The Sustainability Balanced Scorecard as a Framework for Eco-efficiency Analysis

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Keywords

eco-efficiency
environmental information systems
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Summary

To provide valuable support for successful decision-making, managers need a balanced set of financial and nonfinancial measures that represent different requirements, strategic goals, strategies, resources, and capabilities and the causal relationships between these domains. The balanced scorecard is such a measurement system. As an open system the balanced scorecard facilitates the consideration of sustainability issues. But enhanced balanced scorecards require a new type of data. This is where eco-efficiency analysis comes into play.

This article discusses the relationship between so-called sustainability balanced scorecards and eco-efficiency analysis. Eco-efficiency analysis not only provides a data source for sustainability balanced scorecards; in the perspective of environmental information systems it also serves as a link between the balanced scorecard and corporate environmental accounting systems so that eco-efficiency as a component of an environmental information system becomes an adapter with two interfaces, which are characterized in this article. The main focus is on the principle of cause and effect, its different forms, and the implications for the design of appropriate information system components.

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Introduction

Managers communicate with stakeholders of companies, they set strategic and operational objectives, they develop resources and capabilities, and they work out corporate strategies. To do so, managers need appropriate information, as "the fourth basic element in the work of the manager is measurement" (Drucker 1999, 20). But performance measurement systems are not only oriented to formal, isolated domains. Strategic management also deals with relationships between different stakeholders, strategic goals, strategies, resources, and capabilities. In this paradigm of instrumental rationality, managers derive the strategic goals from the specific purpose and mission of the business. They have to think through the coherence of strategies using, for example, SWOT analysis (see Boseman and Phatak 1989), "where strategy is formulated in relation to four sets of considerations: Strengths, Weaknesses, Opportunities, and Threats. While strengths and weaknesses relate to the resources and capabilities of the firm, opportunities and threats relate to the external environment" (Grant 1996, 44). Many of the external issues influencing business are nonmarket or sustainability issues addressed by stakeholders. Consequently performance measurement systems have to represent this special kind of causal relationship.

Because businesses exist "for the sake of economic performance" (Drucker 1999, 36), prominent performance measures are return on capital employed, net profit margin, or assets turnover (see Eilon 1999, 63). These performance measures express mainly the relationship between the business and its shareholders as a special group of stakeholders. Often this focus results in the dominance of the financial perspective. But basing decisions only on a few financial measures provides a poor basis for considering all domains of a business. In the financial perspective it is difficult to take into consideration dependencies on financial outcomes and activities in domains such as customer satisfaction, product quality, process quality, new-product development, or organizational learning. Therefore it is necessary to operate with a mix of financial and nonfinancial measures. One approach that has been designed to deal with a mix of financial and nonfinancial measures has recently become popular under the name of the "balanced scorecard" (see Kaplan and Norton 1996).

Balanced Scorecard

The balanced scorecard was developed by Kaplan and Norton to improve established performance measurement systems, which are focused mainly on financial performance and conventional physical and tangible assets. The balanced scorecard, as a broader approach, also takes into account customers, processes, and organizational learning as additional issues and perspectives. Kaplan and Norton want "to incorporate the valuation of a company's intangible and intellectual assets, such as high-quality products and services, motivated and skilled employees, responsive and predictable internal processes, and satisfied and loyal customers" (Kaplan and Norton 1996, 7). So "the Balanced Scorecard complements financial measures of past performance with measures of the drivers of future performance. The objectives and measures of the scorecard are derived from an organization's vision and strategy" (Kaplan and Norton 1996, 8). Therefore, in all four key perspectives (see figure 1), the balanced scorecard consists of an appropriate, consistent, and balanced set of key performance indicators. Taken together, the indicators show whether companies and their subunits have improved their performance across a range of activities and outcomes (see Schaltegger and Burritt 2000, 151).

The balanced scorecard is more than a collection of distinct indicators, grouped by four perspectives. The causal relationships between different domains of management are represented by so-called *strategy maps* (see Kaplan and Norton 2001, 68, 131; Kaplan and Norton 2004). The strategy maps link together several domains and elements of the strategy in the four key perspectives. These linkages visualize hypotheses about cause-and-effect relationships and are based on the principle of cause and effect and on the paradigm of instrumental rationality in particular (see Kaplan and Norton 1996).

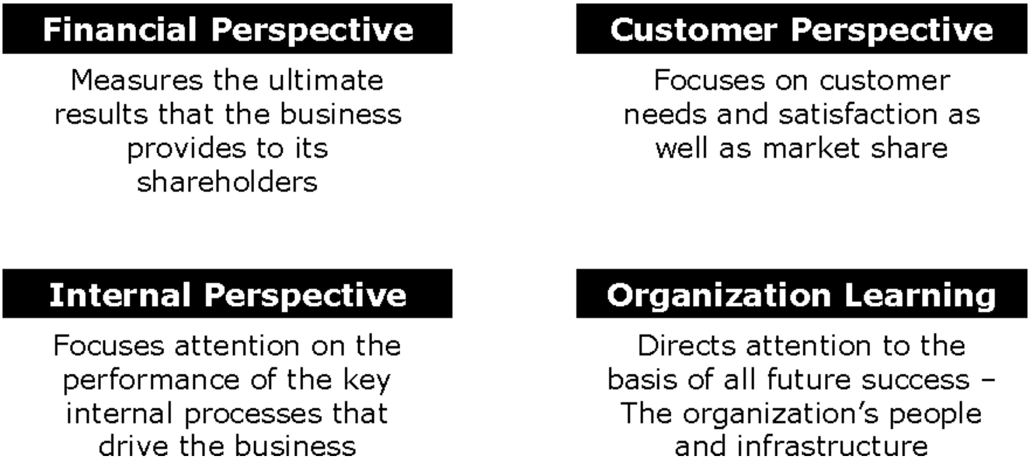

Figure 1 The four perspectives of the balanced scorecard. *Source:* Kaplan and Norton 1996.

Strategy maps are the result of almost ten years of experience with balanced scorecards. In their first books, Kaplan and Norton mention cause-and-effect chains on a few pages (see Kaplan and Norton 1996). Eight years later they write, "We now realize that the strategy map, a visual representation of the cause-and-effect relationships among the components of an organization's strategy, is as big an insight to executives as the Balanced Scorecard itself" (Kaplan and Norton 2004, 9). Strategy maps play a prominent role in strategy formulation and strategy implementation. By means of strategy maps the balanced scorecard becomes the starting point for a modeling process.

One main task in the modeling process, therefore, is the development and design of strategy maps (see figure 2). In fact, no two companies develop the same strategy maps. But some strategy maps have similar structures. One typical pattern of conventional balanced scorecards for private-sector organizations shows the cause-and-effect linkages between the learning and growth perspective, internal perspective, customer perspective, and financial perspective (see Kaplan and Norton 1996, 2004). Refinements of this highly aggregated design pattern are presented normally by case studies in different business sectors. The case studies sample sector-related reference models. Other companies can customize the reference models to implement balanced scorecards and strategy maps in their individual organizations.

Sustainability Balanced Scorecard

Kaplan and Norton assume that prominent performance measures such as Return on Investment are the ultimate indicators in the strategy maps and balanced scorecards. The term "balanced" refers to a "balance between external measures for shareholders and customers, and internal measures of critical business processes, innovation, and learning and growth. The measures are balanced between the outcome measures—the results from past efforts—and the measures that drive future performance. And the scorecard is balanced between objective, easily quantified outcome measures and subjective, somewhat judgmental, performance drivers of the outcome measures" (Kaplan and Norton 1996, 10; see also Epstein and Birchard 1999, 95). Furthermore, the balanced scorecard allows making a balance between past- and future-oriented, quantitative and nonquantitative, and financial and nonfinancial information (see Schaltegger and Dyllick 2002, 28f.). In spite of the fact that the conventional balanced scorecard considers nonfinancial and nonquantitative issues, which characterize many ecological and sustainability aspects, it basically does not explicitly distinguish and balance

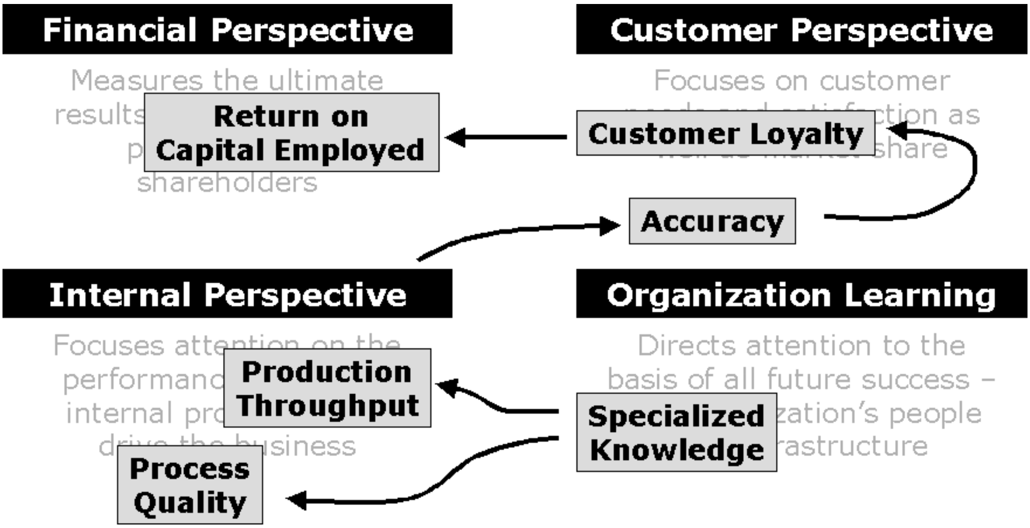

Figure 2 The strategy map as a "sequence of hypotheses about the cause-and-effect relationship between outcome measures and the performance drivers of those outcomes" (Kaplan and Norton 1996, 31; Kaplan and Norton 2004) in the four perspectives.

different stakeholder interests, eco-efficiency and sustainability issues, and derived strategic goals. Fortunately, the balanced scorecard is an open system: "All stakeholder interests, when they are vital for the success of the business unit's strategy, can be incorporated in a Balanced Scorecard" (Kaplan and Norton 1996, 35).

In the case of corporate sustainability it is obvious to reflect on connections between sustainable development and an enhanced balance scorecard. From an environmental perspective, one advantage of balanced scorecards is that they show the relationship between long-term resources and capabilities, including sustainability issues, and short-term financial outcomes. The cause-and-effect chains with sustainability-related resources, capabilities, and activities involved should not comprise only environmentally indicated costs, but rather all direct and indirect outcomes. The interpretation of the term "balanced" in that case is extended to the intentions and objectives of corporate sustainability. Balanced scorecards containing such enhancements can be referred to as sustainability balanced scorecards (SBSC).

The balanced scorecard can incorporate sustainability issues in different ways. One way is to restructure the existing perspectives; another is to add a new key perspective. In the first case, the arrangement of the four perspectives is not modified. Research and case studies have shown that this approach allows incorporating all sustainability issues that have direct relevance to one market, that is, the financial market, the customer market, the supplier market, or the labor market. Using the four perspectives of the conventional balanced scorecard increases acceptance of the enhancements. Nevertheless, users of conventional balanced scorecards have to revamp their strategy maps and indicators. In that case the financial perspective describes the outcomes not only in conventional financial terms but also in terms of the market relevant corporate sustainability issues. Adequate indicators represent the starting point for thinking through related performance drivers in the other perspectives, so that the sustainability balanced scorecard can be implemented in an evolutionary process starting with conventional design patterns (Hahn and Wagner 2001).

Indeed, the purpose of such a process is not simply to add some new indicators. Starting from a reconsidered vision, new design patterns are required. These design patterns should incorporate, in particular, requirements of corporate sustainability. Orientation guides include, for example,

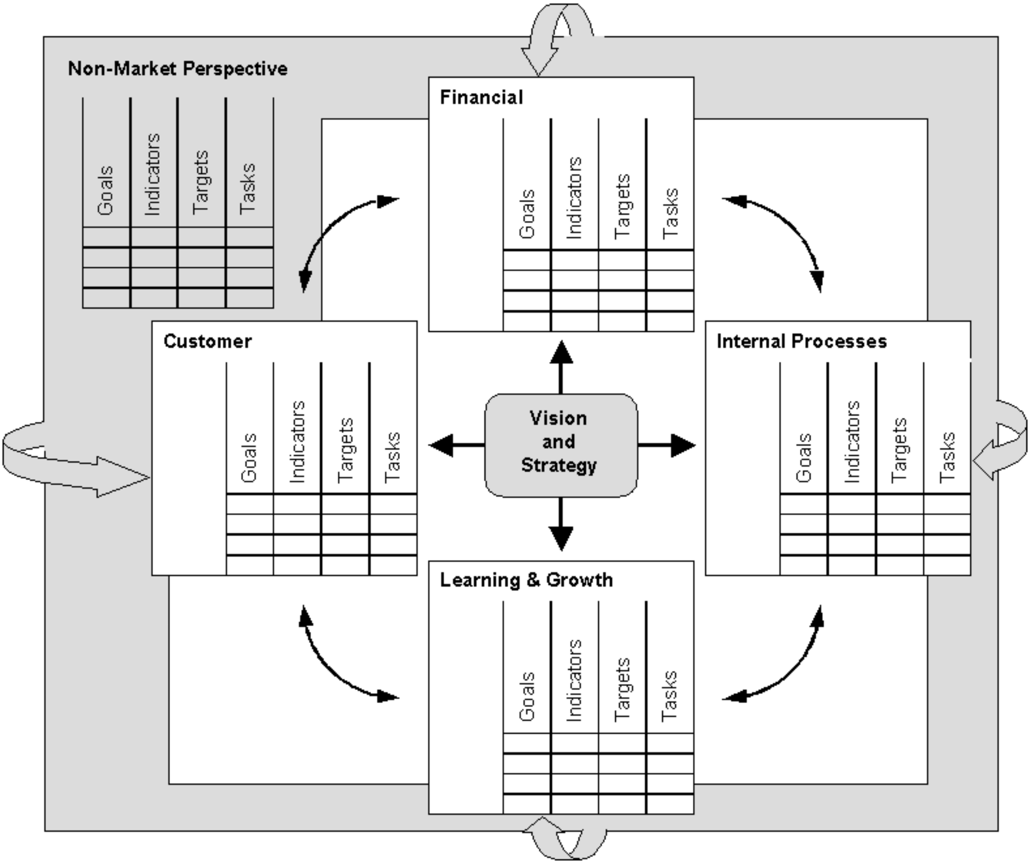

Figure 3 Balanced scorecard enhanced by a nonmarket perspective (Figge et al. 2002).

publications, guidelines, and international initiatives for the "greening" of industries. Often these texts contain appropriate visions and metaphors that can guide the strategy map development. For instance, Romm uses the term "Cool Companies" to draw a picture of prosperous companies whose success is based on cutting greenhouse gas emissions (see Romm 1999).

Sometimes it makes sense to expand the balanced scorecard with a new nonmarket perspective (Figge et al. 2002); see figure 3. The nonmarket perspective complements all four conventional perspectives by nonmarket issues that are not covered in the conventional four perspectives (e.g., social pressure of neighbors or due to child labor at subcontractors). The nonmarket perspective is drawn as a basic layer in figure 3 because societal issues constitute the framework of market operations with the financial community, customers, suppliers, and employees. The expanded sustainability balanced scorecard allows well-defined consideration of nonfinancial outcomes of a business. Consequently, the nonmarket perspective does not incorporate all sustainability-oriented objectives and indicators of the business, but only nonmarket issues that cannot be covered in the conventional perspectives.

Regardless of the way that is chosen, such balanced scorecards and associated strategy maps constitute an open framework that comprises sustainability-oriented indicators as key performance indicators in the balanced scorecard.

Sustainability Balanced Scorecard and Eco-efficiency Analysis

With the inclusion of sustainability-related resources, capabilities, and activities, the sustainability balanced scorecard requires entirely new data. For example, when it comes to getting process engineers to reduce specific process emissions, there is no one-stop source of information. The parameters of such a ratio between desired process output and correspondent process emissions cannot be expressed in monetary terms only. This leads to an important question: what are the key measures and parameters describing efficiency with regard to environmental protection and sustainability?

In general, efficiency expresses a relationship between positive and negative effects of a decision. Efficiency is not bound to the financial or technological dimension: different dimensions such as the economic and ecological dimension can be combined (see Schaltegger and Burritt 2000, 50). Negative effects in the ecological dimension include all negative impacts on the environment, whereas net profit is often used to indicate economic value creation. Eco-efficiency can be interpreted as the ratio, or a causal relationship, between economic value creation and environmental impact added (see Schaltegger and Sturm 1990, 279ff.). Economic value added and environmental impact added can occur at different points in time. To prevent distortions in eco-efficiency analysis, these time issues should be considered carefully (see, e.g., Schaltegger and Burritt 2000, 309ff., 361ff.).

Eco-efficiency analysis (Ilinitch and Schaltegger 1995; Saling et al. 2002) is not restricted to direct positive effects (see Eichhorn 2000, 140) or specific outcomes such as products or services. Guidelines for measuring corporate eco-efficiency, though, are mainly focused on goods and services produced by a company (e.g., WBCSD 2000). In this case the sales revenues are used to indicate the economic outcome. This kind of eco-efficiency can be called product eco-efficiency (see Schaltegger et al. 2003, 64). With regard to balanced scorecards and strategy maps, the interpretation of eco-efficiency as product eco-efficiency seems to be insufficient. Two adjustments concerning integration into balanced scorecards are deemed reasonable. First, economic value creation is not limited to net profit or sales revenues in the financial dimension. In the broader sense economic value creation also comprises all required resources and capabilities of the business. All financial and nonfinancial variables in the balanced scorecard, such as specialized knowledge or process quality, should be taken into consideration. Second, it is not necessary to incorporate indirect economic outcomes into the eco-efficiency analysis. This is a basic function of balanced scorecards and strategy maps, respectively. Consequently, the main focus of eco-efficiency analysis is directed at environmental impacts as the denominator in an eco-efficiency ratio.

Estimating the environmental impacts of decisions and activities requires appropriate modeling techniques. Life-cycle assessment is such a modeling approach. The process of developing a balanced scorecard—also a modeling process—serves to “translate” the business strategy into operational activities (Kaplan and Norton 1996). The balanced scorecard process thus deducts the operational business purposes and environmental goals from the company’s strategy. This, in turn, is the basis for defining functional units and system boundaries in the life-cycle assessment. Indicators that stand for environmental impacts are calculated in two steps: life-cycle inventory and life-cycle impact assessment. Life-cycle inventory addresses cause-and-effect chains in material and energy flow networks that correspond to the life of a product, process, resource, capability, or activity. These cause-and-effect chains include material and energy flows and transformations outside the boundaries of the company because major environmental impacts occur as external effects. “Consequently, internal company information has to be supplemented by data on the environmental impacts of the pre-life-cycle steps and the post-life-cycle steps outside the corporate accounting entity” (Schaltegger and Burritt 2000, 242).

For strategic management it is not necessary to perform a comprehensive life-cycle assessment to estimate the environmental impact and to compute eco-efficiency indicators. The specification of the diffuse term *environmental impact* arises from strategic goals, mainly in the nonmarket perspective. For example, one target in the nonmarket perspective could be to reduce the contribution of the business to climate change. Another concern could be to counteract migration into cities in the region where the company resides. So the balanced scorecard facilitates

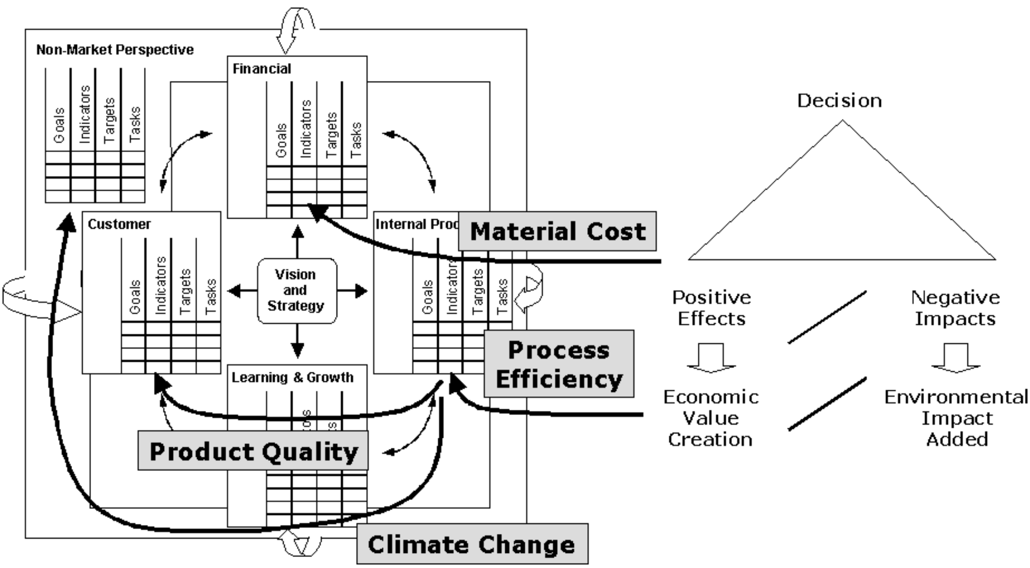

Figure 4 Eco-efficiency indicators embedded into a strategy map, resp. balanced scorecard.

the strategically relevant cost-effective application of life-cycle thinking in companies. (See figure 4.)

As a framework, the sustainability balanced scorecard specifies subsequent information management, data collection, and modeling steps. From this point of view eco-efficiency analysis is an instrument for estimating and controlling the appropriate key performance indicators for two major aspects of sustainability, namely the environmental and economic issues. Moreover, eco-efficiency analysis can be considered a bridge between the balanced scorecard and environmental management information systems, which rely on material and energy flow analysis and life-cycle assessment approaches.

Environmental Information Systems

The terms *environmental information system* and *environmental management information system* refer "to organizational-technical systems for systematically obtaining, processing, and making environmentally relevant information available in companies. Above all, these systems aid in determining the environmental damage caused by companies and designing support measures to avoid and reduce it" (Page and Rautenstrauch 2001, 5; see also Hilty and Rautenstrauch 1997, 21). Environmental information systems support eco-efficiency analysis by providing the informational basis for it (Ilinitch and Schaltegger 1995). An environmental information system thus integrates corporate environmental accounting and ecological accounting.

Corporate environmental information systems are not restricted to considerations of eco-efficiency issues (see Haasis et al. 1995). The measurement of eco-efficiency-oriented information for the support of sustainability balanced scorecards can be one main purpose and a suitable concept for a computer-based environmental information system. Consequently, the main analysis steps (life-cycle inventory and life-cycle impact assessment) play a prominent role in those systems. It is necessary to have a look at the dependencies concerning eco-efficiency analysis and life-cycle assessment on the one hand and corporate environmental accounting and computer-based corporate environmental information processing on the other hand.

As described, life-cycle inventories are based on cause-and-effect chains in material and energy flow networks. One consequence is that the input-output relationships of material and energy transformations in those flowcharts have to be described in a linear manner, because the

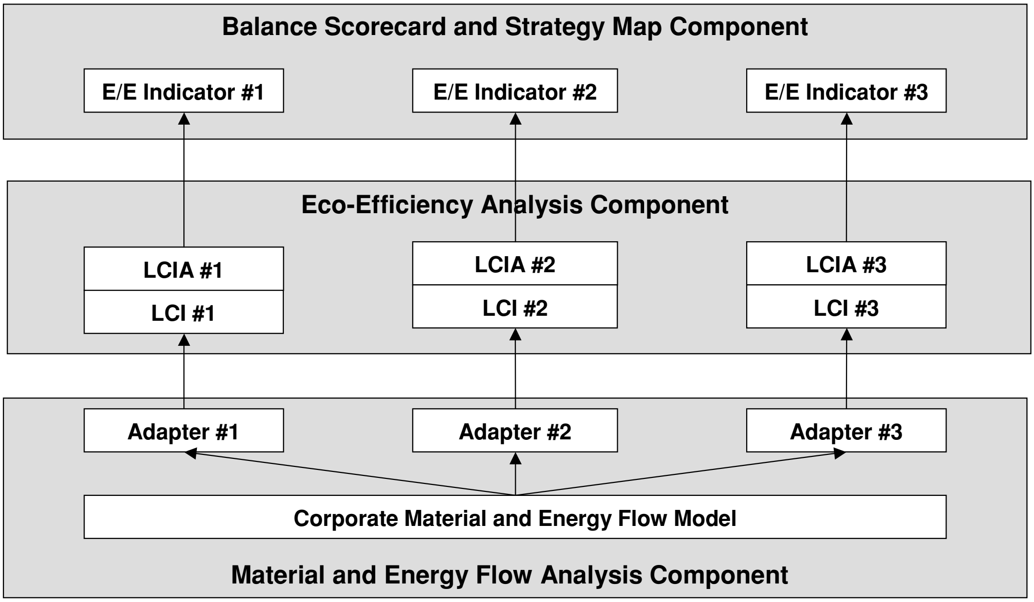

Figure 5 Components of an environmental information system (including a balanced scorecard component). LCI = life-cycle inventory, LCIA = life-cycle impact assessment, E/E = eco-efficiency.

quantitative occurrences of the transformations are scaled to the reference flows and functional units (in fact, the quantitative contributions from the transformations are the results of linear systems of equations that describe the flowcharts in a mathematical manner; see Heijungs 1994). Another consequence is the necessity of applying allocation rules for joint productions. But most important, it is relevant for environmental information systems that cause-and-effect chains in life-cycle inventories are always related to single functional units. Therefore, based on the company's corporate material and energy flow model, individual life-cycle inventories would be deduced for each eco-efficiency indicator incorporated into the sustainability balanced scorecard (see eco-efficiency analysis components in figure 5). In practice, however, it is not possible to establish an environmental accounting system for each eco-efficiency indicator. It seems to be reasonable to think about life-cycle inventories as eco-efficiency oriented analyses of joint material and energy flow models. Computer-based corporate environmental accounting systems have to provide material and energy models that can be analyzed in different ways.

The need is quite evident to distinguish three different components or layers in a computer-based environmental information system: a sustainability balanced scorecard component at the top level, a corporate environmental accounting component that contains joint material and energy flow models, and an eco-efficiency analysis component as a link (see figure 5). This eco-efficiency component can contain multiple instances of eco-efficiency indicators. These instances are linked to the joint material and energy flow models via adapters. In these adapters the life-cycle inventories are calculated using the material and energy flows of the database as fundamental data input. The corresponding calculation steps within the adapters are

- Interpretation of the input and output flows of the processes in the material and energy flow model as production coefficients;
- Identification of the reference flows of all processes: process output of goods and/or process input of waste (for details see Möller 2000);
- Decomposition of joint processes by applying allocation rules so that we get "single processes" (Heijungs 1994);

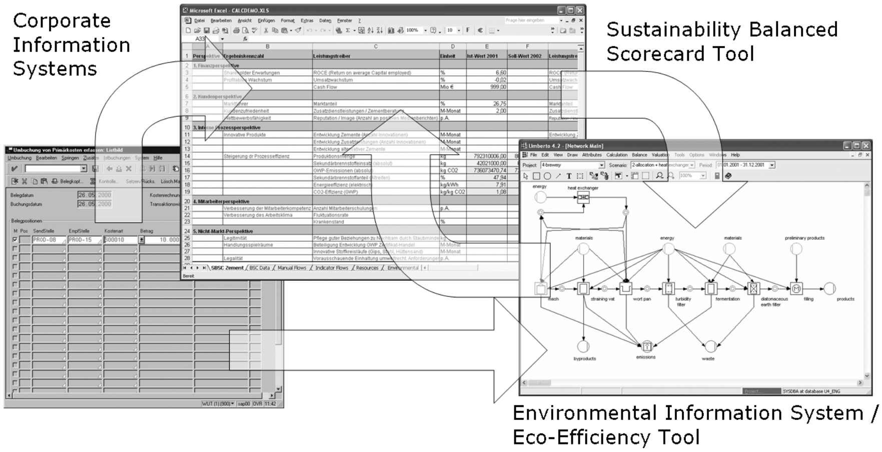

Figure 6 Data flow between software components of an environmental information system.

- Compilation of the process matrix relative to the eco-indicator and the accordant system reference flow;
- Application of the matrix method (see Heijungs 1994) to calculate the contributions from all processes.

Whereas the models in the corporate environmental accounting component represent the material and energy flows in a system for specific time periods (e.g., fiscal years), the adapters determine the functional-unit-oriented material and energy flows. They bridge life-cycle assessment methods and period-oriented material flow analysis concepts, as shown in figure 6.

Although the corporate environmental accounting component can be characterized as a database, nevertheless the balance scorecard, the strategy maps, and the eco-efficiency indicators constitute the models of this component. All goals and indicators together determine the coverage of the material and energy flow models. Additional data sources, such as other corporate information systems, ERP systems (enterprise resource planning systems; see Lee et al. 2003), or data warehouses can be used.

Conclusions

This article addresses three different levels of modeling and decision support. At the lowest level, computer-based environmental accounting systems deal with material and energy flows and transformations inside and outside the boundaries of a company. The main focus is on the relationship between planned or realized process levels and the resulting material and energy flows. Environmental accounting systems incorporate all material and energy flows and stocks regardless of single targets and indicators. In this manner, environmental accounting systems constitute a database of subsequent analyses.

At the middle level, eco-efficiency analysis is concerned with the causal relationship between economic value creation and environmental impact added. Life-cycle inventories and life-cycle impact assessment serve as a link to the top level eco-efficiency indicators, which are utilized mainly to represent and to assess the corresponding environmental impacts of corporate decisions and activities.

The top level focuses on the relationship between different requirements, goals, activities, resources, and capabilities. Here the principle follows the paradigm of instrumental rationality.[1]

These levels are linked together by interfaces. Eco-efficiency analysis can be interpreted as such an interface for environmental and economic issues as two major aspects of sustainability. It brings together different modeling processes and activities. Depending on the point of view, eco-efficiency analysis interfaces sustainability balanced scorecards and life-cycle assessment or serves as a bridge between sustainability balanced scorecard and corporate environmental accounting systems.

Moreover, the sustainability balanced scorecard helps to link the pillars of sustainability, because the sustainability balanced scorecard involves social issues as well (triple bottom line). It is not necessary to expand eco-efficiency analysis and accordingly the accounting systems. They are designed as environmental-specific components in the corporate information system.

Note

1. Instrumental rationality is a special interpretation of the principle of cause and effect reflecting the means-ends relationship and the identity principle. For more on this term, please see the book by Collins (1985) on Max Weber and the one by Riebel (1990) on direct costing.

References

Boseman, G. and A. Phatak. 1989. *Strategic management—Text and cases*. Second edition. New York: Wiley.

Collins, R. 1985. *Max Weber*. Thousand Oaks, CA: Sage Publications.

Drucker, P. F. 1999. *Management—Tasks, responsibilities, practices*. Oxford: Butterworth-Heinemann.

Eichhorn, P. 2000. *Prinzip Wirtschaftlichkeit* [The Efficiency Principle]. Second edition. Wiesbaden, Germany: Gabler.

Eilon, S. 1999. *Management strategies—A critique of theories and practices*. Norwell, MA: Kluwer Academic.

Epstein, M. J. and B. Birchard. 1999. *Counting what counts*. Reading, MA: Perseus Books.

Figge, F., T. Hahn, S. Schaltegger, and M. Wagner. 2002. The sustainability balanced scorecard. Linking sustainability management to business strategy. *Business Strategy and the Environment* 11(5): 269–284.

Grant, R. M. 1996. *Contemporary strategy analysis*. Second edition. Cambridge, MA: Blackwell.

Hahn, T. and M. Wagner. 2001. *Sustainability balanced scorecard. Von der Theorie zur Umsetzung* [Sustainability Balanced Scorecard. From Theory to Implementation]. Lüneburg, Germany: CSM (Centre for Sustainability Management).

Haasis, H.-D., L. M. Hilty, H. Kürzl and C. Rautenstrauch. 1995. Anforderungen an Betriebliche Umweltinformations-systeme (BUIS) und Ansätze zur Realisierung [Requirements to Environmental Management Information Systems (EMIS) and Implementation Approaches]. In *Betriebliche Umweltinformationssysteme (BUIS)* [Environmental Management Information Systems (EMIS)], edited by H.-D. Haasis et al. Marburg, Germany: Metropolis.

Heijungs, R. 1994. A generic method for the identification of options for cleaner products. *Ecological Economics* 10: 69–81.

Hilty, L. M. and C. Rautenstrauch. 1997. Environmental management information systems for production and recycling. *Proceedings of the 2nd International Symposium on Environmental Software Systems (ISESS)*, edited by R. Denzer. Whistler, British Columbia, Canada: 21–29.

Ilinitch, A. and S. Schaltegger. 1995. Developing a green business portfolio. *Long Range Planning* 28(2): 29–37.

Kaplan, R. and D. Norton. 1996. *The strategy-focused organization: How balanced scorecard companies thrive in the new business environment*. Boston: Harvard Business School Press.

Kaplan, R. and D. Norton. 2001. *The balanced scorecard: Translating strategy into action*. Boston: Harvard Business School Press.

Kaplan, R. and D. Norton. 2004. *Strategy maps: Converting intangible assets into tangible outcomes*. Boston: Harvard Business School Press.

Lee, J., K. Siau, and S. Hong. 2003. Enterprise integration with ERP and EAI. *Communications of the ACM* 46(2): 54–60.

Möller, A. 2000. *Grundlagen stoffstrombasierter Betrieblicher Umweltinformationssysteme* [Foundations of Material and Energy Flow based Environmental Management Information Systems]. Bochum, Germany: Projekt-Verlag.

Page, B. and C. Rautenstrauch. 2001. Environmental informatics—Methods, tools and applications in environmental information processing. In *Environmental information systems in industry and public administration*, edited by C. Rautenstrauch and S. Patig. Hershey, PA: Idea Group.

Riebel, P. 1990. *Einzelkosten- und Deckungsbeitragsrechnung* [Direct Costing]. 6. Edition. Wiesbaden, Germany: Westdeutscher Verlag.

Romm, J. J. 1999. *Cool companies—How the best businesses boost profits and productivity by cutting greenhouse gas emissions*. London: Earthscan.

Saling, P., A. Kicherer, B. Dittrich-Krämer, R. Wittlinger, W. Zombik, I. Schmidt, W. Schott and S. Schmidt. 2002. Eco-efficiency analysis by BASF: The method. *International Journal of Life Cycle Assessment* 7(4): 203–218.

Schaltegger, S. and R. Burritt. 2000. *Contemporary environmental accounting—Issues, concepts and practice*. Sheffield, UK: Greenleaf.

Schaltegger, S., R. Burritt, and H. Petersen. 2003. *An introduction to corporate environmental management—Striving for sustainability*. Sheffield, UK: Greenleaf.

Schaltegger, S. and T. Dyllick, eds. 2002. *Nachhaltig managen mit der Balanced Scorecard* [Sustainability Management Using the Balanced Scorecard]. Wiesbaden, Germany: Gabler.

Schaltegger, S. and A. Sturm. 1990. Ökologische Rationalität [Ecological Rationality]. *Die Unternehmung* 4: 273–290.

WBCSD (World Business Council for Sustainable Development). 2000. *Measuring eco-efficiency—A guide to reporting company performance*. Conches-Geneva, Switzerland: WBCSD.

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