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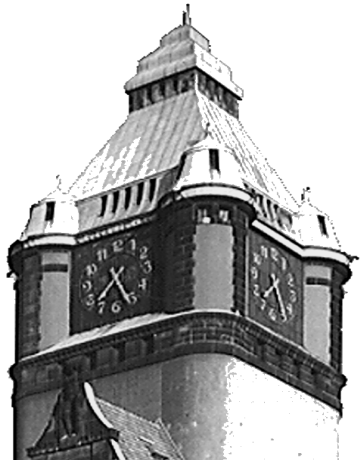
Environmental Performance Measurement

- Descriptive Assessment-

Edeltraud Günther, Anke Sturm



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Edeltraud Günther, Anke Sturm

ENVIRONMENTAL PERFORMANCE MEASUREMENT[1]

- Descriptive Assessment -

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[1] We would like to thank Ms Katrin Pönisch-Pörschke from the Language Centre of Dresden University of Technology and Stephan Schöps, who committed themselves greatly to the English translation of this paper.

1 Research Design

In the past, environmental management mainly focussed on the identification of ecologically oriented requirements made on enterprises by relevant stakeholders, on the development of related corporate strategies and also on the introduction of a corporate system of environmental management. Meanwhile, research shifted its focus onto the assessment of the actual results that are obtained with the introduction of an environmental management system as well as onto the determination of consistent criteria for the measurement, evaluation and assessment of these results (Environmental Performance Measurement (EPM)). These criteria will allow internal and also external benchmarking.[2]

The Chair of Business Management, especially Environmental Management at Dresden University of Technology has dedicated a research project to the question of measurement, evaluation and assessment of the environmental performance or the ecological success of an enterprise (Environmental Performance Measurement (EPM)). An ideal-typical model has been developed at the Chair for this purpose, which includes the following five steps:

1. Identification of the relevant stakeholders of the enterprise and – starting from these in order to satisfy the stakeholders‘ interests – determination of the goals that are to be obtained by using Environmental Performance Management.
2. It is necessary to measure, i.e. to record the environmental influencing factors[3] as the basis of the environmental performance or the ecological success. The influencing environmental factors are measured using the principle of ecological breakdown of ecological results (cf.
3. Fig. 5 below).
4. The known influencing environmental factors of the company have to be evaluated in order to make operational decisions concerning the environmental performance. As a result, the effects[4] the company has on the environment can be ascertained.
5. For the determination of the environmental performance or the ecological success it is necessary to compare the known actual values (company influence on the environment) with the target values (objectives of Environmental Performance Management) and to determine the degrees to which the objectives are achieved.

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2 Cf. GÜNTHER, E. / STURM, A. (2000).

3 Cf. ETTERLIN, G. / HÜRSCH, P. / TOPF, M. (1992), p. 19. Environmental influences are emissions, e.g., of carbon dioxide or sulphur dioxide. In the following scientific discussion we are going to use the term *environmental influences* instead of the term *environmental effects* contained in the EEC Environmental Audit Directive, (and in the Questionnaire, cf. Annex), since, however, environmental effects are substantially referred to as environmental influences in accordance with the EEC Environmental Audit Directive, but they could be easily mixed up with the term environmental impacts (cf. 4).

4 Environmental impacts are caused by environmental influences. The first designate impacts (immissions) on the flora, fauna, human beings and materials, cf. also Section 3 (1) and (2) of the Federal Immission Control Act (BImSchG).

6. These objective achievement degrees form the basis to derive the relevant action recommendations in the company. Additionally, decision making should be accompanied by checking the established EMP objectives.

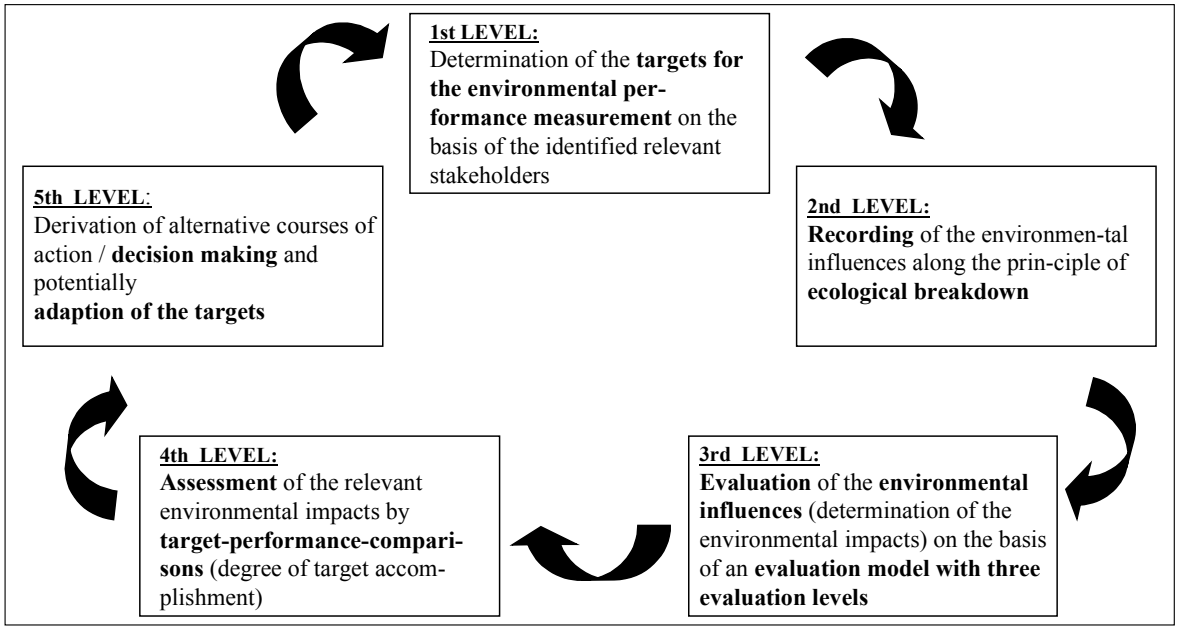

Fig. 1: Ideal-typical model for the Environmental Performance Measurement (EPM) (scheme designed at the TUD Environmental Management chair)

The **particular features** of this model are:[5]

- **Strategic layout of the environmental objectives**. There should be a close link between the environmental performance measurement at the operative level and the environmental objectives at the strategic level, i.e., the environmental performance parameters should reflect the strategic targets. The strategic targets are determined on the basis of the identified (internal and external) stakeholders.
- **Ecological breakdown of ecological results**. The ecological breakdown of ecological results (cf.
- Fig. 5 below) is applied to support the strategic orientation, i.e., ordinary and extraordinary and also goal-oriented and not goal-oriented environmental influences, in other words influences that aim at or do not aim at environmental objectives, are recorded and systemised to be able to predict the achievement of targets. As the environmental influences are broken down, internal control potentials may additionally be identified to improve the company's environmental performance.
- **Process and control orientation**. Greater emphasis should be placed on the targets of the ecological breakdown of ecological results (identification of internal control mechanisms and thus discovery of potentials for ecological improvements) by checking the production processes and the activities.

5 Cf. GÜNTHER, E. / STURM, A. (2000).

- **Quality-target-oriented evaluation model with three evaluation levels**. Basically, we distinguish between three levels or three possible kinds of quality targets, to which operational environmental objectives may relate, in order to be able to evaluate environmental influences: the quality target given in the legal provisions (e.g., limit values), the quality target of company-specific environmental goals that are expected to exceed the limit values given by the EEC Environmental Audit Directive and the DIN ISO 14001 and which can take up, e.g., new scientific findings, and also the quality target of sustainability with the three dimensions economy, ecology and social issues. These three ways of evaluation do not exclude each other, instead they require each other.

2 Investigation Design

The five-step model formed the theoretical basis for the empirical investigation into the Environmental Performance Measurement. The empirical investigation aimed at acquiring data, which are necessary to measure, evaluate and assess the environmental performance, and thus at the empirical examination of the theoretical model, in particular the ecological breakdown of ecological results.

When the population was chosen, emphasis was placed on two aspects:

- **Reference to industrial sections**. The Environmental Performance Measurement model is designed to be section-specific, i.e., the ecological problem groups are supposed to differ from sector to sector due to the different production processes, activities and materials used. Therefore, it is recommended to define the ecological problem groups section-specifically to find out if it is useful to restrict the comparison to one branch only or to compare several branches, before benchmarking is carried out. Owing to the leading economic and ecological position of the German mechanical engineering industry, this investigation concentrates on the latter;[6] although it may quite as well be applied to other industries.
- **EMAS and DIN ISO 14001**. German mechanical engineering enterprises were chosen if they qualified either for the *Evaluation according to EMAS (EEC Environmental Audit Directive)* or to the *Certification according to DIN ISO 14001* since it was assumed that these companies had collected comparatively secure ecological data as a result of the previous certification. Since a first analysis of the environmental declarations delivered by the EMAS enterprises showed that this information was not sufficient for the empirical substantiation of the theoretical model, a standardised questionnaire was developed for this purpose (cf. Attachment).

After the objectives had been set and the reference to branches had been defined, the population was made up of 111 company sites of the German mechanical engineering community, which had been either evaluated according to EMAS (EEC Environmental Audit Directive) and/or certified according to DIN ISO 14001. The corporate sites, which had been certified according to DIN ISO 14001 exclusively, amounted to 18.0 %. In February 1999,

6 Cf. BATSCHARI, A. (1995), p. 161; KRIEGBAUM, H. (1995), p. 52; VORNHOLZ, G. (1999), p. 40.

these enterprises were interviewed by members of the Chair of Business Management, especially Environmental Management and asked to give written answers on the study *Measurement of the Corporate Ecological Results in the German Mechanical Engineering Industry*. All participants in the study were asked to fill in the questionnaire (primary research) and the EMAS sites were invited to send their environmental declarations (secondary research).

The collection of data was closed early in September 1999. Out of the 111 companies, which were asked, 52 answered (rate of answers: 46.8%); 45 of them returned the filled in and processible questionnaires (return rate: 40.5%). Out of the 91 EMAS sites (82.0% of the population) 83 environmental declarations (including simplified declarations) of 65 sites could be processed (return rate: 71.4%); the analysis of questionnaires was done according to sites, not to companies.

The analysis of the questionnaires and the environmental declarations focussed in particular on the following **questions**:

1. According to which **main issues** are the **environmental objectives** formulated?

   (Cf. stage 1 of the model (objectives) and also the analysis of question 11 of the questionnaire and the environmental declaration)

2. Are the environmental influences separately classified, i.e., according to ordinary and extraordinary as well as goal-oriented and not goal-oriented causes or influencing factors following the principle of the **ecological breakdown of ecological results**?

   (Cf. stage 2 of the model (measurement) and also the analysis of questions 9, 10, 11 of the questionnaire)

3. Is it possible to relate the environmental influences to the production processes (as the source) and the activities (**process orientation/control orientation**)?

   (Cf. stage 2 of the model (measurement) and also the analysis of questions 4 and 6 of the questionnaire)

4. What is the **evaluation basis** to determine the environmental impact?

   (Cf. stage 3 of the model (evaluation) and also the analysis of questions 5 of the questionnaire)

5. Are target performance comparisons made to **evaluate** the environmental impacts?

   (Cf. stage 4 of the model (assessment) and also the analysis of question 3 of the questionnaire)

6. Which **criteria** form the basis for the **assessment** of the environmental impacts?

   (Cf. stage 4 of the model (assessment) and also the analysis of question 12 of the questionnaire)

3 Empirical Investigations - Results

3.1 Environmental Objectives

3.1.1 Analysis of the Questionnaires

On the one hand, question 11 of the questionnaire is supposed to establish, whether the achieved environmental load reductions[7] may be related to the individual causing item (following the principle of ecological breakdown of ecological results, cf.
Fig. 5) by the companies interviewed; on the other hand, it should be examined as well on which ecological foci the environmental goals concentrated (years 1993 – 1998). When the question is examined, it becomes obvious that those wastes that are in special need of monitoring (e.g., sludges of waste paint and varnish) and also process materials and supplies (e.g., paint, varnish, cleaning agents, cooling lubricants etc.) and their emissions into the environmental media water and air are to be found in the upper part of the nominations as classical environmental influences of the mechanical engineering industry. This result coincides with the analysis of the environmental declarations with regard to the main foci of the environmental objectives (cf. Fig. 3 and Fig. 4). Moreover, Fig. 2 clearly shows that the environmental objectives above all focus on the waste sector, which is due to its economic significance of the company on the one hand, and, on the other hand, to the ecological risk potential and the consequent obligation of the enterprises to produce supporting documents on account of the waste that is in special need of monitoring (as defined by the Closed Substance Cycle Waste Management Act (KrW-/AbfG).

[7] The terms *environmental loads and load reductions* are used to designate alterations in directions (environmental loads stand for increased environmental influences, environmental load reductions stand for reduced environmental influences).

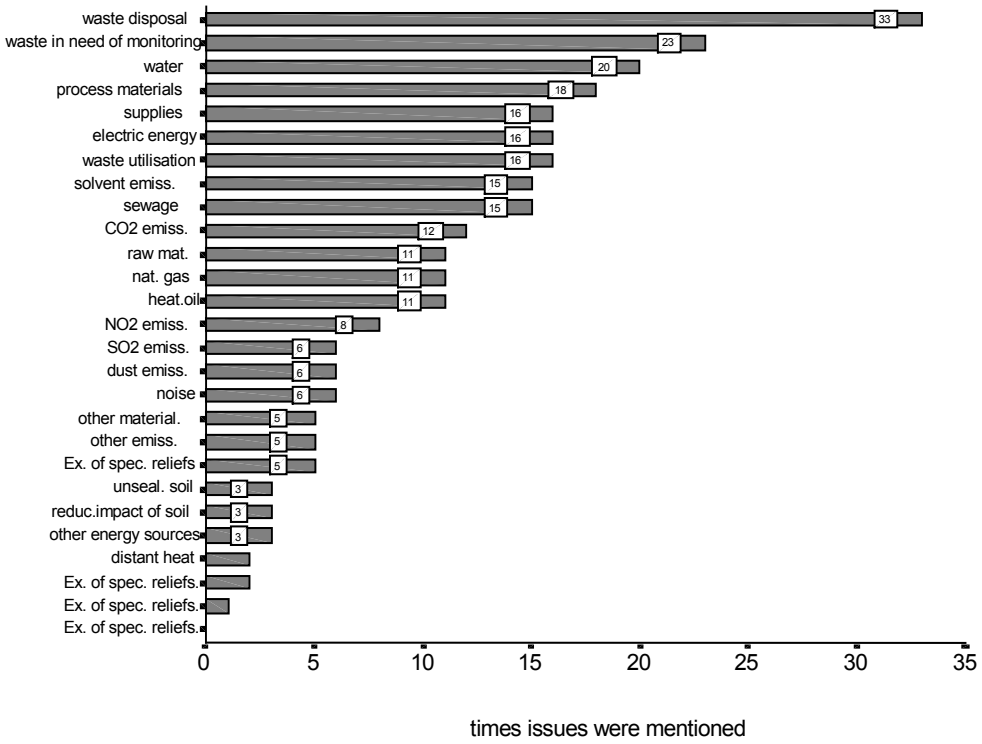

Fig. 2: What are the main foci when environmental objectives are declared? (analysis of the questionnaire) (Random sampling: 37 company sites; multiple answers possible)

3.1.2 Analysis of the Environmental Declarations of the EMAS Enterprises

The analysis of the environmental declarations in view of the main foci of the environmental objectives was carried through according to two criteria:

- „Environmental objectives of the past“: This criterion is valid for sites that have already taken part in the EMAS system and whose environmental declaration(s) relate(s) to past environmental objectives established within EMAS (cf. Fig. 3)
- „Environmental objectives for the future“: This criterion is valid for sites that have already taken part in the EMAS system and also those which have just conceived an environmental declaration (cf. Fig. 4).

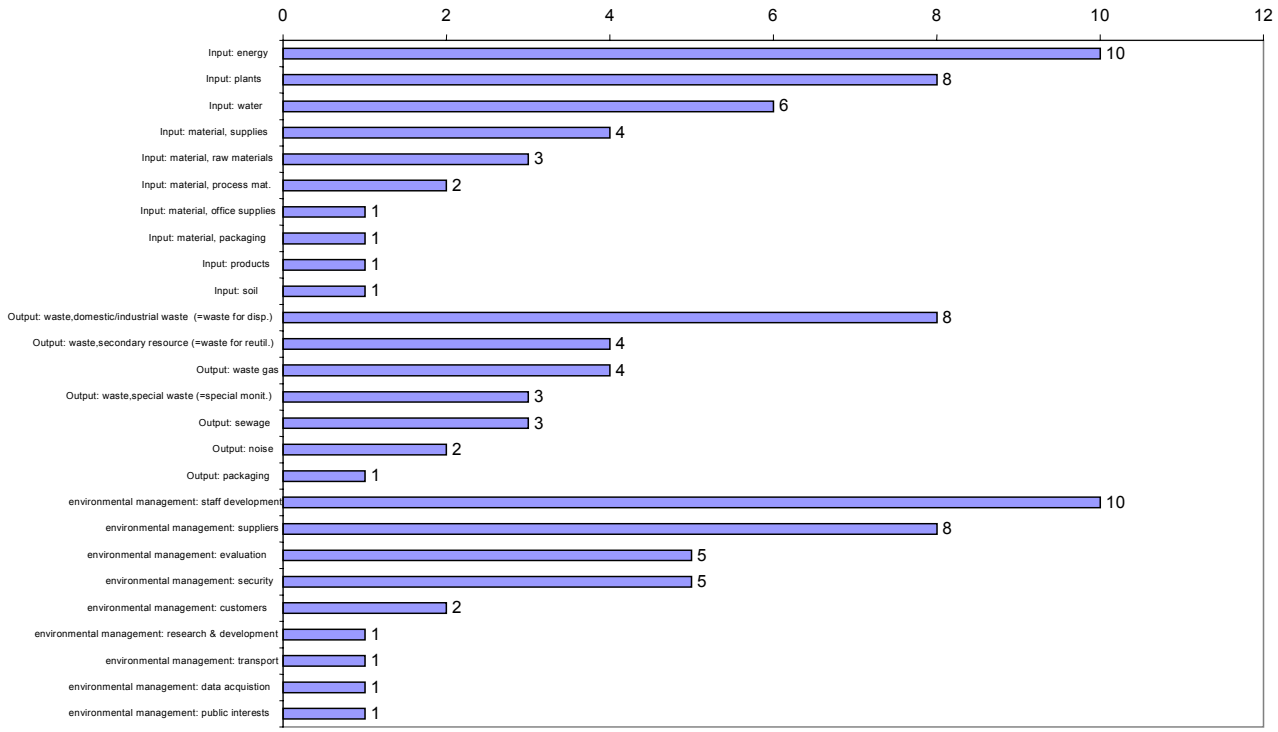

Fig. 3: What are the main fields, when the environmental objectives (of the past) are set?
(analysis of environmental declarations)
(random sample: 12 company sites; multiple answers possible)

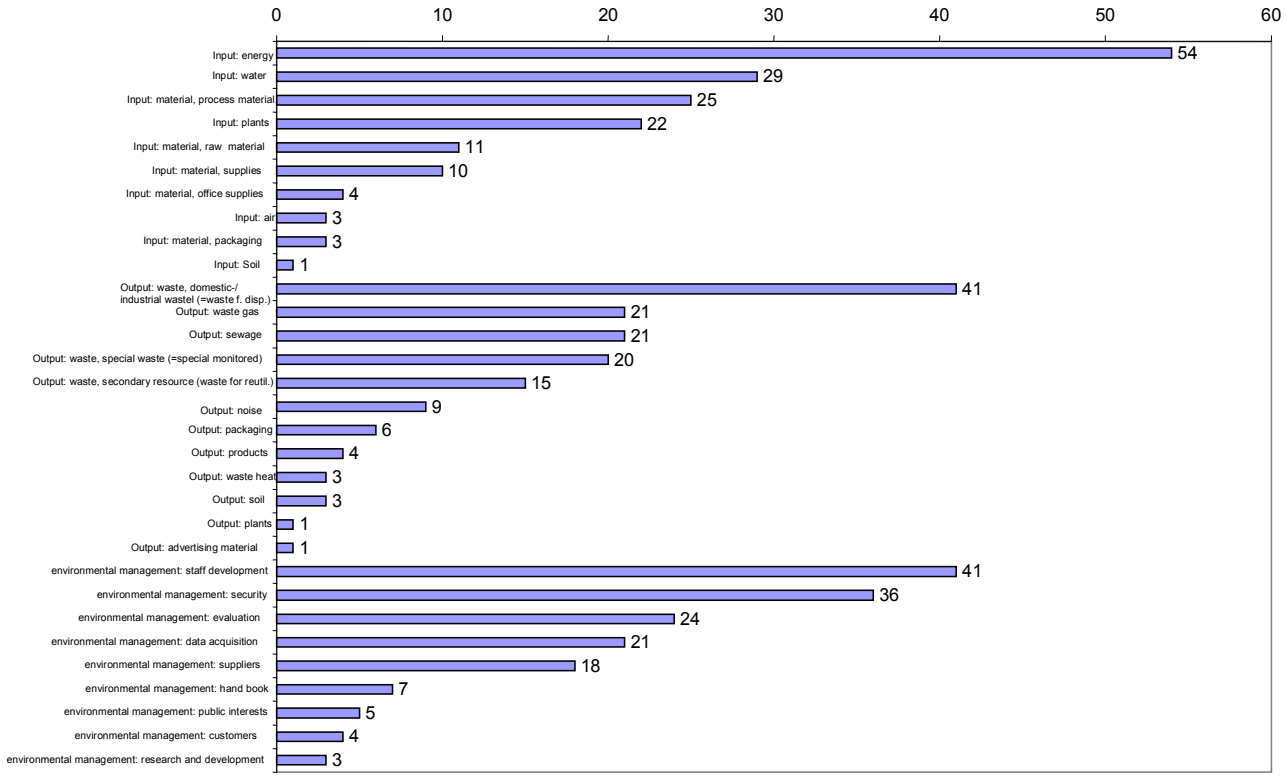

Fig. 4: What are the main fields, when the environmental objectives (of the future) are set?
(analysis of environmental declarations)
(random sample: 65 company sites; multiple answers possible)

If we have a closer look at the environmental objectives in the individual environmental sectors, the following specific features are interesting:

- **Input**:
  - The environmental sector *Input: Plants*, which was in the third position of the past environmental objectives, is only in the eighth position of all sectors mentioned for the future environmental objectives. Because of this result one might suppose that the energy saving potentials, which were discovered for the existing plants for the first time and which were tackled by appropriate objectives (environmental objectives of the past) and end-of-the-pipe steps, are realised after the first setting of objectives and that integrated steps are necessary for further energy saving potentials in the plant sector. Since these integrated steps require adequate investment, however, the environmental objective *Input: Plants* has lost some of its priority.
  - The good position of the input *Energy* has to be related to those environmental sectors, which stimulate both ecological and economic motivation for appropriate ecology-oriented measures, i.e., it is possible that with these measures ecological and economic load reductions may be achieved. As far as the ecological relevance is concerned, the input *Energy* is important above all for the heating plants and for mechanical engineering enterprises with an own foundry. The formulation of energy saving measures is very often supported by a good basis of data in the enterprises.
- **Output**:

  The waste sector (waste to be disposed and waste that is in need of monitoring) can be found among those sectors that are most frequently mentioned for both objectives *Environmental objectives of the past* and *Environmental objectives for the future*. There has been a slight shift of emphasis for the *Environmental objectives for the future* for the waste that is in special need of monitoring and the corresponding sector of Dangerous Materials Management.
- **Environmental Management:**
  - The environmental objective Staff development plays an important part for the Environmental objectives of the past and also for the Environmental objectives for the future. The forward position of this sector does not only demonstrate the necessity to provide the organisational preconditions for the reduction of environmental loads, but it also reflects known deficits in the field of the ecological training of the staff.
  - Compared with the Environmental objectives of the past, the environmental objective Environmental management: evaluation has significantly gained importance as far as the Environmental objectives for the future are concerned. This fact underlines the necessity to evaluate the environmental influences for the purpose of in-house decision making, after they have been measured and/or classified by means of adequate and feasible procedures.

3.2 Ecological Breakdown of Ecological Results

Analogously to the breakdown of the management performance[8], the ecological breakdown of ecological results is supposed to identify success factors and thus internal control possibilities to be ecologically successful or to achieve the ecological performance. Therefore, as a first step the environmental influences are measured on the basis of the criterion *System Boundary*. These are influences, which may be registered within the company and which may – as a result – be controlled by the company itself **(ecological operating results)**. A difference has to be made between the latter and the **ecological financial results**, which relates to company investment outside its system boundary.

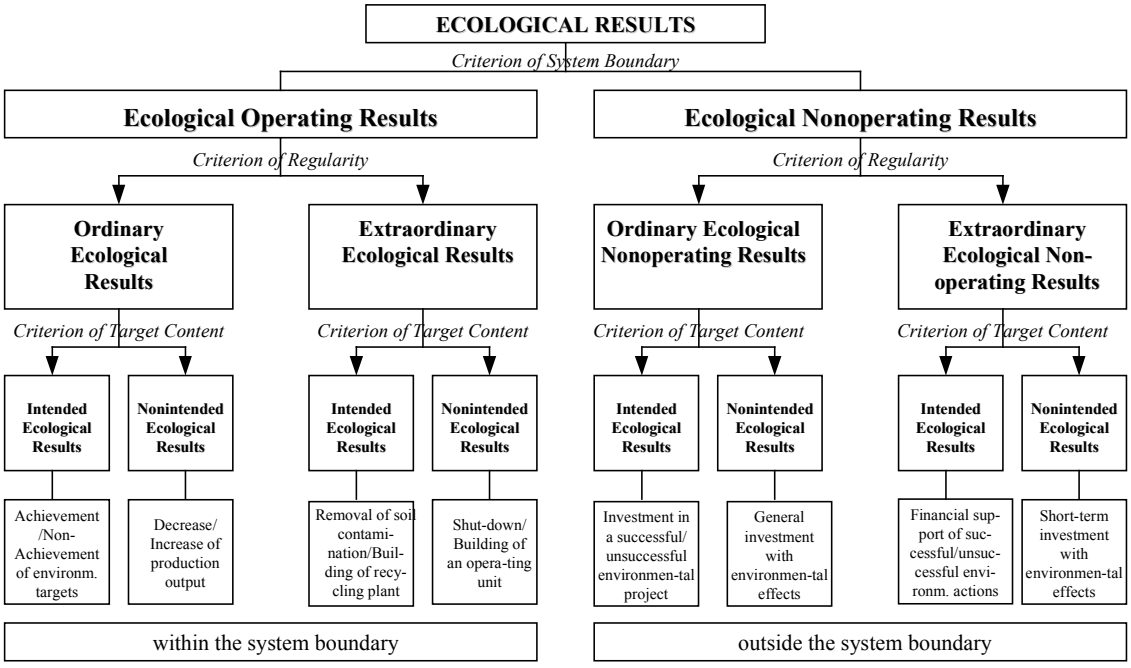

Fig. 5: The concept of ecological breakdown of ecological results (scheme designed at the TUD Environmental Management chair)[9]

The criterion of ordinariness differentiates between the **ordinary ecological performance**, which is influenced by regularly occurring factors, and the **extraordinary ecological performance**, which is caused by irregular, extraordinary factors.

These two success categories may be further differentiated, namely by the objective character of the influencing factors. If the objective character is mainly ecological, an **ordinary**

8 The management breakdown differentiates between the operational and the financial performance in accordance with the criterion *Employment* and the ordinary and extraordinary performance in accordance with the criterion *Ordinariness*. The operational and financial performance of the enterprise are regarded as ordinary performance, while the extraordinary performance comprises „all extraordinarily occurring, i.e., extraordinary and extra-period performance/success components“, cf. COENENBERG, A. G. (1997), p. 337.

9 Cf. STURM, A. (2000).

or **extraordinary ecological performance** may be stated. If the predominant objective refers to economic issues above all, however, the **ecological performance** may be divided into **regular** and **irregular ecological performance**.

Questions 9, 10, and 11 of the questionnaire aimed at the empirical examination of the ecological breakdown of ecological results or at the question, whether the companies have already got the data basis that is necessary to carry out the ecological breakdown of ecological results.

Concerning the **ecological financial performance** (cf. question 9), for only 8.9 % of the enterprises appropriate investment could be proved. All enterprises that stated an ecological financial success invested in other projects than those mentioned in the questionnaire (it must be added that these were often supports from within the company or the affiliated group so that they can not be designated as ecological financial success in the actual sense of the term); only one company indicated to have sponsored a regional project. Thus, the investment forms named in the questionnaire *Participation in ecological or environmental funds* and *Sponsoring of supraregional or regional ecologically oriented projects* are not feasible in practice. Moreover, this brings us to the conclusion that the most efficient point to control and reduce environmental influences is within the company.

With regard to the **ordinary and extraordinary ecological performance** in the sense of **environmental loads** (cf. question 10), the clear priority of the influencing factor *production increase* may be stated: For example, 53.3% of the companies indicate that environmental loads were brought about over the last five years as the production volume had been increased. Thus, with regard to the **ordinary ecological performance** in the sense of an **environmental load** (cf.
Fig. 5), we can start from the fact that the companies have collected the relevant data and that these data can be proved.

Further influencing factors are in the order of their priority

- *other factors* (e.g., increased examinations (on the machines) or restructuring, 13.3% of the number of items it was named),
- *extraordinary economic measures* (e.g., construction of a new operating unit, 11.1% of the number of items it was named),
- *accidents* (was named 4.4 % of the times),
- *extraordinary ecological measures* (e.g., sealing of the soil by building an own sewage treatment plant) (was named 2.2 % of the times) and
- *missing the environmental goals set within the company* (was named 2.2 % of the times)

It is obvious that ecological influencing factors are hardly identified as relevant for the existence of environmental loads. Instead, economic factors are clearly considered as more significant influencing factors that are responsible for environmental loads.

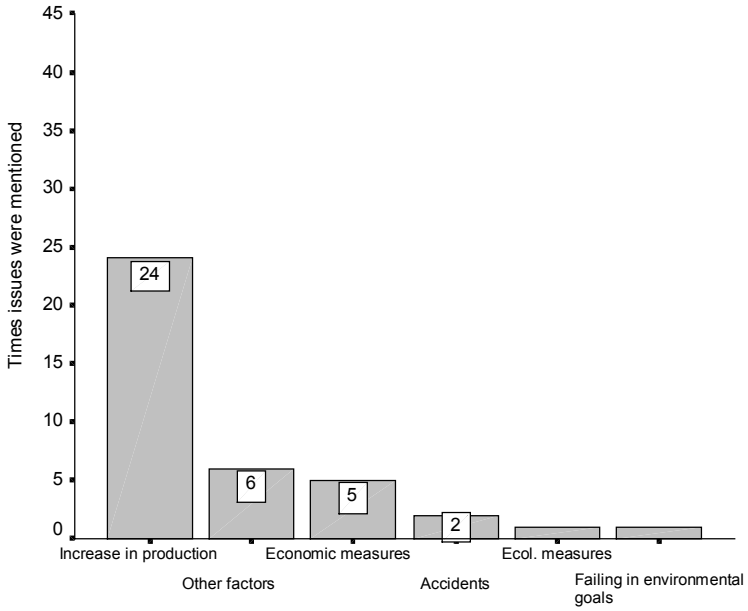

Fig. 6: Are the environmental influences covered separately (in the sense of environmental loads) following the principle of the ecological breakdown of ecological results?
(random sample: 43 company sites; multiple answers possible)

Concerning the **ordinary and extraordinary ecological performance** in the sense of an **environmental load reduction** (cf. question 11), 82.2% of the companies related the environmental influences to the appropriate causes, i.e., an ecological breakdown of ecological results is possible. The environmental influences have not been classified by 17.8% of the enterprises.

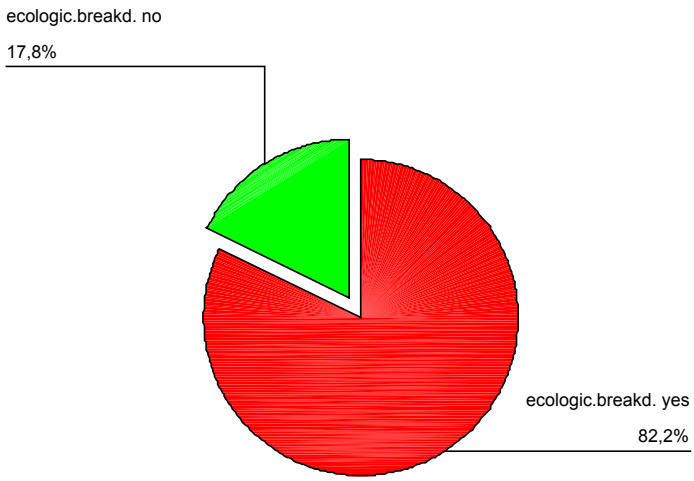

Fig. 7: Are the environmental influences covered separately (in the sense of environmental load reductions) following the principle of the ecological breakdown of ecological results? (random sample: 45 company sites)

Of the companies that did not classify the environmental influences, 50.0% indicated that classification was not possible; 37.5% indicated other reasons (e.g., in-house restructuring).

When the classification of the environmental load reductions with the individual causing items is examined, we get a different picture compared with the environmental loads: In addition to the economic influencing factor *extraordinary economic measures* (e.g., close-downs of operating units) (was named 14.4% of the times) the ecological factor *achievement of relevant environmental goals* (was named 71.2% of the times) is priorly named as the polluter quantity.

The *achievement of environmental goals* was named most frequently and thus identified as the main influencing factor for environmental load reductions; it is related to the individual environmental load reductions following the principle of the ecological breakdown of ecological results (cf. Fig. 2). As a result, we can assume that a sufficient data basis is available for the present population to determine the performance in view of the **scheduled ecological performance** in the sense of an **environmental load reduction** (cf. Fig. 5).

3.3 Process and Control Orientation

Question 6 of the questionnaire aimed at the classification of the strongest environmental influences with the related production processes and activities. It could be stated that the companies interviewed could overwhelmingly (73.3%) relate the strongest environmental influences to the polluting materials/substances, production activities and plants. For 6.6% of the companies only a partial classification was possible, i.e., a classification of only some of the environmental influences mentioned. For 20.0% of the enterprises a classification was not possible.

The high percentage of those enterprises, which can classify the environmental influences, may be explained when we have a closer look at the approaches to control the environmental influences (cf. question 4 of the questionnaire): Here the process orientation – together with the total enterprise consideration – is in the first place (80.0% of the enterprises). The product, however, still plays a minor part – in particular when compared with the issues enterprise and process – (product consideration: 33.3%, product service life: 20.0%). The weak position of the product consideration has surely to be evaluated before the background of the availability of suitable information for the company (e.g., by composition certificates).

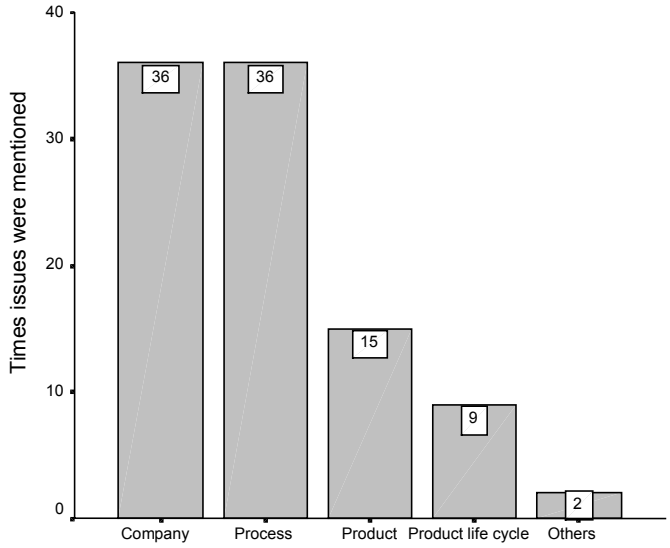

Fig. 8: Can the environmental influences be classified with the production processes and activities (process and control orientation)?
(random sample: 45 company sites; multiple answers possible)

3.4 Evaluation Basis

Concerning the evaluation of the environmental influences, it is important to know the evaluation basis, which is applied in accordance with the quality-goal-related three-step evaluation model (cf. question 5 of the questionnaire). With 97.8% of the companies, we can state a clear priority of the company-specific environmental goals compared to the other evaluation possibilities, legal regulations (e.g., limit values, 62.2.%), sustainability goals (31.1%), and other evaluation procedures (e.g., company-specific procedures, orientation towards the environmental compatibility test or external measurements, 24.4%). The high relevance of the company-specific environmental goals probably depends very much on the basic population chosen. However, it also indicates that main ecological fields are defined in the companies on the basis of limit values. From the point of view of the enterprise, these main fields should concentrate on specific ecological, in particular economic-ecological problems in the company.

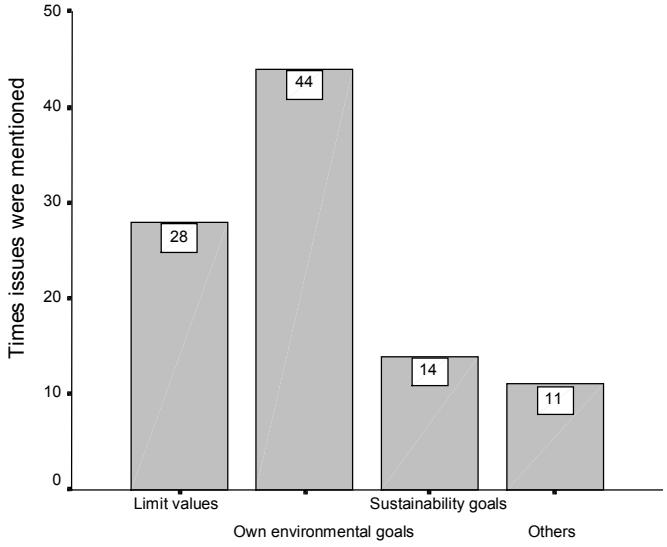

Fig. 9: What is the evaluation basis on which the environmental influences are identified? (random sample: 45 company sites; multiple answers possible)

3.5 Evaluation

The evaluation and also the target performance comparisons are closely linked with the evaluation principles. For example, target performance comparisons can be made using either limit values (e.g., emissions measurements) or taking the environmental goals set within the company as the basis.

The analysis of question 3 shows the following: The concentration on the company-specific environmental goals, which has already become apparent during the evaluation, is also reflected during the assessment: 82.2% of the companies state that they ascertain the reduction of environmental impacts by a target performance comparison on the basis of

their own environmental goals. However, the determination of environmental load reductions by comparing eco-balances over several periods is mentioned more often (88.9% of the companies) than this target performance comparison. Since this temporal comparison on the actual basis, i.e., the comparison of the environmental influences from the eco-balances over several periods, is the pre-condition for the formulation of environmental goals, this result is no surprise. It is, however, not sufficient to assess the environmental performance of the company due to the lacking evaluation. In the third place (55.6%) are the emissions measurements (target performance comparisons on the basis of limit values).

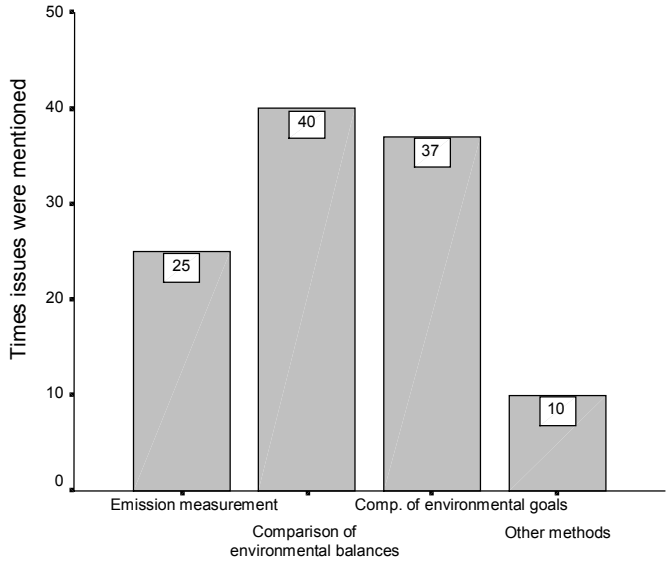

Fig. 10: Are target performance comparisons made to assess the environmental impacts? (random sample: 45 company sites; multiple answers possible)

3.6 Assessment Criteria

Question 12 of the questionnaire (assessment criteria) is a summary of the evaluation (cf. question 5) and the assessment (cf. question 3) issues.

Legal regulations are listed first as assessment criteria: 84.4% of the companies rate the assessment criterion as very important. Further criteria, which were rated as very important, are the *formulation and achievement of company-specific environmental goals* (target performance comparisons) (62.2%), *the introduction of an environmental management system* (55.6%) and also *the formulation of environmental goals, which refer to the strongest environmental impacts of the company* (53.3%). This result helps to recognise the importance of target performance comparisons as an assessment criterion, and not the formulation of environmental goals. Moreover, the company goals should – according to the company's interpretation – be oriented towards the ecological problem areas to qualify as assessment

criteria (cf. result of 53.3 %). The environmental goals also show that sustainability has hardly been important when environmental impacts are assessed: only 8.9% rate the sustainability criterion as very important and 53.3% of the enterprises rated this criterion as not relevant (for the sake of comparison: legal regulations: 6.6%, company-specific environmental goals, which refer to the strongest environmental impacts of the company: 24.4%). This result is not surprising as concepts for the realisation of sustainability in companies have been missing at all or have been very rarely available, respectively.

Further special features of the assessment are the facts that external environmental performance criteria, such as the result of a so-called eco-ranking/eco-rating or the reception of an environmental award, are not considered decisive criteria: 6.7% of the enterprises attach great importance to the assessment in eco-rankings/eco-ratings, the reception of an environmental award is by no enterprise regarded as very important. Two conclusions may thus be reached: On the one hand, the companies consider the environmental performance measurement primarily as an internal instrument to influence their environmental impacts; on the other hand, benchmarking aspects – to determine the relative ecological success – are not yet considered very important. This may partly be the result of the eco-benchmarking procedures actually applied, which compare companies with different production processes and activities thus limiting the deducibility of statements on the environmental impacts of a company compared with those of another company.

Criteria of assessment	not mentioned	mentioned without indication of importance	very important	important	rather unimportant
Observance of legal regulations (e.g., limit values)	6.6 %	-	84.4 %	8.9 %	-
Formulation of company-specific environmental goals that refer to	13.3 %	31.1 %	46.7 %	8.9 %	-
....the sectors soil, water, air, material and energy	26.6 %	2.2 %	46.7 %	24.4 %	-
....the strongest environmental impacts of our company specifically	24.4 %	-	53.3 %	22.2 %	-
....the ecological problem areas within the mechanical engineering industry	57.7 %	-	4.4 %	28.9 %	8.9 %
that orient towards	53.3 %	-	8.9 %	31.1 %	6.7 %
....a sustainable development (e.g., exploitation of renewable resources)	86.6 %	-	6.7 %	2.2 %	4.4 %
that refer to					
....other contents:.....					
Formulation **and** achievement of these environmental goals	8.8 %	-	62.2 %	28.9 %	-
Introduction of an environmental management system	11.1 %	-	55.6 %	26.7 %	6.7 %
Decline of the ecological loads in the fields:	28.8 %	51.1 %	13.3 %	6.7 %	-
soil	48.8 %	-	22.2 %	22.2 %	6.7 %
body of waters/water	42.2 %	-	31.1 %	22.2 %	4.4 %
air	40.0 %	-	31.1 %	26.7 %	2.2 %
material	40.0 %	-	28.9 %	26.7 %	4.4 %
energy	33.3 %	-	35.6 %	28.9 %	2.2 %
Decline of your (formerly) strongest environmental impacts	22.2 %	2.2 %	44.4 %	31.1 %	-
Reception of a (federal, state and / or regional) environmental award for your company	33.3 %	-	-	26.7 %	40.0 %
Good or very good assessment in published ecology-oriented company rankings / company ratings	37.7 %	-	6.7 %	35.6 %	20.0 %
Other assessment criteria indicated by the companies (e.g., company internal guidelines; economic relevance)	84.4 %	2.2 %	13.3 %	-	-

Fig. 11: Which criteria are taken as a basis for the evaluation of environmental influences?
(random sample: 43 company sites; Multiple answers possible)

4 Summary and Outlook

The descriptive evaluation and representation of the results of the study *Measurement of the Corporate Ecological Results* is a first vital step towards the empirical substantiation of the theoretical model (cf. Fig. 1). The results show that the theoretical knowledge and also the fundamental data essential for the realisation of the model are already available in the companies; these relate to

- the necessity of process orientation, which has, however, to be supported by suitable tools, e.g., process balances,
- the possibility, which is given thanks to the data basis, to carry through an ecological breakdown of ecological results to support the process and control orientation,
- the formulation of company-specific environmental goals that are oriented towards ecological problem areas within the company. A target performance comparison is made to check whether the goals are achieved.

Those sectors still demonstrating considerable theoretical and empirical deficiencies need external benchmarking to determine the relative environmental performance or the relative ecological success of a company, respectively, and also product orientation. With regard to the external benchmarking on the basis of production processes, it can be stated for the German mechanical engineering industry that this is possible; this is illustrated by the similar weighting of the main issues of the environmental goals.

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6 Attachment

The questionnaire that was sent out to the mechanical engineering companies by the Chair of Business Management, especially Environmental Management is shown on the following pages, at first in English and then in German.

Activities of your company:

1. Which major activities have to be carried out for making your products / product groups?

Product / product group	Major activity / major activities	activities placed outside your company
1.		
2.		
3.		
4.		

Environmental management / environmental goals of your company:

2. When did you start to reduce your environmental impacts ?

(Please indicate the year:) .....

3. How do you detect a reduction in environmental loads caused by your company ? (Multiple answers possible)

☐ through emission measurement (compliance with legal limit values)
☐ through comparison of environmental balance data of several years
☐ through comparison of the environmental goals achieved with those set in advance
☐ through other methods:.....

4. Which starting point do you choose for controlling your environmental loads ? (Multiple answers possible)

☐ Operation
☐ Process (production activities)
☐ Product (stages of production within your company)
☐ Product life cycle (product stages within and outside your company)
☐ Others:.....
.

5. How do you assess your impacts on the environment ? (Multiple answers possible)

☐ with the help of legal limit values
☐ with the help of company-specific environmental goals
☐ with the help of sustainability goals
☐ with the help of other methods:.....

6. What were your company's most important impacts on the environment in the previous five years (1993-1998) **?**

(e.g., solvent emissions)

Environmental impact	Year
1.	
2.	
3.	
4.	
5.	

a.) Which of the materials / substances used were mainly responsible for the environmental impacts?

(e.g. (solvent-containing paint)

Environmental impact	Used materials / substances
to 1.	
to 2.	
to 3.	
to 4.	
to 5.	

b.) With which production activity/ stage of production (e.g., painting) and which (manufacturing) plant (e.g. painting plant) could **you** mainly **class these environmental impacts ?**

Environmental impact	Kind of production	(manufacturing) plant
to 1.		
to 2.		
to 3.		
to 4.		
to 5.		

☐ No. ..... has not been classified

☐ as classification was not possible

☐ for other reasons:.....

7. Which impacts on the environment are currently **the most important environmental impacts of your company ?**

Environmental impact	Production activity	(manufacturing) plant
1.		
2.		
3.		

8. Are your current environmental goals designed to improve these environmental goals?

☐ yes

☐ no ⟶ If no, why:

☐ Technologies for solving this problem are not developed by now

☐ Technologies are available, but too expensive

☐ Other rea-

sons:.....

9. Does one of your environmental goals **of your company involve investment in other ecology-oriented companies (e.g., shares/holdings) and/or in** ecology-oriented projects (outside your company**)?**

☐ no

☐ yes ⟶ If **yes**, where do you invest?

☐ investments in so-called 'Ecofonds' (e.g., Ökovision, SarasinÖkoSar etc.)

☐ in national ecology-oriented projects (e.g., wind farms etc.)

☐ in regional ecology-oriented projects

☐ in other pro-

jects:.....

10. Which factors were responsible for increasing environmental impacts of your company's activity within the last five years (1993-1998)**? (Multiple answers possible)**

	Factors	Type of environmental impact (please indicate, e.g., an increase in solvent emissions)	Year
☐	.....through missing company-specific environmental goals		
☐	.....through an increase in production		
☐	.....through environmental measures with an extraordinary impact on the environment (e.g. sealing of soil when building an own sewage treatment plant)		
☐	.....through accidents		
☐	.....through extraordinary economic measures (e.g. more resources needed for the erection of new corporate units etc.)		
☐	.....through other factors:		

11. Which of the following ecological improvements **were initiated by your company's activities** within the last five years (1993-1998)**? (Multiple answers within one improvement possible)**

Ecological improvement... / Kind of improvement	.....through achieving **company-specific environmental goals**?	.....through **decreases in production**?	....through **extraordinary ecological measures** (e.g., redevelopment of a contaminated site)?	.....through **extraordinary economic measures** (e.g., shutdown of a corporate unit)?
	Year/s:	Year/s:	Year/s:	Year/s:
Unsealing of **soil**	☐	☐	☐	☐ .....
Decline of **soil loads**	☐	☐	☐	☐ .....
Decline in **material consumption**:	Year/s:	Year/s:	Year/s:	Year/s:
☐ raw materials	☐	☐	☐	☐ .....
☐ supplies	☐	☐	☐	☐ .....
☐ process material	☐	☐	☐	☐ .....
☐ Other materials:	☐	☐	☐	☐ .....
Decline in **energy consumption**:	Year/s:	Year/s:	Year/s:	Year/s:
☐ Electric energy	☐	☐	☐	☐ .....
☐ District heating	☐	☐	☐	☐ .....
☐ Natural gas	☐	☐	☐	☐ .....
☐ Heating oil	☐	☐	☐	☐ .....
☐ Other sources of energy:	☐	☐	☐	☐ .....
Decline in **water consumption**	☐	☐	☐	☐ .....
Decline in **emissions**:	Year/s:	Year/s:	Year/s:	Year/s:
☐ NO_2-emissions	☐	☐	☐	☐ .....
☐ SO_2-emissions	☐	☐	☐	☐ .....
☐ CO_2-emissions	☐	☐	☐	☐ .....
☐ Solvents	☐	☐	☐	☐ .....
☐ Dust	☐	☐	☐	☐ .....
☐ Noise	☐	☐	☐	☐ .....
☐ Other emissions:	☐	☐	☐	☐ .....
Decline in **waste:**	Year/s:	Year/s:	Year/s:	Year/s:
☐ Waste for utilization	☐	☐	☐	☐ .....
☐ Waste for disposal	☐	☐	☐	☐ .....
☐ Waste that requires special monitoring)	☐	☐	☐	☐ .....
Decline in **sewage**	☐	☐	☐	☐ .....
Other improvements:	Year/s:	Year/s:	Year/s:	Year/s:
☐	☐	☐	☐	☐ .....
☐	☐	☐	☐	☐ .....
☐	☐	☐	☐	☐ .....
☐	☐	☐	☐	☐ .....

☐ no classification with the individual polluters

☐ as classification was not possible

☐ for other reasons:

.....

12. How do you assess the ecological performance of your company?

☐ very successful

☐ successful

☐ normally successful

☐ less successful

☐ not successful

Which criteria do you take as a basis for the assessment of your company's environmental performance?

How important are these criteria for the assessment? (Multiple answers possible)

	Importance		
Criteria of assessment	very important	important	rather unimportant
☐ observance of legal regulations (e.g. limit values)	☐	☐	☐
☐ Formulation of company-specific environmental goals that...	☐	☐	☐
☐....refer to the sectors soil, water, air, material and/or energy	☐	☐	☐
☐....refer specifically to the strongest environmental impacts of your company	☐	☐	☐
☐....refer to the ecological problem areas within the mechanical engineering industry	☐	☐	☐
☐....orient towards a sustainable development (e.g. employing renewable resources)	☐	☐	☐
☐....refer to other aspects.....	☐	☐	☐
☐ Formulating **and** achievement of these environmental goals	☐	☐	☐
☐ Introduction of an environmental management system	☐	☐	☐
☐ Decline in ecological loads in the fields of:	☐	☐	☐
☐ Soil	☐	☐	☐
☐ Bodies of water / water	☐	☐	☐
☐ Air	☐	☐	☐
☐ Material	☐	☐	☐
☐ Energy	☐	☐	☐
☐ Decline in your (formerly) strongest environmental impacts	☐	☐	☐
☐ Reception of a (federal, state and / or regional) environmental award for your company	☐	☐	☐
☐ Good or very good assessment in published ecology-oriented company rankings/-ratings	☐	☐	☐
☐ Other assessment criteria:	☐	☐	☐

Outlook:

13. Which factors determine your further commitment to ecological issues? (Multiple answers possible)

☐ The increased public recognition of your environmental commitment, e.g., by customers, suppliers etc.

☐ The increased political recognition of your environmental commitment, e.g., deregulation

☐ The general economic development of your company

☐ Other factors:

.....

.....

Thank you very much for your participation