will be successful in the long run.
>
> (Grothe and Gentsch, 2000, p.125)

To derive business value from BI it is vital to put the decisions into action (Williams and Williams, 2007, section 1.5). Taken measures based on informed decisions have to be incorporated into the operative processes. The concept of continuous process management addresses this issue, as it targets the implementation of new processes as well as the incremental improvement of existing processes (see Becker, 2002, p.299). The new or changed processes generate new operative data, which provides BI users the opportunity to observe and analyze effects of change and to take further decisions and actions towards improvement.

The concept of "Active data warehousing" suggests a partial automation of this process. The basic idea is to introduce an automatic feedback loop of analysis results to operative IT-systems. This means, analysis results are written back into operational data stores and are therefore available to be accessed by operational IT-Systems. In this way, operative processes can be automatically changed, as IT systems can consider the new information in subsequent operations (see Kemper et al., 2010, p.95). This can be illustrated by looking at an example from Customer Relationship Management.

Using data mining techniques (see Section 4.2.3) it has been found that customers with certain characteristics tend to buy more products if they receive special offers per email frequently and others tend to buy less. If the CRM system has access to this information it can automatically treat customers differently depending on their categorization.

Active data warehousing introduces a closed-loop between analysis processes and operative processes, and provides active decision support on the basis of analysis rules. Thereby the latency time between analysis, decision and action can be reduced (see Kemper et al., 2010, p.95).

4.3 Information Need

A central concept which has to be considered in relation to all layers of Business Intelligence, is the concept of information need. Needed information which is not provided, as well as provided information which is not needed, are problematic and are characteristics of inefficient information management. A precondition for successful management of the information demand is preferably concrete knowledge and description of information needs. Only when the information demand is transparent, a good fit between information need and information supply can be reached (see Krcmar, 2005, p.62f).

In a differentiated view on the information needs different facets can be distinguished (see Figure 4.11). The lower circles (1 and 2) represent the objective and subjective information need. The objective information need expresses the information needed to fulfill a task. In contrast, the subjective information need is the information, which the individual person needs, the actual requested information is a subset of the subjective information need (3). Subjective and objective information need are not necessarily the same, in fact, in most cases they differ. The top circle (4) represents the information which is provided.

The intersection set of all four circles represents the information which is subjectively and objectively needed, requested and deliverable. The optimal state is reached, when all three circles are congruent and thus the intersection set is maximized.

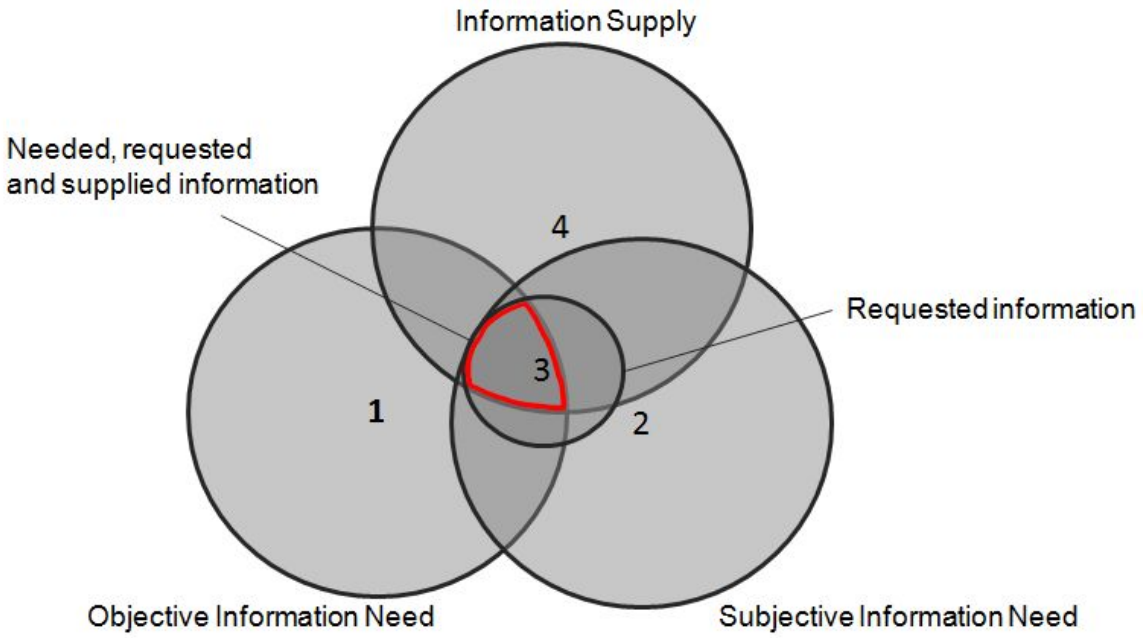

Fig. 4.11: Model of Information Needs (Szyperski, 1980)

4.4 Methods and Applications of BI to Support Management

As illustrated above, Business Intelligence fulfills many functions on different layers. Generally, companies can apply BI in many different ways, depending on the information needs within their organization. In this section, based on the BI layers discussed above, an overview about common Business Intelligence methods and applications will be provided. It is important to note, that there are endless opportunities to apply BI methods to different business scenarios and that the concrete application always depends on the specific situation of the individual company. Here, common ways how BI is used to support business are presented.

4.4.1 Application of BI to Support Corporate Processes

Generally, three types of applications of BI can be distinguished, BI support for managerial processes, for market-oriented processes, and for operational processes (Tonchia and Quagini, 2010, p.83; Williams and Williams, 2007, Chapter 7)

Applications of BI to Support Managerial Processes

Planning and forecasting are future oriented endeavors and rely on business information about what has happened in the past. A common example are production plans, which are created by manufacturing companies, which highly rely on business information about product sales in the past. Historical information such as the unit sales and dollar sales by plant, by month, by product or product family, manufacturing companies can develop forecasts about future demands (see Williams and Williams, 2007, Chapter 7).

Performance management, process improvement, quality management and performance optimization all of these management processes have to measure performance along relevant dimensions, such as cost, quality or relation to plan. Therefore, they need historical and past information in order to be able to assess whether activities progress toward a desired state. Furthermore, these management process often require information from many different areas of the company, originating in many different operational systems. BI is designed to integrate all these different information, in order to provide a sound data basis, for quantitative analysis and reporting (see Williams and Williams, 2007, Chapter 7).

One important tool for performance management is the *Balanced Scorecard*. “Balanced Scorecards are essentially analytical applications that map, accumulate, display and report multidimensional performance information, including financial and non-financial perform-

ance targets, actual performance measures, variance and trend analyses, and associated meta data.[19] Given these functions, "traditional BI tools are ideally suited to the task of automating the data collection, aggregation, and presentation tasks associated with using the Balanced Scorecard as a performance management framework" (Williams and Williams, 2007, Chapter 7).

Applications of BI to Support Market-Oriented Analyses

By means of a quantitative *customer analysis*, companies can identify customers with the greatest profit potential. Moreover they can increase the likelihood that these customers want the product or service offered by the company (see Davenport, 2006, p.105).

With the ability to overview millions of detailed records about business transactions with customers, companies can extend the practice of *customer segmentation*. Volvo Cars of North America, for example uses these techniques to predict the behavior of its customers and sales prospects. Thereby, BI enables Volvo to predict the probability of customers to buy a Volvo based on their demographic characteristics (see Williams and Williams, 2007, Chapter 7).

Business Analytics in the area of *Pricing* helps companies to identify the price that will maximize the profit, e.g. Marriott International has established a system for calculating the optimal price for guest rooms (see Davenport, 2006, p.105).

In the context of *advertising, direct marketing and public relations* BI can help companies to gain a richer understanding of customers as a valuable input for marketing activities. Furthermore, BI provides the ability to measure the effectiveness of advertising and direct marketing that is directed towards increased revenues (see Williams and Williams, 2007, Chapter 7).

Applications of BI to Support Operational Processes

By bringing together multidimensional information about all aspects of operations, BI provides the tools needed to improve asset, utilization reduce cycle times, improve quality and reduce costs. By applying BI concepts, companies can simulate and optimize supply chain flows and reduce inventory level and stock-outs. BI can also be applied to improve HR processes, as a tool to select the best employees for particular tasks or jobs. Several sports teams (e.g. New England Patriots, Oakland A's and Boston Red Sox) used analytics to improve player

[19] For more information about the BSC see Section 3.4.1 or (Kaplan and Norton, 1996)

selection, to predict and prevent injuries and to evaluate players performance (see Davenport, 2006, p.105).

4.4.2 Towards a Portfolio of BI Applications and Methods

In previous sections, several important BI methods have been introduced. These methods can be applied to many different applications in the business context. In this section, based on a review of BI literature, specific BI applications are identified and integrated with the introduced BI methods, in order to provide a broad overview about the BI portfolio of applications and methods.

The literature[20] was scanned for BI applications and methods, which were subsequently summarized and structured according to the seven layer model introduced above[21]. The resulting BI-Porfolio, is illustrated in Figure 4.12 and provides the answer to the question "Which methods and applications does BI provide to support businesses?" (Research question 1.1).

For a company-specific BI portfolio, BI methods and application have to be aligned to the company internal decision processes. The process of managing the decision support through BI, is referred to as "BI portfolio controlling". The aim of BI portfolio controlling is to optimize the selection and application of decision support instruments in a way, to increase the efficiency and effectiveness of decision making processes (see Bensberg, 2010, p.24).

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20 Kemper et al. (2010), Lenz (2007), Gluchowski et al. (2008), Grothe and Gentsch (2000), Quaing (2010), Williams and Williams, 2007

21 A detailed view on the identified applications, methods, and the sources can be found in B

Decision & Action	Management processes	Market oriented analysis	Operational processes	Active BI Real-time BI Closed-Loop BI Classic BI
	Planning Consolidation Budgeting Balanced Scorecard Monitoring Controlling Scenario Engineering Forecasting Diagnosis Benchmarking	Customer analysis Sales analysis	Performance measures and metrics Trouble shooting and risk assessment Productivity analysis Quality analysis Risk analysis Inventory analysis Financial analysis Channel analysis Supply chain analysis	
Distribution	Management Dashboard BI-Portal / Portal Personalization	Mobile BI BI Desktop Widgets		
Presentation	Standard Reporting Ad-hoc Reporting	Exception Reporting Interactive Reporting	Specific Visualisation and Presentation Functionality	
Analysis	OLAP Data Mining Process / Multimedia / Text / Web Mining			
Provision	Data Mart Data Warehouse Extraction, Transformation, Load			
Generation	Internal Data	External Data		

Fig. 4.12: BI Portfolio

5 Application of Business Intelligence to Support Corporate Sustainable Development

"Corporate Sustainable Development" as a means to secure a company's market position and to open up new business opportunities while contributing to sustainable development of the society and "Business Intelligence" as an integrated approach to support managerial decision making, represent the two core concepts of this thesis. In this chapter, these two concepts will be brought together, so as to be able to identify application opportunities of Business Intelligence to support companies during the important transformation towards enhanced corporate sustainability. Chapter 3 discussed how companies implement and manage corporate sustainability, chapter 4 showed which applications and methods BI provides to support management. Now these concepts will be studied in conjunction, by linking the individual concepts of the Sustainability Performance Management and Measurement framework with the developed BI portfolio.

5.1 BI Support for Sustainability Balanced Scorecard

When taking a closer look at the SPM-framework and the BI portfolio, it becomes obvious that the concept of BSC is used in both approaches. Therefore the most obvious way of linking BI and CS is through the concept of the BSC.

In the context of Corporate Sustainable Development the BSC is used as a tool to transform the sustainability aspects defined in the corporate strategy into key performance indicators in order to translate the high-level strategic goals into a more operational language.

From the perspective of Business Intelligence, the Balanced Scorecard can be seen as a framework for definition of performance indicators which helps to specify the information need in different dimensions. According to this information need, BI can help to collect, transform, analyze and present the respective information.

As the BSC is an approach belonging to the area of Performance Management, which highly relies on the management and measurement of Business Information, Business Intelligence systems by definition are well-suited to support the implementation of such management concept.

5.1.1 Corporate Performance Management and Business Intelligence

At this point, it should be mentioned, that generally the terms Business Intelligence and Corporate Performance Management (CPM) are often used synonymously and that boundaries are not always clear. Generally, CPM is seen as a managerial approach, aiming primarily at helping companies to implement their strategies and create value using improved forecasting and analytical capabilities (see Tonchia and Quagini, 2010, p.83). Business Intelligence, on the other hand, with its similar goal, to support corporate decision making and thereby improve Business Performance, is an integrated managerial and technical approach, where the focus is more on the alignment of managerial decision making and the underlying BI technology. Therefore, the two approaches can be seen as similar overlapping concepts, with CPM focusing on the implementation of strategy and BI focusing on the technical implementation of decision support instruments.

A Performance Management System (PMS) is an instrument for CPM, which helps companies to establish a link between strategic planning and operational control. The Balanced Scorecard is a particular model of a PMS, but as the best known and most diffused PMS model, it is now regarded a synonym for PMS (see Tonchia and Quagini, 2010, p.37).

5.1.2 The Balanced Scorecard and Business Intelligence

Following the argumentation above, Business Intelligence is a well-suited approach to support the development of the Balanced Scorecard. This can be also clearly be demonstrated when looking at the functionality of BI systems currently available on the market. Seven of the eight leading BI systems[22] provide features dedicated to the development, maintenance and usage of Balanced Scorecards. The Palladium Group (formerly Balanced Scorecard Collaborative), founded by KAPLAN and NORTON the creators of the Balanced Scorecard methodology, provide a certification for software products, which meet defined functional requirements. According to the Palladium Group, most of the typical BI systems were certified under the original BSC certification program.[23]

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[22] The eight leading BI Vendors were identified based on a BI vendor positioning provided by GARTNER RESEARCH (2012, p.4) as a result of a conducted BI market review.

[23] The original BSC certification program was in 2000. In 2012, a new program was launched with significantly more challenging criteria. So far SAP Business Objects was certified under the new program, but many others are still in the reviewing process and are expected to be certified soon (State: 24/02/2012, Email from Kent Smack, Employee of the Palladium Group.)

BI Solution Name	BSC Module Name	BSC support
SAP Business objects	Strategic Enterprise Management	x
IBM Cognos	Metrics Manager	x
Oracle Business Intelligence Foundation Suite	EPM system	x
Microsoft analysis and reporting services	Business scorecard manager	x
SAS Business Intelligence	Strategic Performance Management	x
Webfocus Intelligence	Webfocus	x
Business Intelligence Platform	Report services	x
Qliktech	Qlikview	1)

1) It is possible to structure KPI according to the four BSC dimensions with reporting functionality, however there is no specific BSC support (e.g. development of strategy maps)

Tab. 5.1: Support of BSC Development in Technical BI Tools

5.1.3 Requirements Specific to the Sustainability Balanced Scorecard

Generally, the usage of Balanced Scorecards can be well supported by BI applications. Therefore, also the Sustainability Balanced Scorecard, as an extended version, can use most of the already available functionality. However, depending on the specific type of SBSC some specific requirements arise.

As illustrated in Section 3.4.1, there are basically four different ways how to transform a BSC into a SBSC (see Table 5.2).

Name	Basic characteristics
Partial SBSC	Sustainability indicators are added in one perspective
Transversal SBSC	Sustainability indicators are added in all perspectives
Additive SBSC	A “non-market” perspective is added as fifth perspective
Derived SBSC	In addition to a partial, transversal or additive SBSC, a second more detailed BSC is derived which includes only societal factors.

Tab. 5.2: Transformation of a BSC into a SBSC

The partial and transversal SBSC approach, add sustainability aspects by modification of the content of one or more perspectives of the BSC. As the content of the perspectives is by definition individual to the particular company, any software application supporting the development of a BSC, has to provide the functionality to modify the KPI within the single perspectives. Therefore, a modification of a BSC into a partial or transversal SBSC is not problematic, with regard to their implementation in a BI software tool.

In contrast, the transformation of a BSC into an additive SBSC, changes the scorecard's structure, which requires the additional functionality of BSC software tools to add a new perspective. Even in certified applications this is not a warranted feature, as stated in the certification requirements:

> Typically, there are four perspectives; financial, customer, internal and learning and growth. Others may be added or replace these based on a specific strategic need. Certified applications will include *at least four* basic perspectives (financial, customer, internal processes, learning and growth) and have the ability to rename perspectives at the user's option
>
> (Palladium Group, Inc, 2011, p.10)

.

The derived SBSC, which is a version derived from the main BSC containing only environmental and social aspects, which have to be linked to the environmental and social aspects in the main BSC. Hence, this approach is an extension of the previous stated SBSC. In the process of developing a BSC and cascading the strategy to lower organizational levels, it is common practice, to derive subordinate BSC from the corporate BSC. The derived SBSC can be seen as such a subordinate BSC and therefore be implemented, using functionality already available for traditional BSC development.

To summarize, mostly the SBSC differs from a traditional BSC implementation only content wise, thus the application of the SBSC methodology in a company can be as well supported by BI as the application of the regular BSC. However, in case of the additive BSC, where a fifth perspective is added, existing support might not be enough.

5.2 BI Support for Sustainability Accounting

As discussed in Section 3.4.2, sustainability accounting describes new information management and accounting methods that aim to create and provide high quality information to support a corporation in its movement towards sustainability. (Schaltegger et al., 2006, p.15). As main functions of BI are to generate and provide information (Layers data generation and data provision), BI is well-suited to support this task.

From a technical perspective, BI can support the task of sustainability accounting, which is "to create and provide high quality information", by identifying the possible source systems and extracting, transforming and loading the data into the data warehouse. However, a critical factor is to provide the right information.

In sustainability accounting, either internal analyses of strategic sustainability issues (inside-out approach) or external requirements defined by stakeholders (e.g. government) or standards, e.g. GRI (outside-in approach) determine the information need. In both cases, but especially in the outside-in approach, the information need is defined independently of the actual data inventory. This might lead to a major challenge especially in the field of sustainability accounting, as environmental and social data are sometimes not automatically processed in information systems, which is nowadays mostly the case for financial data. Based on this fact, special requirements for BI systems arise on the layers of data generation and data provision.

5.2.1 Data Generation: Collection of Sustainability Data

Ideally, data for calculation of sustainability KPI can be collected automatically by IT systems, which is very time and cost efficient, standardized and less error-prone. Sustainability data includes data about economic, social and environmental aspects and therefore potentially originates in a broad range of IT Systems.

The reporting framework provided by the Global Reporting Initiative (Global Reporting Initiative, 2011), for example, encompasses indicators from six different areas: Economic, Environmental, Social: Labor Practices and Decent Work, Product Responsibility, Human Rights, Society.

Data for KPI in the economic area could be collected in transaction oriented accounting systems or Point-of-Sale systems. Environmental data can originate in Environmental Information Systems or Facility Management Software. Data about labor practices can be collected for example with the help of Human Resource Software. When considering product responsibility, human rights or societal issues, data collection can be very complex and unstructured. KPI about the number of actions in response to incidents of corruption, the risk of child-labor in supplier's production facility or the monetary value of significant fines for non-compliance with laws and regulations are typically not processed on a transactional basis in common operational systems.

Therefore, data generation in the context of sustainability accounting, has to take further sources of information into consideration. If the company cannot collect data for sustainability aspects automatically, it has to gather the data by means of non-automated data acquisition methods, like interviews, audits or internal assessments.

5.2.2 Data Provision: Integration of Sustainability Data

Focusing on data provision, BI systems facilitating corporate sustainable development, face two challenges. Firstly, the integration of many different source systems and data formats. Secondly, the integration of data, which cannot be collected automatically.

The first challenge is not only specific to the context of sustainability, as the basic idea of a Data Warehouse is to integrate data which originates in many different transactional systems. Trough the ETL-process, these data is transfered from the source system into the DWH and transformed into the common data format. Considering this fact, BI is perfectly suited to face this challenge.

The second aspect is more challenging, as a main goal of Business Intelligence is to replace manual data collection and reporting. However, the problem can be tackled by adding another operational source system, like a sustainability data collection platform, which serves as an additional data source to be integrated in the data warehouse. Some BI vendors offer an own interface for definition of manually entered KPI information, e.g. SAP Strategy Management Entry and Approval (see Clay, 2007, p.4).

5.3 BI Support for Sustainability Reporting

The integrated, provided accounting data constitutes the basis for sustainability reporting. Sustainability reporting refers to new formalized means of communication which provide information about corporate sustainability (Herzig and Schaltegger, 2006, p.307f). Based on four typical types of usage of sustainability data which is communicated by means of reporting, Sustainability reporting mainly fulfills four tasks: (i) to monitor compliance with environmental policies and regulation, (ii) to motivate continuous improvement, (iii) to provide data for internal decision-making, and (iv) to provide data for external reporting (based on Henri and Journeault, 2010, p.65).

In order to identify possible interaction points between sustainability reporting and BI methods and applications, the four tasks of sustainability reporting are now matched to the methods and applications in the BI layers *Presentation and Distribution*, which are mainly related to the task of reporting. The mapping is illustrated in Table 5.3 and described in more detail below.

	Presentation & Distribution								
	Special Visualization Techniques	Interactive Reporting	Ad-hoc Reporting	Exception Reporting	Standard Reporting	Management Dashboard	BI-Portals	BI Desktop Widgets	Mobile BI
External Reporting	x	x							
Monitor compliance with policies and regulations	x			x	x			x	x
Motivate continuous improvement							x	x	x
Provide data for internal decision-making		x	x			x	x		

Tab. 5.3: Mapping BI Methods to Sustainability Reporting Tasks

Provide data for external reporting

Reporting is one of the core functions of Business Intelligence, which provides relevant content in an appropriate form specific to the user and the particular decision problem (see Gluchowski et al., 2008, p.114) in documents containing information in form of text, graphics and tables (see Gleich and Michel, 2008, p.21).

Sustainability reports, as described in the GRI guidelines, contain text about the company's profile, management approaches related to the different sustainability dimensions and information about key performance indicators, represented by figures and diagrams (see Global Reporting Initiative, 2011, p.4).

As Business Intelligence is based on the generation and provision of quantitative data, it cannot create whole sustainability reports automatically. However, it can provide calculations, figures and diagrams related to the key performance indicators to be included into a sustainability report.

In this way, KPI data is stored centrally and can be reused for future sustainability reports to illustrate trends and time lines. Furthermore *interactive reporting* functionality, provides an convenient interface for designing tables, graphical illustrations, and other *special visualization techniques*. Report definitions can be easily adapted and stored for future use.

Monitor compliance with policies and regulation

Different BI reporting functionalities can support sustainability reporting for monitoring compliance with internal or external policies and regulations. With *exception reporting*, deviations from defined thresholds for critical aspects can be immediately reported to the responsible person or organizational unit automatically.

Standard reporting can be used to periodically report about sustainability issues, by means of *visual representation techniques*, e.g. traffic light representations or color coding, reports can - if correctly defined - lead the readers attention to the critical issues.

Another way to keep track of critical sustainability issues is to integrate these into BI desktop widgets or mobile BI applications. As a consequence, these key performance indicators are more often in the visual range of the user, who can react faster to critical developments.

Motivate continuous improvement

Sustainability data can only motivate continuous improvement if it is presented or at least accessible by the intended audience. In a recent study, BENGTSSON AND AGERFALK (2010) demonstrated that the presence of a sustainability portal, which inscribed the sustainability indicators of GRI, significantly increased employees' awareness of sustainability issues in a company.

In this case, another application of the BI portfolio can be applied. *BI Portals* structure, filter and prepare the available information supply. With a data basis containing sustainability data, it is well suited to act as a sustainability information portal, to illustrate figures and diagrams about sustainability issues in the responsibility area specific to the user.

BI desktop widgets or *mobile BI applications* could also contribute to sustainability awareness. Nowadays more and more smartphone applications targeting to increase environmental sustainability appear on the market (see for example Figure 5.1).

A possible application scenario for widgets or mobile applications is, for example, a visualization of the amount of printed paper per day or the energy consumption for a specific office or part of the building. Once these measures become apparent, employees could be motivated to propose suggestions for improvement.

Fig. 5.1: The Mobile Application CarbonCatcher Helps to Measure the Carbon Footprint of Food (Carbon Catcher, 2012)

Provide data for internal decision-making

Once, the sustainability data is provided in the data warehouse. Managers can pull the information they need through interactive ad-hoc reporting. With the help of convenient report design facilities, they can pick and choose the information required to solve the particular decision problem.

By means of portlets in BI-Portals users can customize the BI-Portal user interface and create their personal set of information needed to support every-day decision problems.

5.4 BI Support for Sustainability Controlling

The last core concept of the SPM-framework is sustainability controlling. In order to identify the intersection points of BI and Sustainability controlling, this section will explore how BI can support the application of controlling instruments.

JÄNICKE (2011, p.164f) studies the operational application of sustainability controlling and lists a comprehensive set of controlling instruments[24], which can be applied to facilitate sustainability-oriented managerial decision-making (see Table 5.4).

[24] based on the study of Herzig et al., 2007

ABC Analysis	Efficiency analysis	Product line analysis
Audit	Emission permit trade (company internally)	Risk Analysis
Reporting	Early warning	Sponsoring
Benchmarking	Indicators	Stakeholder Value
Accounting	Capital Expenditure Budgeting	Scenario Analysis
Budgeting	Compass	Employee suggestion system
Checklist	Label and ratings	Quality circle
Cross-Impact Analysis	Mission statement	
Dialog supporting instruments	Material and energy flow calculation	

Tab. 5.4: Sustainability Controlling Instruments

This portfolio of instruments can serve as a pool of possible instruments. The controlling function can select and provide specific instruments depending on the problem, the general corporate sustainability approach, and requirements specific to the individual area of responsibility (Jänicke, 2011, p.192).

When viewing the instruments in this list in relation to the BI Portfolio, possible ways to support sustainability controlling with BI methods and applications can be identified. In a detailed analysis, each of the tools has been analyzed, and compared to the BI Portfolio in order to determine the degree of possible BI support (full support, partly supported, not supported). The complete analysis is illustrated in in Table 5.4.

Tool	BI Support Level	Inherently Supported by BI	Relying on BI core functionality	Serve as Data Source	Benefits from General BI benefits	Not Supported by BI
ABC Analysis	Full support		x			
Audit	Partly supported			x	x	
Reporting	Partly supported	x				
Benchmarking	Full support	x				
Accounting	Partly supported		x			
Budgeting	Full support	x				
Checklist	Not supported			x		
Cross-Impact Analysis	Not supported			x		
Dialog Supporting Instruments	Not supported					x
Efficiency Analysis	Supported		x			
Emission Permit Trade (company internally)	Partly supported			x		
Early Warning	Full support		x			
Indicators	Full support		x			
Capital Expenditure Budgeting	Full support		x			
Compass	Not supported			x		
Label and Ratings	Partly supported				x	
Mission Statement	Not supported					x
Material and Energy Flow Calculation	Partly supported			x		
Product Line Analysis	Full support		x			
Risk Analysis	Full support	x				
Sponsoring	Not supported					x
Stakeholder Value	Full support		x			
Scenario Analysis	Full support	x				
Employee Suggestion System	Partly supported				x	
Quality circle	Not supported					x

Tab. 5.5: Five Ways How BI Supports Sustainability Controlling Instruments

Tool	Description	BI Support Comment	BI Support Level
ABC Analysis	An ABC analysis classifies resources depending on differing criteria. In the context of sustainability, materials can be classified according to their share in total recycling cost or CO2 emissions.	An ABC analysis is based on aggregated transactional data. Therefore the calculation of the ABC analysis can be defined in a BI report design tool and subsequently used in a standard report.	Full support
Audit	An audit is a checklist based tool, which helps to assess the As-Is state for a specific organizational unit. An audit can be executed internally (by members of other organizational units) or externally (by independent assessors). The aim of audits is to provide information about performance and compliance to stakeholders.	From a BI perspective, data gathered during audits can serve as data source. The audit process itself can not be supported by BI. However, BI supports subsequent analysis and interpretation of the gathered information.	Partly supported
Reporting	Sustainability reporting is discussed in detail in Section 3.4.2	BI can support reporting in various ways (see Section 5.3). However, traditional sustainability reports contain qualitative information, which can be not generated automatically. However it can be complemented by quantitative information provided by BI reports.	Partly supported
Benchmarking	Benchmarking is a method to compare processes, products or perform to other companies (externally) or other organizational units (internally). The aim is in both cases to identify improvement opportunities and to gain awareness about improvement opportunities (see Herzig et al., 2007, p.71).	Benchmarking is inherently part of the BI-portfolio, because it supports on the one hand definition of reports according to external standards, e.g. GRI, which can be used for external Benchmarking and on the other hand, through the multidimensional data representation it can aggregate information on different organizational levels and thereby facilitate the comparison of data between different organizational units.	Full support
Accounting	Sustainability reporting is discussed in detail in Section 3.4.3	BI can support sustainability accounting in various ways (see Section 5.2). But in the area of data collection it is in many cases dependent on manual data entry.	Partly supported

Tool	Description	BI Support Comment	BI Support Level
Budgeting	Budgeting refers to the development of plan values for a specified future period. Traditional budgeting defines, for example, a particular profit value to be achieved by a specific organizational unit. In eco-budgeting, values for the consumption or emission of a resource are defined. Budgeting aims to provide employees specific goals and the freedom to choose how to reach these goals.	Budgeting is inherently part of the BI portfolio, since it provides the specific "write-back" functionality. By means of write-back functionality, users of BI applications are able to perform bottom-up and top-down analyses, by entering data at different levels of aggregation. The data is automatically apportioned based on patterns or business rules, providing enterprises the possibility to create and analyze what-if scenarios (see Politan, 2003).	Full support
Checklist	Checklists help to determine the current state of economic, environmental, or social issues in different areas of the company in a structured way.	Checklists are not covered by the range of the BI portfolio. However, as for Auditing, data gathered through the application of checklists can serve as a data source to be integrated into the DWH.	Not supported
Cross-Impact Analysis	The cross-impact analysis is a method for analyzing impacts between different areas of interest. Based on qualitative statements of experts, the impact between e.g. stakeholder groups and company departments is estimated in a numeric value	As this method is based on qualitative data it can not be supported by BI. However, the resulting numeric values can serve as an input for the DWH.	Not supported
Dialog supporting instruments	The aim of dialog supporting instruments is to establish a platform for communication between the company and different stakeholder groups, e.g. citizens, representatives of NGO. As a form of communication has already been established, communication in conflicting situations is easier.	This methods is mostly based on soft factors and can therefore not be supported by BI. But generally, BI Reports create transparency about corporate sustainability actions, which can help to overcome the information assymetry between the company and stakeholders.	Not supported
Efficiency analysis	The efficiency analysis is a tool to relate environmental with economic measures and social with economic measures, e.g. CO2 Emission (t) / Added-Value (EUR)	The method is based on quantitative calculations. Provided the relevant basis data exists in the DWH, Eco- and socio-efficiency values can be calculated and aggregated by means of OLAP.	Supported
Emission permit trade (company internally)	Generally emission permit trade is an instrument used in environmental politics. A company can also introduce a emission permits company internally on a voluntary basis. In this way, an overall emission goal is set for the whole corporation to regulate total emissions. Departments can trade emission permits internally.	As BI is not a transactional system it can not support emission trade directly. However if used as a data input, BI facilitates subsequent analysis and interpretation.	Partly supported

Tool	Description	BI Support Comment	BI Support Level
Early warning	Early warning and early recognition systems detect specified internal or external changes and can thereby inform management about increasing risks or potentials in an early stage. Early warning systems monitor indicators and notify specified receivers when they recognize specific signals.	BI can support early detection in two ways. Firstly, a BI system can automatically monitor indicators and trigger exception reports when certain thresholds are exceeded. Secondly, data mining can be applied to automatically detect certain signal patterns in indicator values.	Full support
Indicators	Indicators are a method to quantify and measure facts about the actual situation and serve as foundation for many other instruments, e.g. Efficiency analysis, Reporting, or Benchmarking.	BI supports the data collection, data provision, calculation, analysis and presentation of indicators.	Full support
Capital Expenditure Budgeting	Capital expenditure budgeting helps to plan and calculate the expected return and related expenses for a capital asset, so as to be able to compare different investment options.	With BI Planning modules capital expenditures can be planned, e.g. Oracle Hyperion Capital Asset Planning or SAP BusinessObjects Planning and Consolidation	Full support
Compass	The compass instruments provides a framework for evaluation of different product and process characteristics. Based on six categories environmental impacts are estimated and illustrated. This evaluation provides valuable input for management in selection processes.	This instrument is dependent on estimation and evaluation of experts and can therefore not be automated. The generated classification can serve as valuable input, as addition to existing product or process master data.	Not supported
Label and ratings	Labels certify that a particular product or process complies to predefined standards. Labels are usually issued by external independent organizations, which examine the compliance to the regulation in detail. As consumers mostly do not have a detailed insight into internal processes of a company, labels are an important marketing instrument to gain consumers' trust.	BI can provide a sound information basis to monitor the compliance to regulations and help to provide internal data about sustainability related issues. However the audit process itself is not supported, since it is usually executed by external audit teams.	Partly supported
Mission statement	The formulation of a mission statement which includes environmental, social and economic aspects primarily serves two main goals. Firstly, the establishment of a company internal common mission and awareness about sustainability and secondly, the positioning of the company in front of external stakeholders.	The development of a mission statement is not directly supported by BI. The mission statement represents an input for the development of a SBSC.	Not supported

Tool	Description	BI Support Comment	BI Support Level
Material and energy flow calculation	By means of this calculation method detailed data about changes and movements of physical quantities are gathered and analyzed.	The data gathering is performed by specialized environmental information systems, which serve as data source for the BI System. Therefore, subsequent analysis, e.g. pattern recognition can be supported by BI.	Partly supported
Product line analysis	The product line analysis analyzes environment, social and economic aspects of different phases of product processing (e.g. raw material production, transport, production, transport, retailing, . . ., disposal)	If the according data has been integrated into the DWH, a product line analysis can be well supported by BI. Multidimensional data representation in OLAP cubes allows for analysis of facts on different aggregation levels and dimensions, e.g. product lines, or process phases.	Full support
Risk Analysis	Risk analysis is a procedure for systematic identification and evaluation of risks.	Quantitative risk analysis is fully supported by means of Data Mining techniques, which allows for calculation of risks for specific events e.g. the probability of a plant facility to fail an thereby negatively impact the environment, can be estimated.	Full support
Sponsoring	Sponsoring is a marketing instrument, which helps to communicate decisions related to sustainability.	BI can generally help to increase transparency and thereby support corporate communication. However, BI does not provide specific support for activities related to sponsoring	Not supported
Stakeholder Value	The stakeholder-value is a specific multilevel calculation, which compares cost and benefit of stakeholder relations.	If the according data has been integrated into the DWH, the multilevel quantitative calculation can be defined in a BI report.	Full support
Scenario Analysis	The aim of scenario analysis is the structured analysis of future developments and implications for the company or an organizational unit.	Scenario Analysis is inherently part of the BI portfolio, since it provides the specific “write-back” functionality. By means of write-back functionality, users of BI applications are able to perform bottom-up and top-down analyses, by entering data at different levels of aggregation. The data is automatically apportioned based on patterns or business rules, providing enterprises the possibility to create and analyze what-if scenarios (see Politan, 2003).	Full support

Tool	Description	BI Support Comment	BI Support Level
Employee suggestion system	An employee suggestion system aims to provide input in a "bottom-up" manner, employees can develop suggestion, which are subsequently analyzed and evaluated by the management team.	One task of reporting is to motivate continuous improvement. As BI applications, e.g. mobile BI or BI desktop widgets provide easy access to sustainability information. The awareness and motivation of employees can be increased to develop improvement suggestions.	Partly supported
Quality circle	A quality circle is a communication based instrument, which refers to expert discussions taking place on a regular basis about environmental, social and economic aspects with the aim to develop improvement suggestions.	This instrument is dependent on estimation and evaluation of experts and can therefore not be automated. However, BI Instruments can support quality circle discussions by providing information in form of reports (see Reporting) or instruments (see, for example, Scenario Analysis)	Not supported

Tab. 5.5: BI Support for Sustainability Controlling Instruments

As demonstrated in Table 5.5, 18 of 25 analyzed sustainability controlling instruments can be either partly or fully supported by BI. Basically, five different relations between Business Intelligence and sustainability controlling instruments could be identified:

1. Sustainability controlling instruments rely on methods which are inherently part of the BI Portfolio and are therefore generally comprehensively supported by BI.

2. Sustainability controlling instruments are based on core functionalities of BI, e.g. quantitative analysis or reporting functionality.

3. Sustainability controlling instruments highly profit from the benefits resulting from a holistic BI approach e.g. a sound information basis or increased transparency.

4. Sustainability controlling instruments aim to provide information about processes or products, which can not be directly supported by BI. These instruments can instead serve as a data source for the BI system, and the thereby generated information can be used in future analyses.

5. Sustainability controlling instruments, which are based on qualitative information or soft factors and can not be supported by BI.

Figure 5.2 provides an architectural overview about sustainability controlling instruments in relation to a BI systems. While some controlling instruments, mainly the ones focusing on assessment, evaluation and data collection, serve as data source for the BI system next to operational source systems, others can be supported by BI methods and applications, in order to improve their efficiency or functionality.

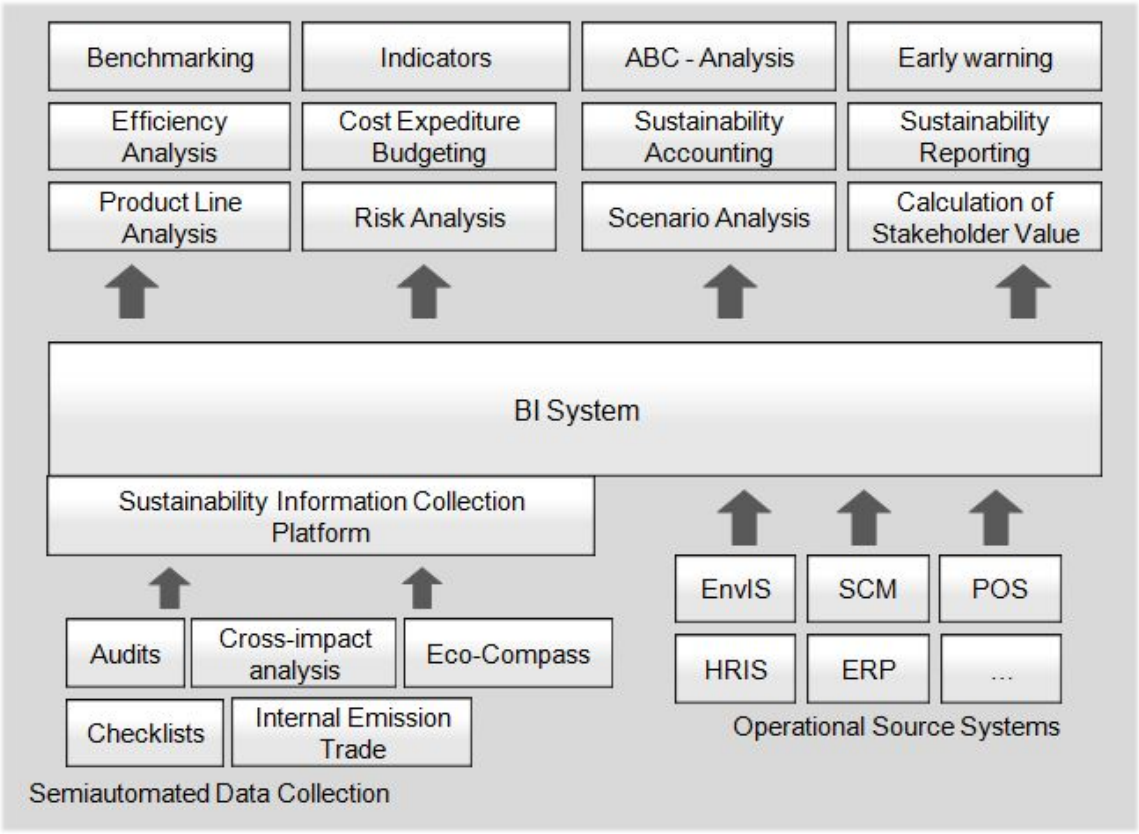

Fig. 5.2: Relation Between Sustainability Controlling Instruments and BI

5.5 BI Support for Corporate Sustainable Development

In the previous sections, it has been shown how BI can support the central concepts of Sustainability Performance Management. To provide an answer to research question 1., this section summarizes the findings.

BI can support Corporate Sustainable Development by facilitating Sustainability Performance Management by means of the Sustainability Balanced Scorecard. The BI data generation and provision functions can assist Sustainability Accounting to provide a sound information basis about economic, environmental and social aspects by collecting and integrating automatically and manually generated data.

Sustainability Reporting can make use of the presentation and distribution features of BI systems, like standard, ad-hoc and exception report to fulfill the four tasks of sustainability reporting more efficiently.

Many Sustainability Controlling Instruments can be automated, enhanced, or supported by the technical BI infrastructure and especially related analysis features, which adapted for a specific decision problem provide decision support to the management function.

Generally, BI can improve information transparency related to economic, environmental and social aspects for both internal and external stakeholders.

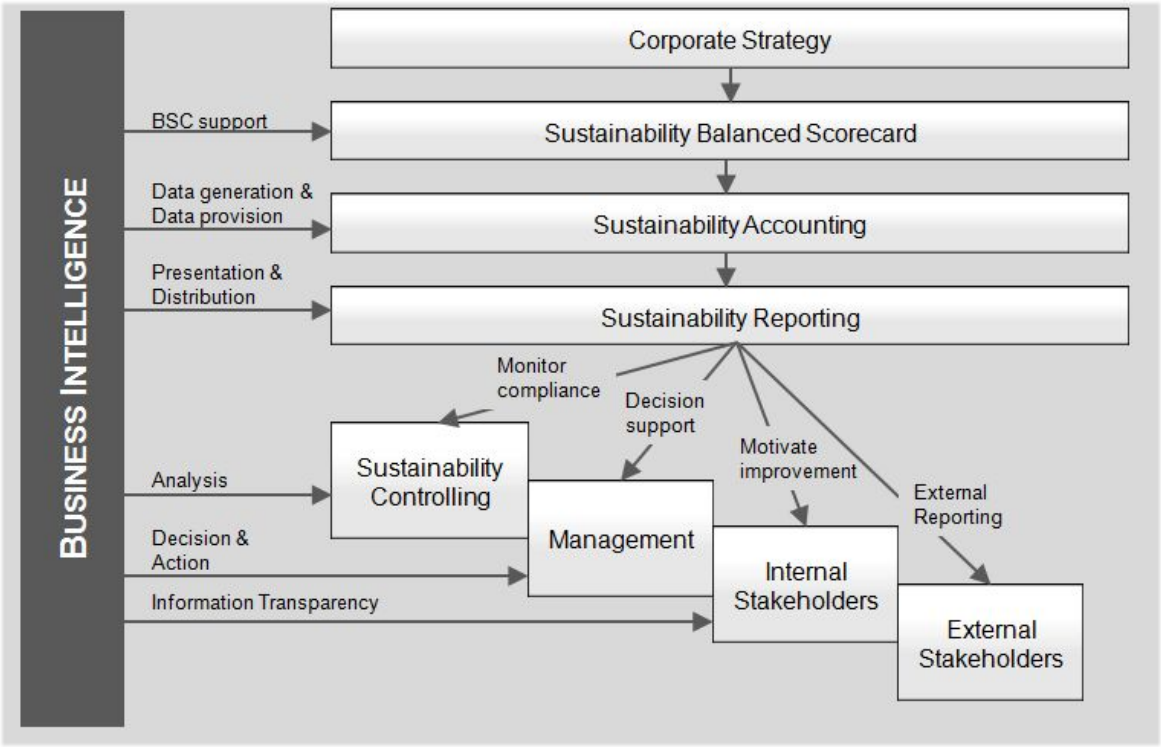

Fig. 5.3: Business Intelligence Support for Sustainability Management

6 Additional Requirements for BI Systems

The last chapter demonstrated how Business Intelligence methods and applications can be leveraged to support Corporate Sustainable Development. This chapters derives specific requirement arising from this specific application of BI and summarizes the implications for BI Systems aiming to facilitate corporate sustainable development.

Data Generation

Sustainability data is generated automatically, by operational IT systems or non-automatically, through the application of sustainability controlling instruments or other manual data gathering techniques. In order to integrate, manually collected data into the data warehouse, an additional data entry interface, e.g. a sustainability data collection platform is necessary.

Requirement 1 Provision of additional operational data input facilities for input of KPI data which cannot be collected automatically

Data Provision

As sustainability data covers a broad range of knowledge fields, it originates in various different operational source systems. In order to integrate all these information into the corporate data warehouse, the BI system has to overcome the challenge caused by the variety of different data formats.

Requirement 2 Support for a wide range of data sources and data formats in order to be able to integrate sustainability data which is collected in a broad range of transactional IT systems

Data Analysis

Many sustainability controlling instruments can easily be supported by standard data analysis operations. A BI system which explicitly enables corporate sustainable development, provides predefined templates and guidelines to implement various sustainability controlling instruments.

Requirement 3 Provision of templates and guidelines to apply data analysis functions to sustainability controlling instruments.

Presentation

The presentation function fulfills an important role in the context of sustainability reporting. The aim of sustainability reporting is to motivate internal stakeholders and to demonstrate transparency and gain the trust of external stakeholders, which leads to the next requirement:

Requirement 4 Provision of innovative presentation features, which present the information in a simple, but inspiring way.

Distribution

The role of BI in support of external sustainability reporting is to present KPI data in tables and diagrams, which can be included into the comprehensive corporate sustainability reports. Therefore, it is important that these information can be exported, so as to be included into these reports.

If corporate sustainability reports are part of the company's website, an automatic data interface should provide the data to the respective Content Management System. For reports created in text processing software, data should be exported in form of common graphic and table file formats.

Requirement 5 Possibility for automated and non-automated export of graphics and diagrams to be used corporate sustainability reports.

Decision

Different instruments can improve sustainability-oriented decision-making, e.g. scenario analysis, budgeting, or performance management approaches like the Balanced Scorecard. However, the specific selection of instruments always depends on the company and the particular decision problem. Therefore, BI systems should provide a portfolio of different methods.

Requirement 6 Feature a variety of different planning methods and guidelines for the selection and application of these methods to sustainability-oriented decision-making.

To support the most popular performance management system, BI systems furthermore have to comply to the following requirements:

Requirement 7 Support of Performance Management based on the Balanced Scorecard methodology

Requirement 7.1, for unlimited support of the Sustainability Balanced Scorecard: Possibility to add a fifth perspective to the Balanced Scorecard Structure

Action

As sustainability related measures and activities are a rather new endeavor for companies, it is important to embed the decisions in organizational structures, so as to ensure that decisions eventually lead to actions and thereby to improved sustainability performance.

Requirement 8 Provision of guidelines to set up organizational structures and mechanisms which ensure that sustainability-oriented decisions ultimately lead to actions.

In order to provide a concrete answer the question, which additional requirements a BI system have to meet in order to facilitate corporate sustainable development (Research Question 2), the requirements are summarized in Table 6.1.

RQ#	Requirement
RQ 1	Provision of additional operational data input facilities for input of KPI data which cannot be collected automatically
RQ 2	Support for a wide range of data sources and data formats in order to be able to integrate sustainability data which is collected in various transactional IT systems
RQ 3	Provision of templates and guidelines to apply data analysis functions to sustainability controlling instruments.
RQ 4	Provision of innovative presentation features, which present the information in a simple, but inspiring way.
RQ 5	Possibility for automated and non-automated export of graphics and diagrams to be used corporate sustainability reports.
RQ 6	Featuring of a variety of different planning methods and guidelines for the selection and application of these methods to sustainability-oriented decision-making.
RQ 7	Support of Performance Management based on the Balanced Scorecard methodology
RQ 7.1.	For unlimited support of the Sustainability Balanced Scorecard: Possibility to add a fifth perspective to the Balanced Scorecard Structure
RQ 8	Provision of guidelines to set up organizational structures and mechanisms which ensure that sustainability-oriented decisions ultimately lead to actions.

Tab. 6.1: Additional Requirements for BI Systems Supporting Corporate Sustainable Development

7 Conclusion

Over-consumption of finite natural resources, climate change, and the need to provide clean water, food and a better standard of living for a growing global population are great challenges for our society (UN Global Compact, 2010). We must not ignore these challenges but actively face them, and strive for more sustainability when satisfying our needs, in order to preserve the ability of future generations to meet their own needs (Brundtland, 1987).

Through corporate sustainable development companies can ensure their long-term existence and contribute to sustainable development of the society as whole. Although many companies include social responsibility and sustainability into strategic considerations, most of the time, they are not integrated into operative business management practices (Petrini and Pozzebon, 2009, p.119). Business Intelligence is an approach to transform operational data into valuable high-level business information and therefore has potential to help companies to close the gap between strategic and operational sustainability considerations. The main objective of this thesis was to explore how Business Intelligence systems can be applied to support corporate sustainable development.

This thesis first examined the business case for corporate sustainability and sustainability management practices and subsequently linked the core concepts of sustainability management with potential business applications of Business Intelligence. A systematic matching between applications within the BI Portfolio to the core concepts of sustainability management showed, that BI can support corporate sustainable development in various ways.

Derived from the corporate strategy a Sustainability Balanced Scorecard can be defined, which helps to translate textual statements into concrete measurable goals. Tradionally, the development, maintenance and monitoring of KPI in a BSC is well-supported by the functions of BI. Depending on the type, the development of a SBSC can pose additional requirements to a BI System.

Furthermore, Business Intelligence can support the function of sustainability accounting, which aims to provide high quality information about economic, environmental and social aspects. BI methods can help to automatically collect sustainability data and to integrate these data with manually gathered data in order to provide a sound information basis for superordinate analysis functions or reporting applications.

Depending on the particular intention of a sustainability report, different BI presentation and distribution features can be leveraged, to partly or fully automate the sustainability reporting process. With regard to sustainability controlling, it has been found that most controlling

instruments are well-suited to be supported by BI analysis methods and others, which focus on generating quantitative data through estimation or assessment of sustainability issues, can serve as data source.

Finally, it can be stated that several potential applications of BI to support different aspects of Sustainability Management could be identified, which suggests that BI is potentially an important approach to enhance corporate sustainable development. A BI system, which fosters corporate sustainable development by design, has to meet certain additional requirements. However, these requirements represent minor functional extensions, rather than groundbreaking structural changes.

This thesis represents a first starting point for companies, to discover application scenarios of BI to their individual sustainability issues. In order to be able to make definitive statements about the impact of BI application to sustainability management, further research is necessary.

The requirements developed in this thesis, can serve as an input for research endeavors applying design-science oriented methods. In this case, a prototype could be developed which meets the additional requirements developed in this paper. The application of such a prototype in an empirical setting, allows for evaluation of the suggested framework and requirements and furthermore helps to discover further application scenarios.

As further sustainability management frameworks are developed, an extension of the framework to other management methods than the Balanced Scorecard, is necessary.

The research community faces a critical role in the global challenge towards more sustainability. With increasing technology improvements, the cost of implementing sustainability are reduced, which is a major factor in business considerations about sustainability and helps to justify the business case for corporate sustainability.

Although a central role is attributed to IS in the quest for advanced corporate sustainability, research in this field is sparse. However, current endeavors to structure this new area of knowledge, show that this field of research is up-and-coming.

There is hope that the IS and other academic communities increasingly follow the call of JOHN HOLDREN and thereby contribute to the essential turn of our actions and thinking, towards more economic, environmental and social sustainability.

Bibliography

Anandarajan, M., ed. 2004. *Business intelligence techniques: A perspective from accounting and finance*. Berlin: Springer.

Balik, M. and Frühwald, C. 2006. *Nachhaltigkeitsmanagement: Mit Sustainability Management durch Innovation und Verantwortung langfristig Werte schaffen*. Saarbrücken: VDM, Verl. Dr. Müller.

Bassler, A. 2010. *Die Visualisierung von Daten im Controlling*. 1st ed. Lohmar [u.a.]: Eul.

Becker, J. 2002. *Prozessmanagement: Ein Leitfaden zur prozessorientierten Organisationsgestaltung ; mit 37 Tabellen*. 3rd ed. Berlin et al.: Springer.

Bengtsson, F. and Agerfalk, P. 2010. „Information technology as a change actant in sustainability innovation: Insights from Uppsala“. In: *The Journal of Strategic Information Systems*.

Bensberg, F. 2010. *BI-Portfoliocontrolling - Konzeption, Methodik und Softwareunterstützung*. 1st ed. Baden-Baden and [München]: Nomos and Vahlen.

Boms, A. 2008. *Unternehmensverantwortung und Nachhaltigkeit: Umsetzung durch das Sustainability-Performance-Measurement*. 1st ed. Lohmar, and Köln: Eul.

Brugger, F. 2010. „Nachhaltigkeit in der Unternehmenskommunikation: Bedeutung, Charakteristika und Herausforderungen“. In: *Nachhaltigkeit in der Unternehmenskommunikation*.

Brundtland, G. H. 1987. *Report of the World Commission on environment and development: "our common future."* [New York: United Nations.

Burritt, R. and Schaltegger, S. 2010. „Sustainability accounting and reporting: fad or trend?“ In: *Accounting, Auditing & Accountability Journal* 23.7, pp. 829–846.

Business Objects 2008. *BusinessObjects BI Widgets XI 3.1 User Guide*. (Visited on 15/01/2012).

Caldelli, A. and Parmigiani, M. L. „Management Information System - A Tool for Corporate Sustainability“. In: *Journal of Business Ethics* 55 (2), pp. 159–171.

Carbon Catcher 2012. *Carbon Catcher*. http://www.myspace.com/carboncatcher/.

Chowdhury, G. 2011. „Building environmentally sustainable information services: A green IS research agenda“. In: *Journal of the American Society for Information Science and Technology*.

Clay, C. 2007. *Building Better Scorecards Using Workflow Based Data Entry*. http://www.sdn.sap.com/irj/scn/go/portal/prtroot/docs/library/uuid/a005d761-e057-2a10-06b5-95590922b520?QuickLink=index&overridelayout=true&18575733571565.

Daum, A. and Steinle, C. 2007. *Controlling: Kompendium für Ausbildung und Praxis*. 4th ed. Stuttgart: Schäffer-Poeschel.

Davenport, T. 2006. „Competing on analytics.“ In: *Harvard business review* 84.1.

Drucker, P. 1984. „The new meaning of corporate social responsibility“. In: *California Management Review* 40.2, pp. 8–17.

Dull, R. B. and Tegarden, D. P. 2004. „Visual Representations of Accounting Information“. In: *Business intelligence techniques: A perspective from accounting and finance*. Ed. by Anandarajan, M., Anandarajan, A. and Srinivasan, C. Berlin: Springer, pp. 150–166.

Duong Dinh, H. V. 2011. *Corporate social responsibility: Determinanten der Wahrnehmung, Wirkungsprozesse und Konsequenzen*. Wiesbaden: Gabler.

Dyllick, T. and Hockerts, K. 2002. „Beyond the business case for corporate sustainability“. In: *Business strategy and the environment* 11.2, pp. 130–141.

Elkington, J. 1998. „Partnerships from cannibals with forks: The triple bottom line of 21st-century business“. In: *Environmental Quality Management* 8.1, pp. 37–51.

Elliot, S. 2011. „Transdisciplinary perspectives on environmental sustainability: a resource base and framework for IT-enabled business transformation“. In: *MIS Quarterly* 35.1, pp. 197–236.

Epstein, M. 2008. *Making sustainability work: Best practices in managing and measuring corporate social, environmental and economic impacts*. Berrett-Koehler Publishers.

Feldman, R. and Sanger, J. 2007. *The text mining handbook: Advanced approaches in analyzing unstructured data*. Cambridge, and New York: Cambridge University Press.

Figge, F. 2004. „Wertschaffendes Umweltmanagement. Keine Nachhaltigkeit ohne ökonomischen Erfolg. Kein ökonomischer Erfolg ohne Nachhaltigkeit“. In: *Others*. URL: http://129.3.20.41/eps/othr/papers/0408/0408011.pdf (visited on 01/02/2012).

Figge, F., Hahn, T., Schaltegger, S. and Wagner, M. 2002. „The Sustainability Balanced Scorecard - linking sustainability management to business strategy“. In: *Business Strategy and the Environment* 11.5, pp. 269–284.

Fischer, T. M., Sawczyn, A. and Brauch, B. 2009. „Nachhaltigkeit und Sustainability Accounting“. In: *Controlling zwischen Shareholder Value und Stakeholder Value: Neue Anforderungen, Konzepte und Instrumente*. Ed. by Schröder, R. W. and Wall, F. 1st ed. München: Oldenbourg, R, pp. 261–287.

Friedman, M. 2007. „The Social Responsibility of Business Is to Increase Its Profits“. In: *Corporate Ethics and Corporate Governance*. Ed. by Zimmerli, W. C., Holzinger, M. and Richter, K. Springer Berlin Heidelberg, pp. 173–178.

Fujitsu Technology Solutions 2010. *Umweltmanagement - Entwicklung und Produktion*. http://www.fujitsu.com/de/about/fts/environment-care/production/. (Visited on 15/01/2012).

Gartner Research 2012. *Magic Quadrant for Business Intelligence Platforms*. http://www.gartner.com/id=1915014. (Visited on 24/02/2012).

Gleich, R. and Michel, U. 2008. *Management Reporting: Grundlagen, Praxisbeispiele und Perspektiven*. 1st ed. Freiburg im Breisgau: Haufe, Rudolf.

Global E-Sustainability Initiative 2008. „SMART 2020: Enabling the low carbon economy in the information age". In: *press release, Brussels, Belgium, June* 20.

Global Reporting Initiative 2011. *About GRI*. https://www.globalreporting.org/information/about-gri/Pages/default.aspx. (Visited on 28/02/2012).

Gluchowski, P. and Kemper, H. 2006. „Quo vadis business intelligence". In: *Zeitschrift BI-Spektrum* 1.

Gluchowski, P., Gabriel, R. and Dittmar, C. 2008. *Management-Support-Systeme und Business intelligence: Computergestützte Informationssysteme für Fach- und Führungskräfte*. 2nd ed. Berlin and Heidelberg: Springer.

Greiling, D. and Ther, D. 2010. „Leistungsfähigkeit des Sustainable Value-Ansatzes als Instrument des Sustainability Controlling". In: *Corporate Sustainability: Der Beitrag von Unternehmen zu einer nachhaltigen Entwicklung in Wirtschaft und Gesellschaft*. Ed. by Prammer, H. Gabler Verlag, pp. 37–68.

Grothe, M. and Gentsch, P. 2000. *Business intelligence: Aus Informationen Wettbewerbsvorteile gewinnen*. München: Addison-Wesley.

Hagemann, H. and Hauff, v. M., eds. 2010. *Nachhaltige Entwicklung - das neue Paradigma in der Ökonomie*. Marburg: Metropolis-Verl.

Hallstedt, S., Ny, H., Robèrt, K. and Broman, G. 2010. „An approach to assessing sustainability integration in strategic decision systems for product development". In: *Journal of Cleaner Production* 18.8, pp. 703–712.

Haneke, U., Trahasch, S., Hagen, T. and Lauer, T. 2010. *Open Source Business Intelligence: Möglichkeiten, Chancen und Risiken quelloffener BI-Lösungen*. München: Hanser.

Hansen, U. and Schrader, U. 2005. „Corporate Social Responsibility als aktuelles Thema der Betriebswirtschaftslehre". In: *BETRIEBSWIRTSCHAFT-STUTTGART-* 65.4, p. 373.

Heemskerk, B., Pistorio, P. and Scicluna, M. 2002. *Sustainability reporting - Striking the balance*. http://www.wbcsd.org/Pages/EDocument/EDocumentDetails.aspx?ID=144. (Visited on 01/02/2012).

Henri, J.-F. and Journeault, M. 2010. „Eco-control: The influence of management control systems on environmental and economic performance". In: *Accounting, Organizations and Society* 35.1, pp. 63–80.

Hermann, S. 2005. *Corporate sustainability branding: Nachhaltigkeits- und stakeholderorientierte Profilierung von Unternehmensmarken*. Deutscher Universitäts-Verlag.

Herzig, C., Kleiber, O., Klinke, T., Müller, J. and Schaltegger, S. 2007. *Nachhaltigkeitsmanagement in Unternehmen: Von der Idee zur Praxis: Managementansätze zur Umsetzung von Corporate Social Responsibility und Corporate Sustainability*. Lüneburg: CSM.

Herzig, C. and Schaltegger, S. 2006. „Corporate Sustainability Reporting“. In: *Sustainability accounting and reporting*. Ed. by Schaltegger, S., Bennett, M. and Burritt, R. Springer, pp. 301–324.

Hoffmann, T. 2011. *Unternehmerische Nachhaltigkeitsberichterstattung: Eine Analyse des GRI G3.1-Berichtsrahmens*. 1st ed. Josef Eul Verlag Gmbh.

Holdren, J. 2008. „Science and technology for sustainable well-being“. In: *Science* 319.5862, p. 424.

Humm, B. and Wietek, F. 2005. „Architektur von Data Warehouses und Business Intelligence Systemen“. In: *Informatik-Spektrum* 28 (1), pp. 3–14.

IBM Corporation 2011. *IBM Cognos Solutions for your IBM Environment*. URL: http://www.ibm.com/software/analytics/cognos/solutions/ibm/websphere-portal.html (visited on 15/02/2012).

Inmon, W. H. 2005. *Building the data warehouse*. Indianapolis: Wiley.

Intergovernmental Panel on Climate Change 2007. *Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. URL: http://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr_spm.pdf.

Isenmann, R. and Lenz, C. 2002. „Internet use for corporate environmental reporting: current challenges-technical benefits-practical guidance“. In: *Business Strategy and the Environment* 11.3, pp. 181–202.

Jenkin, T., McShane, L. and Webster, J. 2011. „Green Information Technologies and Systems: Employees' Perceptions of Organizational Practices“. In: *Business & Society* 50.2, p. 266.

Jenkin, T., Webster, J. and McShane, L. 2010. „An agenda for 'Green' information technology and systems research“. In: *Information and Organization*.

Jänicke, N. T. 2011. *Controlling im Nachhaltigkeitsmanagement*. Marburg: Tectum Verlag.

Jonker, J., Stark, W. and Tewes, S. 2011. *Corporate Social Responsibility und nachhaltige Entwicklung: Einführung, Strategie und Glossar*. Berlin: Springer.

Jourdan, Z., Rainer, R. and Marshall, T. 2008. „Business Intelligence: An Analysis of the Literature“. In: *Information Systems Management* 25.2, pp. 121–131.

Jung, H. 2011. *Controlling*. München: Oldenbourg Wissenschaftsverlag.

Kaplan, R. and Norton, D. 1996. *The balanced scorecard: translating strategy into action*. Harvard Business Press.

Kaplan, R. S. and Norton, D. P. 2007. „Using the Balanced Scorecard as a Strategic Management System.“ In: *Harvard Business Review* 85.7/8, pp. 150 –161. URL: http://search.ebscohost.com/login.aspx?direct=true&db=buh&AN=25358567&lang=de&site=ehost-live.

Kemper, H.-G., Mehanna, W. and Baars, H. 2010. *Business Intelligence - Grundlagen und praktische Anwendungen: Eine Einführung in die IT-basierte Managementunterstützung*. 3rd ed. Wiesbaden: Vieweg + Teubner.

Kimball, R. 2008. *The data warehouse lifecycle toolkit*. 2nd ed. Indianapolis and IN: Wiley Pub.

Kintzinger, A. 1995. „SHELL-BOYKOTT: Wer ist der nächste?“ In: *Focus Magazin* 26. URL: http://www.focus.de/politik/deutschland/shell-boykott-wer-ist-der-naechste_aid_153027.html (visited on 15/01/2012).

Kirchgeorg, M. and Hermann, S. 2004. „Ökocontrolling“. In: *Controlling*. Ed. by Grob, L., Brocke, J. vom, Lahme, N. and Wahn, M. Franz Vahlen München, pp. 597–691.

Knobloch, C. 2004. *Business-Intelligence-Komponenten: Theorie, Realisierung, Entwicklungsprozess*. Herdecke and Bochum: W3L-Verl.

Kraus, P. 2011. *Die Auswirkung von Corporate Governance und Nachhaltigkeit auf den Unternehmenserfolg: Eine Betrachtung im Kontext der wertorientierten Unternehmensführung*. Lohmar, and Köln: Eul.

Krcmar, H. 2005. *Informationsmanagement*. Springer Verlag.

Lenz, H.-J. 2007. *Business intelligence: methods and applications: Essays in honor of Prof. Dr. Hans-J. Lenz*. Ed. by Köppen, V. and Müller, R. M. Hamburg: Dr. Kovač.

Loew, T. 2004. *Bedeutung der internationalen CSR-Diskussion für Nachhaltigkeit und die sich daraus ergebenden Anforderungen an Unternehmen mit Fokus Berichterstattung: Endbericht*. Münster: future e.V.

Luhn, H. P. 1958. „A Business Intelligence System“. In: *IBM Journal of Research and Development* 2.4, pp. 314–319.

Marrewijk, M. 2003. „Concepts and Definitions of CSR and Corporate Sustainability: Between Agency and Communion“. In: *Journal of Business Ethics* 44 (2), pp. 95–105.

Matten, D., Crane, A. and Chapple, W. 2003. „Behind the Mask: Revealing the True Face of Corporate Citizenship“. In: *Journal of Business Ethics* 45 (1), pp. 109–120.

Melville, N. 2010. „Information systems innovation for environmental sustainability“. In: *Management Information Systems Quarterly* 34.1, pp. 1–21.

Mertens, P. 2002. „Business Intelligence - ein Überblick“. In: *Information Management & Consulting, Sonderausgabe* 17, pp. 65–73.

Münstermann, M. 2007. *Corporate Social Responsibility: Ausgestaltung und Steuerung von CSR-Aktivitäten*. Vol. 48. Gabler Verlag.

Murugesan, S. 2008. „Harnessing Green IT: Principles and Practices“. In: *IT Professional* 10.1, pp. 24–33.

Nemati, H. R. and Barko, C. D. 2004. *Organizational data mining: Leveraging enterprise data resources for optimal performance*. Hershey and PA: Idea Group Pub.

Palazzo, G. 2009. „Die Verantwortung der Unternehmen in der Gesellschaft: Eine Kommentierung zur Rolle der Unternehmen“. In: *Nachhaltigkeit in Unternehmen: Konzepte für Organisation und Kommunikation*. Berlin: Logos-Verl, pp. 9–20.

Palladium Group, Inc 2011. *Requirements for Palladium Kaplan-Norton Balanced Scorecard Certified Software Applications*. http://www.thepalladiumgroup.com/KnowledgeObjectRepository/SoftwareCertification2011.pdf.

Pentaho Corporation 2011. *Gain Advantage by Embedding Analytics into Your Application*. URL: http://www.pentaho.com/explore/embedded-bi (visited on 15/01/2012).

Petrini, M. and Pozzebon, M. 2009. „Managing sustainability with the support of business intelligence: Integrating socio-environmental indicators and organisational context“. In: *The Journal of Strategic Information Systems* 18.4, pp. 178–191.

Politan, A. 2003. *Taking Performance to the next level*. URL: http://www.valuebasedmanagement.net/articles_taking_performance_management_next_level.html (visited on 19/01/2012).

Porter, M. and Kramer, M. 2006. „The link between competitive advantage and corporate social responsibility“. In: *Harvard business review* 84.12, pp. 78–92.

Pozzebon, M., Arroyo, P. and Fleury, A. 2010. „Sustainable Scorecard as an Actionable Framework for Managing Sustainability“. In: Teuteberg, F. and Gómez, J. M. *Corporate Environmental Management Information Systems: Advancements and Trends*. IGI Global, pp. 409–424.

Prammer, H. 2010. *Corporate Sustainability: Der Beitrag von Unternehmen zu einer nachhaltigen Entwicklung in Wirtschaft und Gesellschaft*. Gabler Verlag.

Quaing, B. 2010. *Einsatz und Nutzen von Business Intelligence in Unternehmen: Ergebnisse einer kausalanalytischen Untersuchung*. 1. Kovac, J.

Quick, R. and Knocinski, M. 2006. „Nachhaltigkeitsberichterstattung - Empirische Befunde zur Berichterstattungspraxis von HDAX-Unternehmen“. In: *Zeitschrift für Betriebswirtschaft* 76 (6), pp. 615–650.

Schaltegger, S., Windolph, S. and Harms, D. 2010. *Corporate Sustainability Barometer–wie nachhaltig agieren Unternehmen in Deutschland? Centre for Sustainability Management der Leuphana Universität Lüneburg/PricewaterhouseCoopers, Lüneburg/Frankfurt aM*. URL: http://www2.leuphana.de/umanagement/csm/content/nama/downloads/download_publikationen/CorporateSustainabilityBarometer.pdf.

Schaltegger, S., Bennett, M. and Burritt, R. 2006. „Sustainability Accounting and Reporting: Development, Linkages and Reflection. An Introduction“. In: *Sustainability accounting and reporting*. Ed. by Schaltegger, S., Bennett, M. and Burritt, R. Springer, pp. 1–33.

Schaltegger, S. and Wagner, M. 2006. „Managing sustainability performance measurement and reporting in an integrated manner. Sustainability accounting as the link between the sustainability balanced scorecard and sustainability reporting“. In: *Sustainability accounting and reporting*. Ed. by Schaltegger, S., Bennett, M. and Burritt, R. Springer, pp. 681–697.

Schönborn, G. 2001. *Sustainability agenda: Nachhaltigkeitskommunikation für Unternehmen und Institutionen*. Neuwied [u.a.]: Luchterhand.

Simon, H. 1977. *The new science of management decision*. Prentice-Hall (Englewood Cliffs, NJ).

Strauch, B. and Winter, R. 2002. „Stichwort "Business Intelligence"“. In: *Praxishandbuch Wissensmanagement - Strategien, Methoden, Fallbeispiele*. Ed. by Bellmann, M., Krcmar, H. and Sommerlatte, T. Düsseldorf: Symposion, pp. 439–448.

Szyperski, N. 1980. „Informationsbedarf“. In: *Handwörterbuch der Organisation*. Ed. by Grochla, E. 2nd ed. Stuttgart, pp. 904–913.

Tonchia, S. and Quagini, L. 2010. *Performance Measurement: Linking Balanced Scorecard to Business Intelligence*. Springer Verlag.

Tschandl, M. 2012. „Perspektiven der Integration im Umweltcontrolling“. In: *Integriertes Umweltcontrolling*. Ed. by Tschandl, M. and Posch, A. Gabler Verlag, pp. 11–39.

Turban, E., Jay, A., Ting-Peng, L. and Ramesh, S. 2007. *Decision support and business intelligence systems*. 8th ed. Upper Saddle River and N.J: Pearson Prentice Hall.

UN Global Compact 2010. *Formation of the International Integrated Reporting Committee (IIRC)*. URL: http://www.unglobalcompact.org/news/57-08-02-2010 (visited on 19/01/2012).

Vom Brocke, J., Simons, A., Niehaves, B., Riemer, K., Plattfaut, R. and Cleven, A. 2009. „Reconstructing the giant: on the importance of rigour in documenting the literature search process“. In: *17th European Conference on Information Systems*, pp. 1–13.

Wagner, W. E. 2011. „Imagining corporate sustainabiltiy as a public good rather than a corporate bad.“ In: *Wake Forest Law Review* 46.3, pp. 561 –589. URL: http://search.ebscohost.com/login.aspx?direct=true&db=buh&AN=67229700&lang=de&site=ehost-live.

Watson, R., Boudreau, M. and Chen, A. 2010. „Information systems and environmentally sustainable development: energy informatics and new directions for the IS community“. In: *Management Information Systems Quarterly* 34.1, pp. 23–38.

Watterson, B. 1992. *Calvin and Hobbes*. 17 May 1992, distributed by Universal Press Syndicate.

Wigand, R. T., Picot, A. and Reichwald, R. 1997. *Information, organization, and management: Expanding markets and corporate boundaries*. Chichester: Wiley.

Williams, S. and Williams, N. 2007. *The profit impact of business intelligence*. Amsterdam, and Boston: Elsevier/Morgan Kaufmann.

tegos GmbH Dortmund 2010. *Über tegos.BI*. URL: http://bi.tegos.eu/tegos-bi.html (visited on 15/01/2012).

Appendix

A Additional Data for the Literature Review

A.1 Journals and Selected Databases

Domain	Journal title	Database
CS	Accounting, Organizations and Society	ScienceDirect
CS	Ecological Economics	ScienceDirect
CS	Journal of Cleaner Production	ScienceDirect
CS	Journal of Environmental Economics and Management	ScienceDirect
CS	Business & Society	sagepub
CS	Business Ethics - A European Review	EBSCOhost
CS	Business Ethics Quarterly	EBSCOhost
CS	Greener Management International: The Journal of Corporate Environmental Strategy and Practice	EBSCOhost
CS	Journal of industrial ecology	EBSCOhost
CS	Socio-Economic Review	EBSCOhost
CS	Business Strategy and the Environment	Wiley Online Library
CS	Corporate Social Responsibility and Environmental Management	Wiley Online Library
CS	Journal of Business Ethics	SpringerLink
CS	Ökologisches Wirtschaften	Journal website
CS	Umweltwirtschaftsforum	SpringerLink
CS	Zeitschrift für Wirtschafts- und Unternehmensethik	wiso
CS	Accounting Auditing Accountability Journal	Emerald
CS	Society and Business Review	Emerald
BI	European Journal of Information Systems	palgrave macmillian
BI	MIS Quarterly	EBSCOhost
BI	Information & Management	ScienceDirect
BI	Communications of the ACM	EBSCOhost
BI	Information Systems research	EBSCOhost
BI	Journal of Management Information Systems	EBSCOhost
BI	Management Science	EBSCOhost
BI	Harvard Busienss Review	EBSCOhost
BI	Business Intelligence Journal	Journal Website
BI	International Journal of Business Intelligence Research	IGI Global
BI	Middle East Business Intelligence	EBSCOhost
BI	ACM Transactions on Management Information Systems	ACM
BI	Journal of Performance Management	EBSCOhost

Tab. A.0: Journals and Databases Used in the Literature Review Process

Journal	Exclusion criterion
Decision Support Systems	No access
Social and Environmental Accountability Journal	No access
Forum Wirtschaftsethik	No automated search
International Journal of Business Environment	No access
International Journal of Innovation and Sustainable Development	No access
Zeitschrift für angewandte Umweltforschung	No access
Zeitschrift für Umweltpolitik und Umweltrecht	No access
GAIA - Ökologische Perspektiven in Natur-, Geistes- und Wirtschaftswissenschaften	No automated search

Tab. A.0: Excluded Journals and Exclusion Criteria

B Overview of BI Application Discussed in Literature

	Kemper et al., 2010	Lenz, 2007	Gluchowski et al., 2008	Grothe and Gentsch, 2000	Quaing, 2010	Williams and Williams, 2007
Active BI	94				184	
Ad-hoc Reporting	4					
Annotation Functionality					184	
Benchmarking	88					Table 7-2
BSC	4; 131			x		
Budgeting					184	
Closed Loop BI	93				184	
Customer analysis (Customer segmentation, customer value analysis)	88					Table 7-2
Data Mart	12					
Data Mining	4; 113	12–16		x	184	Table 7-2
Data Warehousing	4;92			x	184	
Diagnosis				x		
Expertsystem Functionality					184	
Extraktion, Transformation, Loading	4					
Financial analysis (revenue, profit, cost, accounts receivable)						Table 7-2
Forecasting						Table 7-2
Interactive Reporting	124					
Interpretation				x		
Inventory analysis						Table 7-2
Monitoring and Controlling		12–16				
Multimedia Mining					184	
OLAP	4; 99			x	184	
Performance measures and metrics						Table 7-2
Planning	4; 135		143		184	
Portal Functionality	153;11				184	
Portal Personalization	153					
Process Mining	122					
Productivity analysis						Table 7-2
Prognosis				x		
Pull and Push Functionality				x	184	
Quality analysis						Table 7-2

	Kemper et al., 2010	Lenz, 2007	Gluchowski et al., 2008	Grothe and Gentsch, 2000	Quaing, 2010	Williams and Williams, 2007
Real-Time BI	93				184	
Risk analysis (fraud detection, loss analysis)						Table 7-2
Sales analysis						Table 7-2
Scenario Engineering and Business Planning		12–16				
Specific Visualisation and Presentation Functionality					184	
Standard Reporting	4; 124					
Supply chain analysis						Table 7-2
Text Mining	4; 117			x	184	
Trouble Shooting and Risk Assessment		12–16				
Web Mining	122			x	184	

Tab. B.0: BI Applications Ddiscussed in Literature

Plagiarism declaration

I hereby declare that, to the best of my knowledge and belief, this Masterthesis titled "Counting what Counts: Applying Business Intelligence to Support Corporate Sustainable Development" is my own work. I confirm that each significant contribution to, and quotation in this thesis from the work, or works of other people is indicated through the proper use of citations and references.

Münster, on the 28. February 2012