

# **“GREEN” PERFORMANCE MEASUREMENT**

**By**

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**ABSTRACT** This paper tries to: (1) Demonstrate that environmental impact constitutes part of an enterprise’s competitiveness. (2) Convince the reader of the necessity for monitoring environmental impact. (3) Outlining how an enterprise can design a green performance measurement system. Argumentation on the importance of environmental friendliness as a source for competitiveness is based on general trends in society. This is followed by an overview of the development of modern performance measurement systems, showing that while these have started to also incorporate the environmental dimension, it has not been covered well enough. Simultaneously, a number of references show that there is a clear need for environmental monitoring, both at a national and enterprise level. The suggested green performance measurement approach is based on measurements at three levels, strategic, tactical, and operational. For each of these, performance indicators are suggested that should help an enterprise advance in the right direction.

**KEYWORDS** Performance measurement, environmental impact, competitiveness

## **1 INTRODUCTION - THE ENVIRONMENT AND COMPETITIVENESS**

What makes an enterprise competitive? Which areas of an organization’s operations and which attributes of these contribute to competitive advantage? This is a highly complex question that scientists and practitioners have attempted to answer during the last decades. The objective of this paper is not to provide a general answer to this question. Rather, we aim to demonstrate that one important area has often been neglected. Take, for instance, one example of some alleged areas possibly producing competitive advantage, as presented by Todd (1995):

- Product design and performance.
- Quality and reliability.
- Least manufacturing costs.
- The ability for innovation.
- Shorter lead times and more reliable delivery performance.
- Superior customer service.

This list, along with many similar ones proposed by a number of distinguished authors, emphasize aspects like quality, customer service, low costs, short lead times, etc. as key enablers for competitive advantage. The problem is, times change, and with them, sources for a competitive edge. Very rarely have we seen researchers working on theories of competitiveness that have mentioned environmental friendliness as a source for an advantage over competitors.

However, environmental awareness is probably the singular topic in which general public interest is growing most rapidly, especially in the industrialized countries. Simply from looking at traits of today concerning this issue, we can easily infer what level of importance the average human being attaches to the aspect of environmental impact brought about by a company. Some trends that can be clearly seen these days are:

- The number of members/financial contributors of various environmental preservation societies and associations is increasing dramatically.
- Furthermore, while members of such institutions used to be individuals placed well on the left hand side in terms of political preferences, and especially younger such people, people from all ages and walks of life are drawn to these organizations.
- The amount of legislation related to environmental protection has exploded during the last years, both nationally and at a super-national level, i.e., EU, UN, etc.
- The number of recycling and reuse schemes, both in industry and privately, is on the rise, and most people engage in one or more such programs.
- Unnatural climatic effects suspected to stem from pollution have increased and receive much media attention, e.g., global warming, El Niño, etc.

What consequences do these developments have on the individual enterprise and the ways in which it seeks to achieve competitiveness? Simplified, we could say that the effects materialize at two main levels:

- ❶ Failure to comply with existing legislation can lead to economic penalties in terms of fees and fines. These will impact competitiveness through giving increased costs, which in terms must be recovered through higher prices or suffering lower profitability.
- ❷ Much more important, the ever more conscious customer wants environmentally sound products and has an amazing ability to discover any conduct of the enterprise that contributes to damaging the environment. A high number of these customers, and the number is increasing, demand clean products and are even willing to pay more, accept less comfort or features, or wait longer if this is believed to be more beneficial to the environment.

This means that it is becoming increasingly more important for an enterprise to be able to manage its operations in a way that minimizes the negative environmental impact they might result in, directly or indirectly. At the same time, it is a fact that you cannot manage what you cannot measure (Rolstadås, 1994). Thus, performance measurement is a key element in enabling performance management, performance improvement, performance documentation, etc. When combining the pivotal importance of environmental friendliness with the need for performance measurement, it is evident that “green performance measurement” is crucial and something every enterprise should master. Throughout this paper, we will explore how traditional performance measurement systems can be adapted and developed into green performance measurement systems.

## **2 THE NEED FOR GREEN PERFORMANCE MEASUREMENT**

The environment became an international issue in 1972, with the UN Conference on the Human Environment, held in Stockholm. However, in the following years, only limited results were achieved in making the environment part of national development plans and decision-making (Earth Summit+5, 1997).

The United Nations set up the World Commission on Environment and Development, headed by Gro Harlem Brundtland, Prime Minister of Norway, as an independent body in 1983. The purpose of the Commission was to re-examine the critical environment and development problems on the planet and to formulate realistic proposals to solve them, and to ensure that human progress would be sustained through development without bankrupting the resources of the future generations. The Commission's book, *Our Common Future*, was an important milestone in the public's focus on the environment. In this book, the Commission advocates a holistic view on the extended environment (Brundtland, 1987): "Until recently, the planet was a large world in which human activities and their effects were neatly compartmentalized within nations, within sectors (energy, agriculture, trade), and within broad areas of concern (environmental, economic, social). These compartments have begun to dissolve. This applies in particular to the various global "crises" that have seized public concern, particularly over the past decade. These are not separate crises: an environmental crisis, a development crisis, and energy crisis. They are one".

As a result of the Brundtland report (1987), the UN General Assembly convened the UN Conference on Environment and Development (UNCED). The Conference, known as the Earth Summit, took place in Rio de Janeiro in 1992. It was a turning point in international negotiations on issues of environment and development (Earth Summit+5, 1997). The primary goal of the Summit was to find an equitable balance between the economic, social, and environmental needs of present and future generations. Furthermore, to lay the foundation for a global partnership between developed and developing countries as well as between governments and sectors of civil society based on common understanding of shared needs and interests. In Rio, 172 Governments, including 108 Heads of State or Government, adopted three major agreements to guide future work:

- ❶ Agenda 21, a global plan of action to promote sustainable development.
- ❷ The Rio Declaration on Environment and Development, a set of principles defining the rights and obligations of States.
- ❸ A Statement of Forest Principles, to guide more sustainable management of the world's forests

As stated earlier, one should view the environment in a holistic manner. However, the means for obtaining a better environment is different from international and national levels to businesses and the public. We will first focus on the international and national level, then at the business level.

Why do we need green performance measurement systems? The Commission on Sustainable Development (1995) talks about the need for environmental resource accounting at the national level: "...often referred to as "green accounting", stems from the failure of conventional systems of national accounts to take into consideration the services rendered by environmental resources (such as the sink function of forests), their depletion and the damages to the national ecosystems." The Commission on Sustainable Development (1995) further argues that resources and ecosystems that have until recently been regarded as free goods need to be given economic or monetary value, and that the traditional underpricing of resources has contributed to the wasteful and inefficient production and consumption of resources. One basis for such a system is that the polluter pays.

The Commission on Sustainable Development (1995) further talks about the various instruments governments have to bring about changes in production and consumption patterns: “These include legislation and standards (command-and-control measures), fiscal and pricing policies (economic instruments), education and awareness campaigns (social instruments), public expenditures on complementary facilities and infrastructure, and technology policies. Often, these measures are pursued together to achieve enhanced effectiveness.” The Commission on Sustainable Development concludes that “Environmental monitoring data and other relevant information, including consumer information, which are currently lacking in many developing countries, need to be developed urgently so as to provide a sound information base for policy formulation and decision-making on changing the current unsustainable production and consumption patterns.” The need for green performance measurement at the national level has thus been established.

If we look to the business environment, the Commission on Sustainable Development (1998) argues: “...neglecting environmental and social costs of products and processes is a liability. Corporate stakeholders have expanded (e.g., regulators, pressure groups, insurance entities, and suppliers) and subsequently resulted in demands for broadening the depth and scope of environmental and social information and action. Businesses are now forced to respond to an expanding range of interests and devise mechanisms to meet the increasing demands of internal and external stakeholders.”

The Commission on Sustainable Development (1998) talks about environmental management systems (EMS): “A fully operationalized EMS consists of an integrated structure of production that involves every level of business activity. Like TQM, TQEM (total quality environmental management) incorporates a more statistical and philosophical perspective as well as a focus on alliances and a long-term outlook. Effective environmental management involves goal setting, information management, decision-making, support, piloting and control, communication, and internal and external auditing. TQEM, life cycle assessment (LCA), environmental accounting, environmental reporting, and environmental auditing are all tools to facilitate the above environmental management functions.”

An important part of the environmental management system is environmental accounting. Environmental accounting attempts to facilitate sustainable decision-making within a firm by improving the information system so that better choices are made in regard to social and environmental factors by, for example, including contingent liabilities like environmental induced financial costs and quantifying where possible with tools such as eco-efficiency. The Commission on Sustainable Development (1998) further quotes Schaltegger saying that "The quantitative measurements and the calculation of comparable numbers is, in the opinion of many business leaders as well as a large part of the scientific community, the only practical way to measure sustainable development". Finally, the Commission argues that to be successful, environmental accounting has to be integrated with the overall environmental management system. We would add that it also has to be an integrated part of the management and reporting system of the business as a whole.

Another emerging issue the last years has been the introduction of the ISO 14000 standard. ISO 14000 deals with environment management and is a group of standards covering the following areas:

- Environmental Management Systems (14001,14002, 14004).

- Environmental Auditing (14010, 14011, 14012).
- Evaluation of Environmental Performance (14031).
- Environmental Labeling (14020, 14021, 14022, 14023, 14024, 14025).
- Life-Cycle Assessment (14040, 14041, 14042, 14043).

As can be seen, being able to evaluate an organization's environmental performance is one important aspect of the standard. Lately, a similar rate of implementation of ISO 14000 has been seen as for ISO 9000, the quality management standard, when it took off some years ago.

Another argument for green performance management systems is that despite the growing environmental awareness, the majority of consumers still have little knowledge of the environmental impact of their consumption habits and lifestyles (The Commission on Sustainable Development, 1995). If a green performance management system could assist the customers in their decision making, this could be helpful. We thus conclude that there is a definite need for monitoring the environmental impact of our doings, both at a national and a business level. At both levels, such a system needs to be integrated with the overall management and reporting system. In the remainder of this paper we will focus on green performance measurement for the business level.

### **3 THE DEVELOPMENT OF PERFORMANCE MEASUREMENT SYSTEMS**

This part of the chapter presents a limited chronological history of performance measurement and different systems developed for this purpose.

#### **3.1 Sink and Tuttle**

One of the first approaches to performance measurement was published by Sink and Tuttle (Sink, 1985, Sink and Tuttle, 1989). The model claims that the performance of an organizational system is a complex interrelationship between the following seven criteria:

- ① Effectiveness, doing the right things, at the right time, with the right quality, etc. Defining the criterion as a ratio, effectiveness can be defined as Actual Output/Expected Output.
- ② Efficiency, this is an input and transformation process question, defined as Resources Expected to Be Consumed/Resources Actually Consumed.
- ③ Quality, where quality is an extremely wide concept. To make things more tangible, quality could be measured at six checkpoints: Upstream systems, inputs, the transformation value-adding process, outputs, downstream systems, and the quality management process.
- ④ Productivity, this is the traditional ratio of Output/Input, but it appears as just one of several criteria.
- ⑤ Quality of work life, one essential, but often forgotten element contributing to a well performing system.
- ⑥ Innovation, a key element in sustaining and improving performance.
- ⑦ Profitability or budgetability, the ultimate goal for any organization.

Sink and Tuttle (1989) urge companies to focus on the following four areas:

- ① Performance Improvement Planning.
- ② Performance Measurement and Evaluation.
- ③ Performance Improvement and Control.

#### ④ Cultural Support Systems.

A major objection to Sink and Tuttle's model is the almost total lack of environmental focus. None of the seven criteria are focused on the environment and neither is the underlying system.

### 3.2 TOPP

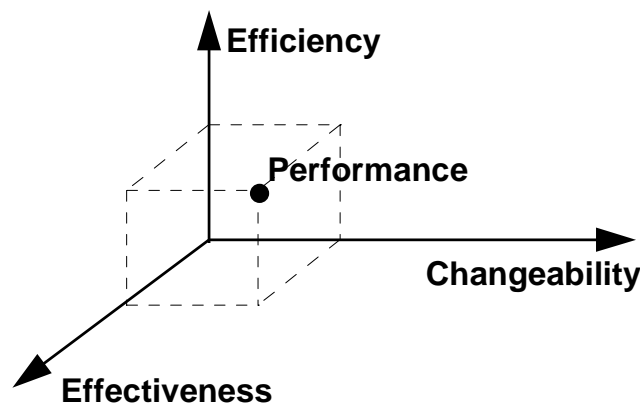
One example of a more recent performance measurement system is the TOPP system, which was developed by SINTEF (SINTEF, 1992) in Norway in partnership with the Norwegian Institute of Technology (NTH), the Norwegian Federation of Engineering Industries (TBL), and 56 participating enterprises. In TOPP, four methodologies were used:

- ① Self-audit (questionnaire).
- ② Extended audit (experts)
- ③ Self-assessment (continuous improvement, trends).
- ④ Benchmarking (breakthrough).

The TOPP system views performance along three dimensions (Moseng and Bredrup, 1993). These are illustrated

Figure 1.

- ① *Effectiveness* - satisfaction of customer needs.
- ② *Efficiency* - economic and optimal use of the enterprise's resources.
- ③ *Changeability* - strategic awareness to handle changes.



**Figure 1 Performance measurement along three dimensions**

A main concern in TOPP is the many surrounding factors that influence the productivity and competitiveness of a company. This is illustrated in the stakeholder model, see Figure 2. In the stakeholder model the environment is one of several factors influencing the company. Our experience is, however, that the environment is becoming one of the most important stakeholders in any company.

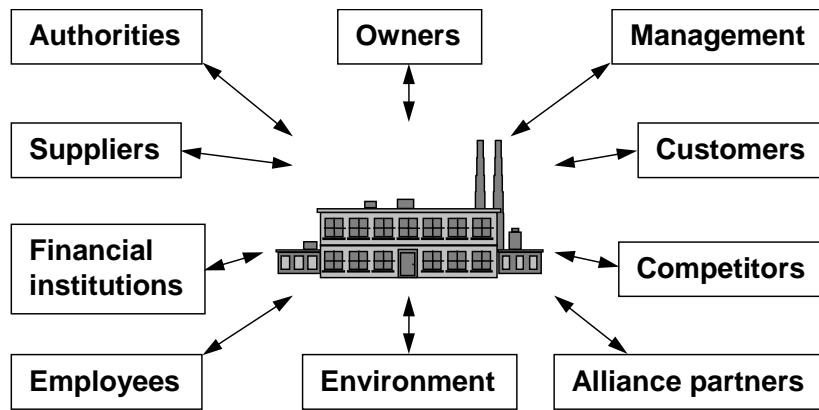
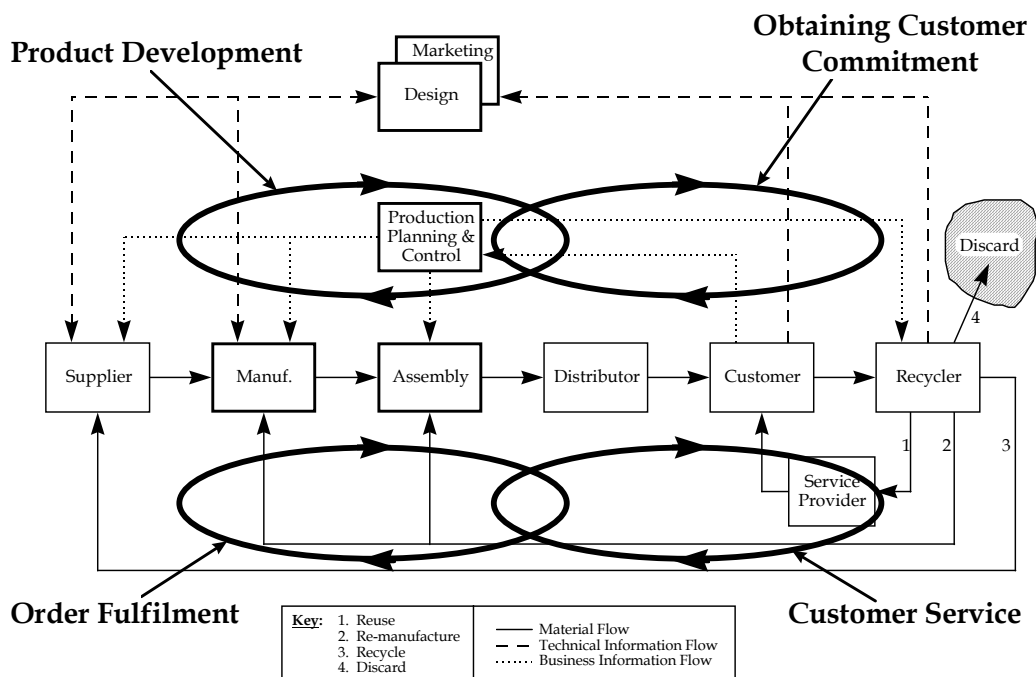


Figure 2 The stakeholder model

The environmental focus of the TOPP system is better than in Sink and Tuttle's model. In the questions for the Self-audit and the Extended audit, the environment is a major part. The environmental focus is not, however, truly integrated with the other aspects and areas as a holistic environmental measurement system should be.

### 3.3 ENAPS

Based on the other performance measurement systems and recent research, a new performance measurement system has been developed. This new performance measurement system is the ENAPS (European Network for Advanced Performance Studies) performance measurement system. Currently involved in the ENAPS project are five research partners (SINTEF, CIMRU, BIBA, GRAI, and TUE) and five industrial partners (TBL, AMT, Volkswagen, AUGRAI, and ITC) in Norway, Ireland, Germany, France, and The Netherlands respectively. ENAPS is currently under development, but a lot of work has already been carried out in the area of performance measurement. The ENAPS business model is shown in Figure 3 and reflects a future view of a manufacturing enterprise as it incorporates the end of life use of products.



### Figure 3 The extended ENAPS business model

The environment is an important dimension in the ENAPS system. The overall environmental focus of the company is one part, which includes what we could call “environmental choices”. In addition the life cycle of the products is emphasized, including reuse, recycling, and environmental impact of this. Finally, a number of environmental performance indicators have been developed at the operational level.

From this business model, ENAPS has suggested three levels of a hierarchy for defining performance indicators. These are “Enterprise Level”, “Process Level”, and “Function Level”. The performance measures used in calculating these performance indicators are measured from all over the enterprise under the following eight headings: “Accounts” (13 measures), “Product Development” (20 measures), “Marketing and Sales” (22 measures), “Planning and Production” (20 measures), “Customer Service” (8 measures), “Purchasing” (11 measures), “Personnel” (16 measures), and “Other” (7 measures). Currently, there are 117 performance measures (shown in Appendix A) used in calculating the performance indicators in the ENAPS performance measurement system.

The “Enterprise Level” performance indicators are very general indicators. They give an overview of the size and financial position of an enterprise. The “Process Level” performance indicators are used to determine the performance of the processes that are defined in the ENAPS framework. The ENAPS performance measurement system has identified two types of processes. These two processes are “Business Processes” and “Secondary Processes”, and are described below.

**Business Processes** are the value-adding processes involved in the creation and production of a product and its sale and transfer to a buyer. There are four of these:

- **Customer Service:** All activities involved in providing after-sales service, including product take-back.
- **Obtaining Customer Commitment:** All activities involved from market analysis to sales.
- **Order Fulfillment:** From receipt of an order until the customer has received and paid for the product.
- **Product Development:** All activities involved in researching, designing, engineering and releasing products to manufacturing.

**Secondary Processes** are the non-value adding processes of an enterprise. ENAPS has identified two groups of secondary processes and these are described below:

- **Support Processes:** are processes that support the business and evolution processes and each other, while providing the resources and infrastructure necessary to perform these processes, such as Financial Management and Human Resource Management.
- **Evolution Processes:** provide means for the enterprise to achieve its long-term strategic objectives through managing and planning the evolution of the enterprise and its environment, such as Human Resource Development and Strategic Planning.

Each of the six processes has a certain number of performance indicators assigned to them. Together with the 16 “Enterprise Level” indicators, there are currently 95 performance indicators in the ENAPS measurement framework.

The generic performance measures and indicators for each process and function were developed with the following six dimensions of measurement in mind:

- Time.
- Cost.
- Quality.
- Volume.
- Flexibility.
- Environmental impact.

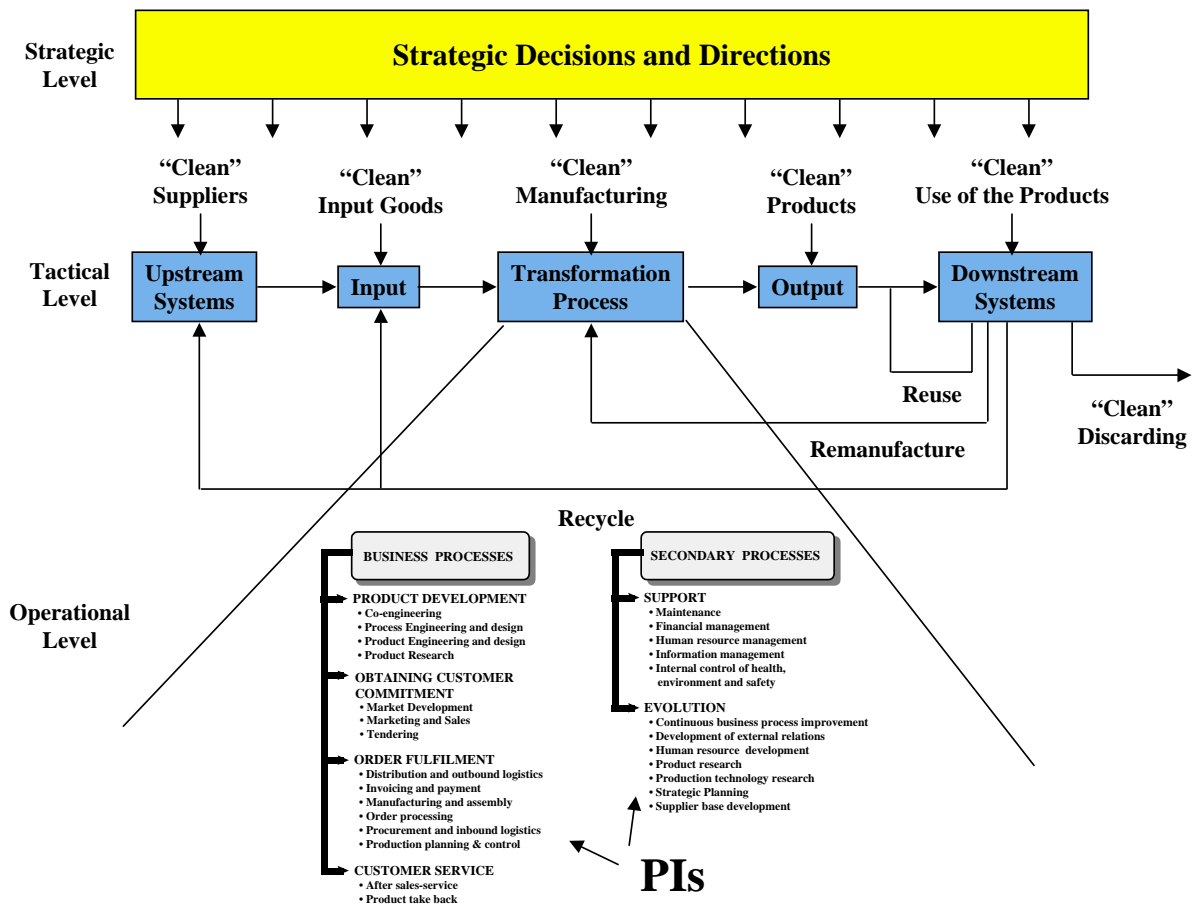
Thus, ENAPS puts much emphasis on the environmental dimension of performance, both through the general business model and the performance measure dimensions.

#### **4 AN APPROACH TO GREEN PERFORMANCE MEASUREMENT**

To develop an approach to green performance measurement, a model must be outlined that can separate the different levels at which performance measurement can be undertaken and also illustrate the areas that should be covered by green performance indicators. In general, performance measurement can occur at the traditional three levels:

- ❶ The strategic level, performance indicators that can tell an organization about the soundness of their strategic decisions. While these strategic decisions and directions they advocate impact the extent to which the organization operates in an environmentally friendly way, there generally tends to be fewer performance indicators at this level.
- ❷ The tactical level, which can be said to encompass issues like which suppliers are used, which overall manufacturing technologies are utilized, etc. As the performance indicators at the strategic level, these are important in setting boundaries for the actual operations of the organization.
- ❸ The operational level, measurement of the performance of the operations and business processes of the organization. This is by far the level in need of the highest number of performance indicators and which in practice determines the environmental impact of the company.

To provide such a holistic model of green performance measurement, we merged these levels, with more detailed interpretations of them, into the result shown in Figure 4. This, along with the performance indicator examples later on, is the most important contribution of this paper.



**Figure 4 The green performance measurement approach**

As can be seen, the strategic level encompasses the entire span of the tactical and operational levels and impacts these fully and generally. The tactical level is represented by a value system model as used by Sink and Tuttle (1989) to illustrate different performance dimensions. This value system model portrays a chain of links in the delivery system, from the supplier and the input goods delivered by the supplier, through the internal transformation processes of the enterprise in question, to out products from the enterprise and its customers. At this level, different extents of recycling and reuse of the products delivered by the enterprise have been defined. Finally, the operational level concerns itself with the core of the value system, the transformation processes taking place inside the enterprise being analyzed. Here, we have decided to use the ENAPS business process framework (Fagerhaug and Andersen, 1998) as the basis for developing green performance indicators.

This framework divided the entire set of business processes of an enterprise into three main categories:

- ❶ Business processes, the core of the value-adding activities of the organization. These have been further classified into four subsets, but these will not be defined in any detail here.
- ❷ Support processes, processes that are installed to aid and facilitate the business processes.
- ❸ Evolution processes, activities that will develop and improve the entire enterprise and its processes.

It should also be pointed out that many industries and enterprises are required by local authorities to undertake certain environmental measurements. Many of the parameters measured under these conditions are in fact quite sound and valid measurements also for performance measurement purposes. The problem with these measurements is the purpose and attitude toward them. Imposed measurements are often perceived as a burden that cost time and money to collect and that have a negative focus, on control, monitoring, and punishment for breaches. If such measurements are to be used in a positively directed performance measurement system, these attitudes must be changed.

The approach depicted in Figure 4 in fact represents a coherent framework for green performance measurement, as it defines the levels and areas that should be measured in order to ensure the achievement of an environmentally friendly existence of the enterprise. In the next section of the paper, examples of specific performance indicators are developed to allow enterprises to implement working green performance measurement systems.

## **5 GREEN PERFORMANCE INDICATORS**

A performance measurement system in general should cover enough levels, dimensions of performance, and areas or business processes of the enterprise to constitute a “rich” instrument panel that will give the “driver” or “pilot”, i.e., management, the necessary information to control the journey. At the same time, care should be exerted not to design the measurement system in a way that inundates management with an abundance of both useful and useless information. Thus, a balance must be achieved between sufficient coverage and sufficient focus. Furthermore, it is self-evident that the performance measurement system must be tailored to the individual enterprise’s characteristics and needs.

Therefore, we have chosen the following approach in this paper: To aid a specific enterprise in its efforts to design a performance measurement system monitoring its environmental soundness, we have suggested a set of example performance indicators covering all of the three levels outlined in Figure 4. This does not, however, mean that we advocate the use of all of these performance indicators at the same time. Rather, they represent a set of possible indicators from which the enterprise can choose when putting together those best suited to its needs. These will certainly also have to be supplemented by indicators so specific for that enterprise that they are not even included in our suggested set. Please also keep in mind that a performance measurement system is a dynamic entity that is supposed to change over time as the needs for measurement changes.

Thus, the following sections contain our suggestions for green performance indicators.

### ***5.1 Performance Indicators at the Strategic Level***

As previously mentioned, indicators at this level are usually few and for the purpose of direction setting. A few relevant indicators of this nature are:

- The existence of an environmental policy. Notice that by environment, we do not only think of nature and wildlife, the environment also includes quality of life in local communities.
- True environmental concern. This means not only an on-the-surface avoidance of potentially environmentally hazardous operations, but rather a state of mind where every day is made a struggle to minimize any negative impact on nature stemming from the company’s activities.

- Contributions to improvement of the environment. It is one thing to do everything a company can to avoid further damage to nature. A truly convincing environmental attitude is seen in organizations that go even further and try to find ways of repairing or improving damage already done.
- Presence in areas that are threatened by pollution, eradication of wildlife or vegetation, or deterioration of quality of life.

Again, these indicators are on a higher level and more intended as an attitude test than operational measurement.

## **5.2 Performance Indicators at the Tactical Level**

The indicators that we have suggested at this level focused mainly on the environmental performance of the actors in the supply chain of which the enterprise is a part. The core areas that should be covered are:

- Strategic choices made by the enterprise's suppliers, along the same lines as the indicators defined for the strategic level of the organization itself.
- Levels of waste, pollution, the use of energy, and the use of irreplaceable resources by the enterprise's supplier.
- Contents of harmful substances of the input goods purchased from the suppliers.
- Levels of waste, pollution, the use of energy, and the use of irreplaceable resources in the enterprise's own transformation processes. This topic is, however, the core focus of the performance indicators at the operational level.
- Contents of harmful substances of the output products delivered by the enterprise to the marketplace, either to the next tier of manufacturers or end customers.
- Levels of waste, pollution, the use of energy, and the use of irreplaceable resources in the use of these output products by the customers.
- To which degree the lifecycle perspective is maintained, not in the least by installing performance indicators that monitor and encourage reuse and recycling of the entire products and components and materials.
- Albeit difficult to measure, at this level, there should also be measures that evaluate the choices made and encourage making the right ones. It is not sufficient to measure and marginally improve the level of discharges from a manufacturing process if the enterprise had the option to initially use a different process that would have been more environmentally friendly, but would cost more.

## **5.3 Performance Indicators at the Operational Level**

As previously mentioned, the number of performance indicators will normally be highest at the operational level. At the same time, this is the level where the need to tailor the indicators to the specific situation is largest. Thus, instead of trying to define general indicators for every single business process, we have defined some key dimensions that should be kept in mind when developing specific indicators, and also given some examples of such indicators.

The main dimensions of performance at this level are:

- Amounts of waste produced by or in connection with the business process.
- Amount of polluting discharges to air, sea, and land generated by the business process.
- Amount of energy consumed by the business process.

- Amount of irreplaceable natural resources consumed by the business process.

Some examples of specific performance indicators are as follows:

- For the business process of product development:
  - Design for recycling = number of produced components recycled/total number of components produced.
  - Design for green manufacturing = number of design choices reducing the negative environmental impact of the product/total number of design choices.
- For the business process of obtaining customer commitment: Green product sales ratio = Sales of products that have received a green label/total sales.
- For the business process of order fulfillment:
  - Percentage scrap = cost of scrap material/purchased material cost.
  - Energy cost = cost of energy/sales.
  - Pollutants discharged = amount of pollutants discharged during manufacturing/sales.
  - CO<sub>2</sub> volume = m<sup>3</sup> of CO<sub>2</sub>/sales.
  - Resource consumption = amount of irreplaceable resources used in manufacturing/total amount of resources used in manufacturing.
  - Distribution efficiency = fuel used for product distribution/sales.
- For the business process of customer service: Product take-back ratio = number of products taken back for manufacturing or reuse/total number of products sold.
- For the secondary support processes:
  - Maintenance impact = scrap or pollutant generation due to poor maintenance/sales.
  - Paper consumption = weight of paper used by the enterprise/number of employees.

## 6 A CASE STUDY - FCS

FCS develops and manufactures flight control systems installed and used in airports all over the world. In addition, some components are also often installed in aircraft, either by the manufacturer of these or as additions opted for by the airlines. Almost every contract for airport installation is awarded through a process of tendering, and in as much as 90% of the cases, the customers are state-operated bodies.

Up to a few years ago, FCS did not undertake much measurement, neither traditional performance measurement nor any environmental measuring. However, during the last three years, a high number of their customers have laid down requirements for environmental impact information in the tendering documents. These include:

- Documentation of any environmental effects from use of the systems.
- Specifications of any discharges or other negative impact on the environment during manufacturing.
- For the latter issue, most organizations are not content with information pertaining to FCS' own manufacturing, but do also demand the same information for all sub-systems and components purchased by FCS.

As a result of these requirements, FCS started a process of implementing an EMS system, i.e., an environment management system. Through a systematic process of identifying potential hazard areas and stages in the development and manufacturing process that could result in discharges or pollution, as many as 167 measurement points were defined. To the extent possible, automated data collection was installed, but many of these also had to be

measured manually. For these, the frequency of measurement was often much lower than those that were automated.

However, the 167 indicators only covered FCS' internal operations, which to quite an extent consisted of assembly. It was believed, or rather known, that the major culprits with regard to environmental damage would be found inside the various manufacturing processes of the suppliers, especially those delivering electronic components and plastic containers. Installing environmental measures at these sites was a much more difficult process. Some suppliers did not want to be part of this approach, others felt it would be too time-consuming and costly, even though FCS made it clear that winning contracts without such documentation would be difficult. As this process dragged out, FCS actually experienced this, as tenders were turned down due to lacking documentation, especially inside the EU and in the US.

To overcome these obstacles, FCS had to replace some suppliers, negotiate single-source supply contracts with others, and in one case share the implementation costs of the measurement system. Today, the system is operational and captures almost all of the relevant environmental impact data. This information had enabled FCS to pinpoint and correct some sources for discharges, some of which seemed almost to exist out of coincidence. For example, one supplier used an oil-based paint containing high amounts of lead when coating the panels where the control systems were mounted. There was no evidence of any use of the systems requiring such wear-resistant paint, which also was more expensive than water-based paint, and it was changed to a much more environmentally friendly compound. All in all, about 60 such changes, smaller and larger, have been implemented, resulting in a much less damaging product and also a higher tender hit rate.

## **7 CONCLUSIONS**

In this paper, we have reviewed the trends in society as a whole regarding environmental concern and the consequences these trends imply when it comes to enterprises' performance in this respect. Our conclusion is that an enterprise's ability to undertake its operations in a way that does not damage the environment is a vital part of the enterprise's competitiveness. To be able to improve its environmental friendliness, an enterprise will require a performance measurement system that also covers this dimension. To aid enterprises in implementing such a system, we have outlined which levels and dimensions should be covered and also given some specific examples of performance indicators for green performance.

It is our hope that the enterprises of this world realize the importance of environmental friendly operations, both for the sake of the planet and for their own competitiveness, and start measuring their green performance.

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