MONITORING AS AN INSTRUMENT FOR IMPROVING ENVIRONMENTAL PERFORMANCE IN PUBLIC AUTHORITIES

Experience from Swedish Infrastructure Management

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March 2009
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Doctoral Thesis
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ABSTRACT

Monitoring is an important tool for gaining insight into an organisation’s environmental performance and for learning about the environmental condition and the effectiveness of environmental management measures. Development of environmental monitoring has generally relied on research aiming at improving monitoring methodology, technique or practice within a particular management tool. Little empirical research has taken into account the organisation’s reality where several management tools are used in parallel. This thesis analyses the practice of environmental monitoring in public authorities with the aim of identifying barriers and possibilities for environmental monitoring as an instrument for improving environmental performance, using the Swedish Rail Administration as a case organisation. The study identified two different types of environmental monitoring: environmental performance measurement (EPM) and activity monitoring, both important for achieving environmental improvements. EPM involves gathering and evaluating data to determine whether the organisation is meeting the criteria for environmental performance set by the management of the organisation. EPM can further be used for judging the success and failure of environmental objectives and strategies. Activity monitoring provides each project of the organisation with information to minimise the negative effects on the natural environment or human health and to ensure that the organisation’s operations conform with regulations.

Problems encountered comprised a variety of little co-ordinated monitoring activities, poor utilization of the monitoring results as well as limited internal feedback on monitoring results. Some of the problems identified seem to be an effect of the management transition from a traditional ‘command and control’ system to a self-administered organisation managed by economic incentives and voluntary management systems.

This thesis suggests several improvements to make monitoring more efficient. Primarily, the monitoring systems must have a clear structure and be adapted to its specific function. The EPE system would benefit from being integrated with the organisation’s central performance measurement, presenting progress towards organisational strategic objectives as well as operational objectives. The system for activity monitoring must not only focus on inputs and outputs to the system but must also include the environmental condition of the system. In order to improve communication and learning, monitoring data within both EPE and activity monitoring must be better transmitted and utilised within the structure of the permanent organisation. Experience from all monitoring activities that now is scattered and inaccessible to the individuals of the organisation could beneficially be stored within a well-structured organisational ‘memory’. Such a system would facilitate an iterative management process where the monitoring results and the knowledge gained are used for making future plans and projects more adaptive, thereby improving the environmental performance of the organisation.

Key words: Environmental Management System (EMS); Environmental Impact Assessment (EIA) follow-up; Strategic Environmental Assessment (SEA); Environmental Performance Evaluation (EPE); organisational learning; Railway
Monitoring as an Instrument for Improving Environmental Performance in Public Authorities

TILL MAMMA OCH PAPPA
ACKNOWLEDGEMENTS

First of all, I would like to express my gratitude to my supervisors Lennart Folkeson and Berit Balfors. Lennart, I truly appreciate your endless support and help along the way. I especially appreciate your sense for the language and for making me realize the importance of details. Berit, thank you for encouraging me when I have been doubting the quality of the research and for interpreting my sometimes fuzzy thoughts.

I also thank the members of the steering committee for fruitful discussions and for comments on my work: Håkan Westerlund, Jan Skoog, Åsa Strömberg, Olof Hjelm, and Karl Kottenhoff. I would also like to thank the former representatives of the group: Anders Boëthius, Helena Bromark, Hans Cedermark, Urban Ledin and Fredrik von Malmborg. A special thanks to Anders Boëthius who patiently explained the construction and function of the Swedish rail infrastructure to me and to Olof Hjelm for good comments and suggestions at my licentiate seminar.

Many informants have been kind to participate in interviews, filling out questionnaires and providing me with documents. Thank you all for your time.

I would like to thank all the colleagues at the Stockholm Environment Institute (SEI), especially, Måns, Oskar and Åsa, for providing a stimulating work environment during my stay there in the winter 2006/2007. You brought new perspectives to my research and formed a much-needed break in my PhD study, which stimulating me to new ideas and new motivation.

It is a rather lonely to work as a PhD student. I therefore want to thank all my current and past colleagues at the Department of Land- and Water Resources Engineering. Your company and discussions during lunch and ‘fika’ has been very valuable and I still miss all of you that have finalized your PhD’s and moved on to new challenges. Susanna and Andreas, thank you for all good discussions during this last year.

Finally, I would like to thank my family and all my friends for believing in me. Fredrik and Hanna. Thank you for not letting me loose track of what is important in life!

The thesis was conducted at the Department of Land and Water Resources Engineering, Royal Institute of Technology, Stockholm. Funding for the research was provided by the Swedish Rail Administration through the Centre for Research and Education in Operation and Maintenance of Infrastructure (CDU).

Kristina Lundberg
Stockholm, March 2009
# Table of Contents

Acknowledgements ................................................................................................................. vii

List of papers ............................................................................................................................ xi

Glossary of Acronyms ............................................................................................................ xiii

1. Introduction ........................................................................................................................... 1
   1.1 Objectives ......................................................................................................................... 2
   1.2 Scope of the thesis ............................................................................................................ 2
   1.3 Structure of the thesis ....................................................................................................... 3

2. Description of the Swedish rail sector and the case organisation ........................................... 3

3. Research approach ................................................................................................................ 5
   3.1 Research process ............................................................................................................... 5
   3.2 Methodology ..................................................................................................................... 6
      3.2.1 Selection of study objects ........................................................................................... 8
      3.2.2 Data collection and analysis ....................................................................................... 8
      3.2.3 Validity and reliability ................................................................................................ 9

4. Theoretical framework ......................................................................................................... 10
   4.1 Evaluation and planning theory ........................................................................................ 11
   4.2 Management and organisational theory .......................................................................... 11
      4.2.1 Organisational learning ............................................................................................ 12
      4.2.2 Management of public administrations .................................................................... 13

5. Results and discussion ......................................................................................................... 13
   5.1 Monitoring practice ......................................................................................................... 15
      5.1.1 Environmental performance measurement (EPM) .................................................. 15
      5.1.2 Activity monitoring .................................................................................................. 17
   5.2 Monitoring problems identified ....................................................................................... 19
      5.2.1 Environmental performance measurement (EPM) ................................................... 19
      5.2.2 Activity monitoring .................................................................................................. 20
   5.3 Suggestions for improving monitoring practice ............................................................... 23
      5.3.1 Environmental performance measurement (EPM) .................................................. 23
      5.3.2 Activity monitoring .................................................................................................. 26
   5.4 Monitoring as an instrument for improving environmental performance ......................... 27
   5.5 Comparable organisations and international experiences ................................................. 28

6. Conclusions .......................................................................................................................... 28

7. Suggestions for future research .......................................................................................... 30

References ............................................................................................................................... 31
LIST OF PAPERS

This thesis is based on the following papers and will be referred to in the text by their corresponding Roman numerals. The papers are reproduced in full in Appendix 1-5


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# Glossary of Acronyms

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>BSC</td>
<td>Balanced Scorecard</td>
</tr>
<tr>
<td>DPSIR</td>
<td>Driving force – Pressure – State – Impact – Response</td>
</tr>
<tr>
<td>EIA</td>
<td>Environmental Impact Assessment</td>
</tr>
<tr>
<td>EMS</td>
<td>Environmental Management System</td>
</tr>
<tr>
<td>EPE</td>
<td>Environmental Performance Evaluation</td>
</tr>
<tr>
<td>EPM</td>
<td>Environmental Performance Measurement</td>
</tr>
<tr>
<td>IEM</td>
<td>Integrated Environmental Management</td>
</tr>
<tr>
<td>ISO</td>
<td>International Organization for Standardization</td>
</tr>
<tr>
<td>MBO</td>
<td>Management by Objectives</td>
</tr>
<tr>
<td>NPM</td>
<td>New Public Management</td>
</tr>
<tr>
<td>PM</td>
<td>Performance Measurement</td>
</tr>
<tr>
<td>PSR</td>
<td>Pressure – State – Response</td>
</tr>
<tr>
<td>SEA</td>
<td>Strategic Environmental Assessment</td>
</tr>
<tr>
<td>SMART</td>
<td>Specific – Measurable – Achievable – Relevant – Time-bound</td>
</tr>
<tr>
<td>SRA</td>
<td>Swedish Rail Administration</td>
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</table>
1. INTRODUCTION

Ecologically sustainable development is becoming an increasingly important concept in the practice of public administration. In Sweden, the process of reorienting traditional environmental policy towards one of sustainable development began in the mid-1990s (Lundqvist, 2004). One of the first measures taken was to condense assorted environmental goals or goal-like expressions from various official policy statements. In May 1998 the Swedish Government presented the result in a Bill proposing 15 national environmental quality objectives to be achieved within one generation, i.e. by 2020-25 (Government Bill, 1998). These objectives were the starting point for a system of environmental governance by objectives and results, involving wide discretion in the selection of instruments for achieving the goals (Edvardsson, 2004; Lundqvist, 2004).

As a means of achieving these objectives, sectoral responsibility, i.e. public authority responsibility for the environment within its scope of practice, was extended. The extension involved integrating the responsibility for ecologically sustainable development into the mandates of 24 public authorities (Government Bill, 2001). These authorities were directed to integrate environmental concerns and resource management into their activities and promote ecological sustainability within their sector in line with the national environmental quality objectives (Lundqvist, 2004). The responsibility involves developing sectoral environmental objectives and targets and integrating the monitoring and evaluation of these objectives into the national monitoring and evaluation of the environmental objectives.

A system based on objectives requires a system checking progress towards the objectives. Furthermore, a system for continuous monitoring and evaluation is a necessary means to gather information about the condition and trends of an ecological system, essential for learning and improving the environmental performance. According to the adaptive management concept, monitoring ‘before and during an intervention enables the system response to be determined and allows managers to learn from past experience’ (Holling, 1978), meaning that learning acquired from on-the-ground actions provides the basis for changes in subsequent actions and policies. The idea of adaptive management is closely linked to similar ideas within business and management (Stankey et al., 2005). Within business, the idea of learning by experience and using acquired knowledge to modify subsequent behaviour is widely discussed. Adaptive management also has a high resemblance to the concept of ‘organisational learning’ (see Argyris & Schön, 1978; Senge, 1990). Both adaptive management and organisational learning focus on enhancing systems to continually increase their capacity for performance.

Many Swedish public authorities are struggling with the important but difficult task of assessing environmental performance and monitoring progress towards national objectives (Swedish Environmental Protection Agency, 2004). One reason for the difficulties could be that tools specifically adapted for assessing public sector environmental performance are lacking (Ramos et al., 2007).

Many research initiatives have been taken with the aim of developing monitoring by improving monitoring methodology, technique or practice within a particular environmental management tool. Some research initiatives related to monitoring of Strategic Environmental Assessment (SEA) are reported by Partidário & Arts (2005) and Nilsson et al. (2009), presenting possible approaches and frameworks for SEA follow-up. Developments of the Environmental Impact Assessment (EIA) follow-up concept have been provided by for example Arts (1998) and Morrison-Saunders & Arts (2004). Furthermore, O’Reilly et al. (2000) provide practical guidance to organisations in selecting relevant, reliable and comparable measures or indicators for Environmental Performance Evaluation (EPE), while Ramos (2007) has developed environmental performance policy indicators for EPE within the public sector. Research has also been conducted on combining and integrat-
ing tools. For example, suggestions have been made to link EIA with Environmental Management System (EMS), in a striving to ensure that environmental monitoring plans proposed in a planning stage are effectively executed in practice (Eccleston & Smythe, 2002; Ridgeway, 2005).

Many research initiatives are hence accomplished by a reductionistic research approach, studying monitoring within one specific management tool. Such research is important as it can contribute to a more effective use of that tool. However, in practice, several tools are generally applied in parallel. Consequently, there is an imperative for a more holistic approach to monitoring, i.e. research that is not connected to one specific tool but rather to a combination of a set of tools. According to Senge (1990), change can best be achieved by ‘seeing the whole’, i.e. how the object being studied interacts with the other constituents of the system. Such focus on the system rather than on the parts of the system is commonly referred to as systems thinking. In this thesis, the reductionistic aim of understanding the parts is used in combination with an effort to understand the whole, meaning that detailed studies of monitoring within specific environmental management tools are combined with studies of the function of the whole environmental monitoring and measuring system of a public authority. Studying the environmental management of public authorities is important, as much has been written on how ecological governance should be designed and how it should function, but much less has been done to empirically determine whether and how such governance is actually working (Lundqvist, 2004).

The research for this thesis was primarily conducted through a case study, studying the contemporary real-life situation of environmental monitoring. The case organisation chosen for the study was the Swedish Rail Administration (SRA), a large public authority responsible for Swedish rail infrastructure.

1.1 Objectives

The overall aim of the thesis is to analyse the practice of environmental monitoring in public authorities. The main objective of these analyses is to identify barriers and possibilities for environmental monitoring as an instrument for improving environmental performance, using the Swedish Rail Administration as a case organisation.

Specific objectives are:

i. To identify the environmental management tools and the organisational activities of SRA in which monitoring is carried out (Papers I, III and V)

ii. To analyse the EMS applied at SRA, specifically its functions for measuring environmental performance (Papers I, II and III)

iii. To analyse the use and function of SEA monitoring and EIA follow-up in relation to infrastructure plans and projects (Papers IV and V)

iv. To analyse barriers to effective environmental monitoring at SRA (Papers III and V)

v. To identify important factors for improved and structured environmental monitoring that can contribute to adaptive environmental management and organisational learning (Papers III, IV and V).

1.2 Scope of the thesis

The public sector consists of many different types of organisations, for example central and local government departments, agencies and public corporations. This thesis considers the central government authority, an administratively autonomous national authority that is subordinate to the government. Central government authorities are responsible for implementing governmental policies, overseeing the provision of many public services and discharging a range of regulatory functions. The empirical research on the central government authority the Swedish Rail Administration was carried out between 2003 and 2006.
There are many environmental management tools, of which EIA, SEA and EMS are some examples. This thesis focuses on these specific tools for the reason that EIA and SEA are important planning tools, required according to legislation. Furthermore, according to a government decision, Swedish central government authorities with special sectoral responsibility for ecological sustainability are required to make Environmental Management Systems (EMS) an integral part of their processes (Lundqvist, 2004).

A limitation of this project was that it was impossible to examine the life cycle of a railway project from the planning stage to construction into operation due to the long time period this involves. Therefore only single projects were examined. Furthermore, rail operation and maintenance projects and railway project and plans were not examined with equal and matching research methods, as the research developed and changed over time.

1.3 Structure of the thesis

The thesis is organised into seven chapters. Following this introduction, Chapter 2 presents the Swedish rail sector and the case organisation and outlines the operations and processes of SRA in which environmental monitoring are carried out. In Chapter 3, the research process and the methodological approaches are described. Chapter 4 gives the theoretical framework. In Chapter 5, the main results from Papers I-V are presented and discussed under the headings: description of environmental monitoring, identification of problems, and suggestions for improvements. Chapter 5 ends with an overall description on how to use monitoring as an instrument for improving environmental performance and presents some results from comparative organisations. Chapter 6 presents conclusions and Chapter 7 provides suggestions for future research.

2. Description of the Swedish rail sector and the case organisation

The Swedish national railway system is strictly governed by regulations and government policies. Important environmental policies are the national transport policy goal and the national environmental quality objectives (Government Bill, 2005; Government Bill, 2006). The transport goal aims at achieving an economically effective and sustainable transportation system, specified in the six sub-goals (i) an accessible transport system, (ii) a high standard of transport quality, (iii) safe traffic, (iv) a good environment, (v) positive regional development, and (vi) a transport system offering equal opportunities (Government Bill, 2006). The national environmental quality objectives describe the desired state of the Swedish environment and provide directions towards ecologically sustainable development. The policy is operationalised in 16 environmental quality objectives. The Ministry of Enterprise, Energy and Communications is responsible for breaking down the policy goals into SRA’s yearly Appropriation Directions, providing the tasks for the fiscal year.

The Swedish railway system consists of roughly 11,000 km of railway, of which about 9000 are electrified (Svensson & Eklund, 2007). The railway infrastructure is owned by SRA, while trains are operated by several different operators. This separation of construction and administration of the railway infrastructure from train operation is a consequence of deregulation of the national state railway monopoly in the 1980s. In 1988 it was decided that the national railway should be split into a public service enterprise responsible for rail transport, the Swedish State Railways, and a body responsible for the rail infrastructure, the Swedish Rail Administration (Jensen & Stelling, 2007). SRA was further divided into a client organisation and several contractor organisations. The infrastructure-owning part of SRA is responsible for railway infrastructure and for planning and managing rail traffic on the state-owned network (see Fig. 1) (Swedish Rail Administration, 2008b). In addition, SRA has sectoral responsibility for the state railway network, meaning that SRA should co-ordinate, provide support and be a driving force in relation to the other parties involved within the sector. SRA is also one of
the 24 Swedish authorities with special sectoral responsibility for ecologically sustainable development.

The operations of SRA can be divided into ‘Planning and Development’ and ‘Operation and Maintenance’. Planning and Development begins with strategic planning (referred to by SRA as action planning), where the strategies for national railway developments are drawn up. The strategies are documented in the national rail plan. A new plan is produced every sixth year. Along with the national action planning, regional transport infrastructure planning is carried out. It is the County Administrative Boards that are responsible for the regional planning, including a programme for regional infrastructure investment (Government Bill, 2006). Resources for constructing the projects in the regional plan are supplied through the appropriations for the Swedish Road and Rail Administration.

Physical planning starts with an initial study where the conditions and needs for a development are clarified. An assessment of the feasibility of the project in relation to the railway function, economy and environmental impacts is also carried out. If the project is approved and the proposal includes several alternative extensions, a more detailed feasibility study is needed. The study analyses, assesses and evaluates the different options. The railway plan that follows focuses on the chosen rail option and the rail design. The railway planning finally results in a construction document prescribing how the construction work should be performed.

Operation and Maintenance involves four components: operation, preventive maintenance, corrective maintenance and reinvestment. Operation is defined as measures with the objective of maintaining the accessibility of the trains without changing the status of the structure (Swedish Rail Administration, 2001). Operation includes four main activities: management of line operation, planning of line use, snow clearance and slipperiness control. Activities defined as maintenance involve actions during the life cycle of a railway unit ‘intended to retain it in, or restore it to, a state in which it can perform the required function’ (International Organization for Standardization, 2001; Swedish Rail Administration, 2001). Examples of such activities are minor installation replacements, clearance of undergrowth (chemical and mechanical), grinding of rails and point switches, screening of ballast, drainage, ditching, shot peening and painting. The maintenance activities are divided into two subtypes: preventive maintenance and corrective maintenance. Preventive maintenance involves predetermined activities on functioning equipment for the purpose of eliminating unplanned traffic stops, whereas corrective maintenance involves restoration after

![Fig. 1. Schematic figure of SRA's operations from a life cycle perspective.](image-url)
failure detection. Finally, reinvestment involves renewal of a part of a facility, performed in order to restore that part of the facility to its original state.

Operation and Maintenance operations are nowadays partially procured on the same basis as investments (Espling, 2007; Swedish Rail Administration, 2008a). Over the past few years, project contracts have become increasingly performance-based, e.g. service level agreements which have penalties if suppliers fail to deliver on specific objectives, triggering innovative activities less likely to occur under conditions of monopoly (Geyer & Davies, 2000). In addition, environmental requirements are increasingly being used in the procurement process. During the course of this doctoral project, SRA underwent major reorganisation. At the onset of the project, the administrative SRA consisted of SRA Traffic, the Railway Regions and Head Office. SRA Traffic administered the traffic and the Railway Regions administered the infrastructure, while Head Office had the overall responsibility for the lines, traffic control and sectoral duties. However, on 1 February 2007 a new organisation entered into force in which the administrative Railway Regions were replaced by two administrative Divisions called the Operations Division and the Investments Division (Swedish Rail Administration, 2008b). Most of the empirical research within this doctoral project took place in the old SRA organisation.

3. R ESEARCH APPROACH

3.1 Research process

Research on environmental management in the operational phase of transport infrastructure is in its infancy, so e.g. environmental management tools generally focus on construction and traffic, whereas operation and maintenance are rather neglected (Faith-Ell, 2005). The research presented in this thesis began with the aim of identifying and quantifying environmental impacts from the operational phase of rail infrastructure. Based on the information obtained, a monitoring system was to be developed. The research was planned from a natural sciences perspective and the tool in focus was EMS, as it was believed to be the most appropriate tool for monitoring environmental aspects of rail operation and maintenance. However, after the initial studies presented in Papers I and II, it became evident that EMS was not operational within the case organisation. Furthermore, the conclusion from the studies was that a monitoring system based on EMS alone was not sufficient for improving the environmental performance of the operational phase. The conclusion was instead that sound environmental management in the operational phase is not possible without continuously ensuring the environmental management measures designed for the Planning and Development phase, as well as continuous monitoring to identify unforeseen effects. Therefore, a more holistic approach to monitoring was taken in which the whole life cycle of the railway facility was included. In addition, the need for a better understanding of the organisational functions and incentives for environmental monitoring, including routines and practice, was acknowledged. As a result of this interest, the research became more interdisciplinary, focusing on the complex relationship between management and environmental actions, using theory from both natural sciences and social sciences. Therefore, the initial aim of the study to quantify environmental impacts from operation and maintenance activities and develop a monitoring system for these aspects was altered. The theories applied in the research and the tools studied are further presented in Chapter 5.

The methods applied within this research project were predominantly of a qualitative nature. Qualitative methods were originally developed in the social sciences to enable researchers to study social and cultural phenomena. However, qualitative research has often been criticised for being subjective and unscientific (Kvale, 1996). The criticisms arise mainly from the school of realism/positivism, where research is believed to give rise to objective, quantifiable scientific facts, free from human influence (Allwood & Eriksson, 1999). In contrast to
positivism stands the school of idealism/relativism, which believes that an objective reality does not exist. According to the relativistic school of thought, all knowledge is subjective. The ontological assumption used in this thesis was that there exists a reality, independent from human cognition but perceived and accessed only through human minds. With this view, environmental change is associated with the independent reality of physical objects. However, the change or the environmental impacts can only be perceived through the consciousness of a person or an organisation, formulated by Burström (2000) in the following statement: 'Environmental change can exist with or without our knowledge, but it is only since we have perceived the changes we can turn them into environmental 'issues' and/or 'problems'.

3.2 Methodology

The method predominantly applied in this study was case study research. According to Yin (2003), a case study is the preferred strategy ‘when a ‘how’ and ‘why’ question is being asked about a contemporary set of events, over which the investigator has little or no control’. A case study is often an investigation of specific real-life phenomena, such as individuals, organisational or managerial processes, programmes and organisational change. Case studies can involve single, multiple or embedded cases (Scholz & Tietje, 2002; Yin, 2003). In the present study, the Swedish public authority SRA was examined as it is one of 15 Swedish government authorities with a central environmental assignment combined with special sectoral responsibility (Government Decision, 2005). Furthermore, a railway authority is interesting as railways are regarded as an environmentally friendly mode of transport (cf. Smith, 2003) and common policy measures for promoting sustainable transport are to promote and prioritise rail transport along with public transport, cycling and walking. Nevertheless, rail authorities can have significant direct and indirect impacts on the environment.

A single case organisation was used, as the holistic research approach to environmental monitoring is a complex endeavour based on a multitude of observations. Therefore, against the weakness of using a single case study stands the advantage of the detailed observations that could be carried out. The assessment was performed by the use of an embedded case study, which means that the case contained more than one sub-unit of analysis (Scholz & Tietje, 2002; Yin, 2003). A case study can be undertaken by several research strategies, i.e. ways of collecting and analysing empirical data. The most recognised strategies are exploratory, descriptive and explanatory case studies (Lundahl & Skärvad, 1999). The present study is best described as exploratory with some descriptive features. An exploratory case study aims at investigating poorly known phenomena, thereby finding new information, generating theory and formulating hypotheses to be tested in further studies.

A total of six studies were performed within the doctoral project. Table 1 summarises these six studies, together with methods, data collection and data analyses. A detailed description of the methodology for each study can be found in the appended papers I-V.
### Table 1. Overview of designs used in the six studies described in Paper I-V

<table>
<thead>
<tr>
<th>Study no</th>
<th>Aim of the study</th>
<th>Study objects</th>
<th>Method for data collection</th>
<th>Data analysis</th>
<th>Paper</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>To evaluate the EMS of SRA, especially its function for monitoring and measuring</td>
<td>SRA Head Office, 3 Railway Regions and one Infrastructure Area Section</td>
<td>Unstructured interviews, direct observation, internal documents</td>
<td>Ad hoc meaning generation</td>
<td>I and III</td>
</tr>
<tr>
<td>2</td>
<td>To provide international experience of environmental management and EMS in rail organisations and to identify good examples</td>
<td>16 railway organisations</td>
<td>Questionnaire survey</td>
<td>Ad hoc meaning generation</td>
<td>I</td>
</tr>
<tr>
<td>3</td>
<td>To analyse the methodology for identification of environmental aspect at SRA with the overall aim of studying the suitability of aspects as benchmarks against environmental performance</td>
<td>Representatives from SRA Head office and 4 Railway Regions</td>
<td>Questionnaire survey, interviews, direct observations, internal documents</td>
<td>Ad hoc meaning generation</td>
<td>II</td>
</tr>
<tr>
<td>4</td>
<td>To develop a performance measurement framework adapted for public organisations, based on experience from SRA</td>
<td>Representatives SRA Head office and 4 Railway Regions</td>
<td>Literature review, focus group interviews</td>
<td>Thematic content analysis including categorisation</td>
<td>III</td>
</tr>
<tr>
<td>5</td>
<td>To examine the type of monitoring carried out and the use of monitoring result within two railway projects with the aim of analysing a potential integration of EIA and EMS as an instrument for improving monitoring practice</td>
<td>Projects ‘Stockholm Södra-Årstaberg New Line’ and ‘East Coast Line - Project Uppsala-Svarfbäcken’ (project managers and environmental coordinators)</td>
<td>Analysing written documentation (including EIA, EMS and EMP documents), unstructured interview with project leaders and environmental coordinators in the projects</td>
<td>Thematic content analysis</td>
<td>V</td>
</tr>
<tr>
<td>6</td>
<td>To gain information and knowledge on monitoring practice and techniques in relation to SEA and transport infrastructure plans</td>
<td>The communication manager at SRA and in 18 Swedish counties</td>
<td>Semi structured telephone interviews.</td>
<td>Thematic content analysis</td>
<td>IV and V</td>
</tr>
</tbody>
</table>
3.2.1 Selection of study objects

The initial focus of the research was on EMS, especially its function for monitoring and measuring. The first study evaluated the EMS of the case organisation, focusing especially on its components for environmental monitoring and measuring activities within operation and maintenance. In Study 2, the environmental management, especially the use of EMS in rail administrations in other countries, was examined. This study was carried out with the aims of documenting international experience of environmental management and EMS in rail organisations and of identifying good examples. The selection of rail administrations for the international survey was based on the following criteria: (i) members of the railway organisation International Union of Railways (UIC) (ii) countries which are OECD members (iii) major railway infrastructure owners in their respective country which are responsible for railway operation and maintenance. These criteria were set up in order for the studied rail administrations to have similar prerequisites as SRA.

Study 3 focused on SRA’s EMS and its procedures for identifying environmental aspects (element of an organisation’s activities or products or services that can interact with the environment (International Organization for Standardization, 2004)). Environmental aspects form the basis of EMS and function as benchmarks against which environmental performance can be assessed (Perotto et al., 2008). A sound and transparent procedure for identifying environmental aspects is thus important. The overall aim of the study was to explore whether the environmental aspects identified at SRA were suitable benchmarks for environmental performance.

Study 4 was carried out as a result of the problems identified in measuring environmental performance. The aim was to contribute to the development of environmental performance measurement tools for public sector organisations.

In Study 5 the construction of two railway projects was studied with the aim of examining environmental monitoring during construction and to analyse whether a linkage of EMS and EIA would be advantageous for improving the environmental performance. Essential criteria for the choice of the case projects ‘Stockholm Södra-Årstaberg New Line’ and ‘East Coast Line - Project Uppsala-Svartbäcken’ was that these projects were the only projects identified as having an EIA based on the new EIA legislation introduced in 1998, but at the time of the study being completed and put into operation.

In Study 6, the aim was to gain more information and knowledge on monitoring practice and techniques in relation to SEA and the national and regional transport infrastructure plans. The managers of communication responsible for the regional transport infrastructure plans within the 21 counties were contacted, as well as the manager of communication responsible for the national transport plan.

3.2.2 Data collection and analysis

Data used for answering and explaining the research questions were collected and analysed with different techniques. Data were collected through different kinds of interviews, including focus group interviews. Furthermore, questionnaires and direct observations were used, as well as reviews of written documents and reports. Along with all the sub-studies, the scientific literature was studied. Important fields of literature were e.g. impact assessment, corporate environmental management, organisational management, evaluation and performance measurement.

Interviews were the main method for data collection in Studies 1, 4, and 6. In the first study a total of nine individuals from different Railway Regions and Departments at SRA were interviewed, mainly by unstructured interviews. The interviews centred on actions and impacts caused by operation and maintenance at SRA, the implementation of EMS at the administrative Railway Regions of SRA, and the function and use of SRA’s system for monitoring environmental performance. Study 4 was based on focus group interviews, conducted with participants from different administrative levels of the SRA.
Three semi-structured focus group interviews were carried out, the first on a regional level with environmental co-ordinators and environmental administrators. This interview focused on the regional environmental management and measurements of performance. The second focus group concentrated on the national level and the overall environmental management, with particular emphasis on measuring environmental performance and the use of indicators. The third focus group also focused on the national level, but the participant had a position within financial support and management and control. The discussion focused on the management and measurement of the strategic objectives and the integration of management tools within the organisation. Study 6, the post-decision stage of the strategic transport infrastructure planning, was examined mainly by telephone interviews. These semi-structured interviews had the explorative purpose of gaining more information about monitoring practice and techniques in relation to regional transport infrastructure planning. Contact was made with the person responsible for each regional transport infrastructure plan, generally the manager of communication within the County Administrative Board. Furthermore, an interview was conducted with the person responsible for the national strategic transport infrastructure planning at SRA.

A questionnaire survey was the primary data collection method in Study 2 and 3. The questionnaire in Study 2 was made up of both quantitative and qualitative questions. The questions were designed and formulated to explore a range of issues related to environmental strategies within rail administrations in an international context. The questions concerned topics such as the adoption of an environmental management system, the certification according to a standard, the existence and content of a monitoring system and the use of environmental objectives or indicators. In Study 3, a questionnaire was sent to the administrative Railway Regions of SRA with the aim of exploring the method used for environmental aspect identification, the type of aspects identified, the composition and expertise of the group performing the identification, and the kind of problems encountered in the process.

As a complement to the interviews, direct observations were conducted in Study 1 and 3. Observations were made through attending environmental audits in the Central and the Southern Regions, as well as attending internal meetings at the Railway Regions. The meetings mainly concerned implementation and operation of the EMS. Furthermore, as part of Study 3, three environmental councils were attended. These councils are held two to three times a year and the participants are the environmental co-ordinators from the Railway Regions, as well as representatives from Head Office.

The data collection for Study 5 was primarily based on reading and analysing written documentation. The documentation analyses were based on project EIA, project management plans including the environmental management plan (EMP), and the final report of projects. The examination of written documentation on projects was combined with unstructured interviews with the project leaders and environmental co-ordinators, as well as with the individuals within the administrative Railway Region responsible for the operating project.

The data were mainly analysed during the research process, unlike data in a quantitative analysis, when they are generally analysed after having been collected. The data analysis for most of the material was based on content analysis (Miles & Huberman, 1994; Kvale, 1996) where data were compressed into fewer content categories. Similar topics or information were marked with a label, allowing the frequency of particular words or phrases in the text to be calculated. In the first three studies, an ad hoc meaning generation approach was used for the data analysis (cf. Kvale, 1996). In this approach, separate techniques are included and used in combinations.

### 3.2.3 Validity and reliability

Validity and reliability are two criteria by which research results are assessed. In their broadest sense, reliability and validity address the quality of the research data and the
appropriateness of the methods used (Cresald, 2003).

Validity in qualitative research has been defined as ‘whether a method investigates what it is intended to investigate’ or ‘the extent to which our observations indeed reflect the phenomena or variables of interest to us’ (Pervin, 1984). Validity is often discussed in terms of construct validity and external validity (Yin, 2003). Construct validity refers to the rigour with which the study was conducted, while external validity deals with knowing whether the results are generalisable or transferable beyond the immediate case.

The construct validity of the studies performed within this thesis was increased primarily through the use of multiple sources of evidence, contributing to triangulation of data. In study 1 and 3 in particular, the validity was increased through the multiple sources of information, combining interviews with direct observations within the organisation and collection of administrative documents. The external validity of the study was more difficult to enhance, as the evidence was based on a single organisational case study. Therefore, the results may be difficult to generalise to other empirical settings. However, according to Yin (2003), case study research relies on analytical generalisation (in contrast to statistical generalisation) in which ‘a previously developed theory is used as a template with which to compare the empirical results of the case study’. Thus, new insights and ideas can be gained even from a single case study. It should further be emphasised that corresponding research of the Swedish Road Administration has revealed similar problems to those identified in this study (Emilsen, 2005; Faith-Ell, 2005; Tilling, 2008), indicating that the results of the case study could be transferable to other organisations and that a particular set of results could be generalised to some broader theory.

The reliability of a research study is decided by its potential repeatability. The objective of high reliability is to ensure that any other investigator at some other time, using the same set of collected data, comes to the same conclusions (Kvale, 1996). The goal of reliability is thus to minimise errors and bias in a study (Yin, 2003). Achieving high reliability in case study research can be done for example through careful documentation of data collected and analyses performed. To increase the reliability of the studies performed within this thesis, such careful documentation of data and analyses was carried out. Case study notes were kept and categorised and case study documentation was classified and stored. In addition, to increase reliability the methods used for data collection as well as the approach to data analysis were described as clearly and transparently as possible. However, a major obstacle to increasing the reliability of the research is that the behaviour of the organisation may change over time after a case study is performed (Scholz & Tietje, 2002).

4. THEORETICAL FRAMEWORK

Research to date in relation to SEA, EIA and EMS has mainly been preoccupied with processes, procedures and practices, while the interest in theory and purpose has been small (Cashmore, 2004; Goh Eng et al., 2006; Retief et al., 2008). The theoretical basis for EIA has been recognised as inadequately developed and poorly defined (Lawrence, 1997; Cashmore, 2004). An explanation could be that the framework of EIA emerged from a political imperative, rather than from a scientific background (Cashmore, 2004). The practice of EIA thus commenced prior to the development of adequate scientific capacity. A theoretical foundation for SEA has also been requested, explaining what SEA is and what it aims to achieve (Retief et al., 2008). Furthermore, the effectiveness of EMS implementation is widely examined in research (e.g. Rondinelli & Vastag, 2000; Melnyk et al., 2003), although research on the development of a comprehensive theoretical framework is largely lacking (Goh Eng et al., 2006).

A central consideration for this doctoral project was that the theoretical origin of SEA and EIA be separated from that of EMS. The theory of SEA and EIA originates primarily from evaluative research and
planning. For example, EIA is described as an uneven mixture of planning theory, traditional scientific theory and discipline-specific social, economic and biological theories (Lawrence, 1997; Cashmore, 2004). In contrast, EMS has evolved from management theory and the need for businesses to improve environmental performance due to more stringent environmental legislation and other measures implemented in society for protecting the environment (International Organization for Standardization, 2004).

One implication of the different theoretical backgrounds is the definition and use of the term ‘monitoring’ (cf. Arts, 1998). The theoretical difference and its consequences for monitoring terminology and practice are described below, as is relevant theory of organisational learning and public administration management.

4.1 Evaluation and planning theory
Monitoring within SEA and EIA generally constitutes one part of the umbrella term ‘environmental follow-up’ (Morrison-Saunders & Arts, 2004). Follow-up encompasses monitoring, evaluation, management and communication. The theoretical origin of follow-up is evaluation research, but it has also been influenced by policy and planning theory (Arts, 1998). Follow-up in evaluation research refers to evaluation of a plan, programme or project after consent has been granted, and is therefore generally referred to as ‘ex post evaluation’. When evaluating plans, conformance is often contrasted to performance (Mastorp & Faludi, 1997). Conformance evaluation is seen as determining conformity between the original plan and changes in the outside world. Conformance evaluation can be achieved through checking compliance against objectives, regulatory requirements or applicable standards. Performance evaluation, on the other hand, involves determining whether the plan plays a role in those decision situations in which it was meant to be used (Barrett & Fudge, 1981; Mastorp & Faludi, 1997). Whether to focus on evaluating the conformance or the performance depends largely on the type of plan. Project plans are expected to have a determinate effect. Therefore evaluation of such plans can follow and measure conformance between what the plan states and the outcomes of intervention. However, for a strategic plan the finished product is a fleeting record of agreements reached (Mastorp & Faludi, 1997). Subsequent changes in the real world therefore do not follow automatically from the plan, as the plan is indicative and mainly forms a frame of reference for negotiations. Evaluating the performance of a plan involves verifying the relationship between the plan’s intentions and environmental or sustainability parameters, i.e. determining how the plan affects the policy-making on an operational level (Arts, 1998; Partidário & Arts, 2005).

As a result of the underlying theories, the focus of the SEA and EIA follow-up is coloured by performance evaluation and conformance evaluation. Recommendations for EIA follow-up involve a focus on changes in the physical environment, determining whether or not the impacts predicted in the ex ante phase of the project occurred (Arts, 1998; Morrison-Saunders & Arts, 2004). SEA follow-up is currently rather unclear and the practical implementation of SEA monitoring is just starting (Hanusch & Glasson, 2008). Nevertheless, the recommendation for SEA follow-up is generally influenced by both performance evaluation and conformance evaluation. For example, Arts (1998) concludes that the critical issues in SEA follow-up are to check to what extent and in which way the objectives and principles of the plan have been realised. Partidário & Fischer (2004) suggest four types of follow-up in relation to SEA including conformance and performance evaluation, while Partidário and Arts (2005) identify five possible pathways for SEA follow-up in which both conformance and performance evolution are included.

4.2 Management and organisational theory
EMS standard ISO 14001 is based on the same principles as the quality management standard ISO 9000 which in turn is founded
on the management strategies of Total Quality Management (TQM) (cf. Hakes, 1991). TQM is based on the philosophy to strive for continually improving quality and customer service, while simultaneously pushing down costs. The principle of continuous improvement refers to an organisation’s ongoing quest for better work methods and organisational processes (Dean & Bowen, 1994).

Monitoring within TQM relies heavily on conformance monitoring or audits, carried out to check the organisation, or a system, process, project or product within the organisation. Audits are ‘generally not concerned with the quality of performance, whether environmental, educational or financial, but rather with the system in place to govern quality’ (Power, 1994). Consequently, environmental audits in EMS do not measure the actual environmental performance. Instead, environmental audits are used for validating the implementation of the management system or for checking compliance with legislation or organisational expectations (Moor & Beelde, 2005).

Continuous improvement is a basic commitment in both quality management system and EMS. However, EMS standard ISO 14001 lacks an operational definition of what continual improvement is and how it should be assessed (Brouwer & Koppen, 2008). ISO 14001 simply explains continual improvement as ‘a process of enhancing the environmental management system in order to achieve improvements in overall environmental performance consistent with the organisation’s environmental policy’ (International Organization for Standardization, 2004). Measurement of performance provides the link between strategy and action and is therefore fundamental to all kinds of management system and for being able to show continuous improvements (Schalkwyk, 1998; Brouwer & Koppen, 2008). Research within TQM shows that new performance measurement systems are needed, incorporating not only financial accountability as in traditional performance measurement systems, but also measuring quality and customer satisfaction (Schalkwyk, 1998). An example of one such innovative tool is the Balanced Scorecard (BSC) (Kaplan & Norton, 1992).

How to measure environmental performance is not expanded upon in ISO 14001 and performance measurement has therefore been described in EPE guidance standard ISO 14031, an optional add-on to the ISO 14001 standard (O’Reilly et al., 2000). The EPE process involves selecting indicators, collecting and analysing data, assessing information against environmental performance criteria, reporting and communicating, reviewing and improving the process. Research into EPE has primarily been conducted within the corporate field and the results have centred on establishing a key set of indicators, corresponding to TQM research on performance indicators (cf. Schalkwyk, 1998). Indicators commonly proposed for EPE relate to environmental efficiency and management measures (Xie & Hayase, 2007), for example regulatory compliance, number of non-conformance reports, number of objectives fulfilled and resource consumption (Ilinitch et al., 1998; Tam et al., 2006).

4.2.1 Organisational learning

Organisational learning was identified in the 1980s as an important factor in increasing organisational performance (Garratt, 1999). But what does organisational learning really mean? It has been defined in several ways. Argyris & Schön (1978) defined it as ‘the detection and correction of faults’. A later definition provided is ‘the process of improving actions through better knowledge and understanding’ (Fiol & Lyles, 1985) or ‘any relatively permanent change in behaviour that occurs as a result of experience’ (Robbins, 1996).

Huber (1991) presents four concepts that he believes are integrally linked to organisational learning: knowledge acquisition, information distribution, information interpretation, and organisational memory. In addition, Argyris & Schön (1978) distinguish between single-loop and double-loop learning. In single-loop learning, the organisation modifies its actions according to the difference between expected and obtained out-
comes. However, it continues with its present policies and goals. Single-loop learning has also been referred to as ‘adaptive learning’ or ‘coping’ (Senge, 1990). In double-loop learning, the organisation questions the values, assumptions, policies and objectives that led to the actions in the first place. Thus, in double-loop learning the organisation is learning about single-loop learning (Argyris & Schön, 1978).

### 4.2.2 Management of public administrations

Within the last 20 years, the OECD countries have reformed their public sectors, as there was a belief that governments were too large, inefficient, ineffective and unresponsive to change (Hood, 1991). This reform is generally known as ‘New Public Management’ (NPM) and is described by OECD as ‘A new paradigm for public management /…/’, aimed at fostering a performance-oriented culture in a less centralised public sector.’ (OECD, 1995). The reform involves more business-influenced management, with closer focus on results in terms of efficiency, effectiveness and quality of service.

As a result of the NPM reform, public administrations have largely transformed and implemented private sector styles of management, such as benchmarking and performance measurement, decentralisation, corporatisation of activities, and a focus on service and client orientation (Hood, 1991; Mathiasen, 1999). Consequently, private management tools such as TQM and performance measurement are now of increasing importance for the public sector.

Railway administrations are not excluded from NPM and railway monopolies in many European countries, including Sweden, have been contracted out since the early 1990s as a consequence of the reform. The importance of contracting out railway administrations has even been specified in an EU Directive (91/440/EEG). As a result, rail traffic has been separated from administration and construction of the infrastructure. Furthermore, planning, construction and maintenance activities are increasingly being carried out as projects, and systems integration is often managed through contract-based transactions. Relying more on project-based modes of organisation is believed to create greater flexibility and adaptability, and thus have the potential to foster innovation and promote effective project leadership (Hobday, 2000). However, project-based organisations have also been associated with some problems. For example, it is well recognised that project-based organisations are weak in co-ordinating processes, promoting cross-project learning and communications, as well as organisational wide learning (Hobday, 2000; Boh, 2007).

Regardless of the NPM reform, the characteristics of public organisations are rather different from those of private, profit-making organisations. For example, public organisations are characterised by more numerous, intangible and conflicting goals, a more rigid hierarchical structure, and sometimes a lower operating efficiency (Poister, 2003; Carroll, 2004). Furthermore, public organisations operate in a political environment dealing not only with efficiency and effectiveness, but also with justice, equity and accountability (Carroll, 2004). Consequently, the NPM reform is not without problems. There are in fact several respects in which traditional views of public administration clash with NPM, e.g. the public sector’s concern for equity and public interests (Mathiasen, 1999). As a consequence, many of the private management tools adopted by public organisations as a result of NPM are not adapted to the public sector environment. Furthermore, the effects of implementing NPM-related management tools and ideas, for example EPE and organisational learning, into the public sector have not been comprehensively explored (e.g. Betts & Holden, 2003; Ramos et al., 2007).

### 5. Results and discussion

This chapter distinguishes between monitoring with the aim of measuring environmental performance and monitoring undertaken within the operations of the organisation. The former type of monitoring is hereafter referred to as environmental performance measurement (EPM) while the latter is referred to as activity monitoring (see Fig. 2).
More specifically, EPM involves gathering and evaluating data to determine whether the organisation is meeting the criteria for environmental performance set by the management of the organisation, i.e. EPM refers to the same process as EPE. However, it is not linked to the ISO 14031 standard. Measurements can be performed at different levels of the organisation, as well as for programmes or projects. The term EPM was chosen instead of the more familiar EPE in order to highlight the focus on internal and ongoing measurement, corresponding to generic performance measurement systems. Methods and tools for EPM can largely be gained from strategic planning, operational research and management science.

Activity monitoring is used as an umbrella term in this thesis for activities performed with the aim of providing information required to ensure that project implementation has the least possible negative impacts on the natural environmental or on human health, and that the activities of the organisation conform with regulations. In addition, activity monitoring is an important part of the operator control principle, stipulated in the Swedish Environmental Code. The methods for activity monitoring generally derive from natural and social science techniques and involve checking e.g. water pollution, soil, biodiversity, air pollution, social environment, etc. Consequently, activity monitoring in the sense in which it is used within this thesis involves several different types of monitoring, which can be defined as follows: Baseline monitoring refers to measurements and recording of existing and changing conditions that will be compared with future observations. It can also be the initial set of measurements, typically done before a system is disturbed by management. Impact monitoring refers to actions enabling actual environmental outcomes to be determined and compared with the predicted impacts. Effectiveness monitoring determines the appropriateness or effectiveness of specific management prescriptions designed and implemented. Compliance monitoring refers to a continuous process of obtaining information on polluting discharges and emissions to ensure that regulatory requirements are observed and standards met. Conformance monitoring means checking whether actions and management are in accordance with some specified standard, for example the international environmental management standard, ISO 14001.

The existing systems for EPM and activity monitoring at SRA are first described. To illustrate the results from the case study, selected phrases with interviewees’ wording are given. This description forms the basis for the subsequent discussion on barriers to effective monitoring, as well as identification of important factors for improved monitor-
ing. There is then a discussion on how the two monitoring systems are paired and on related monitoring research from comparable organisations.

5.1. Monitoring practice

5.1.1. Environmental performance measurement (EPM)

As a result of the New Public Management (NPM) reform, several new management tools have been implemented in governmental organisations (Mathiasen, 1999). One example of such tools in the environmental management field is EMS. In Sweden, EMS has been used within governmental administrations since 1996, as a result of a government decision. The purpose of that decision was to provide for effective environmental work throughout the public sector through systematising environmental management (Lundqvist, 2004).

One important component of the international EMS standard ISO 14001 is monitoring and measurement, which involves recording information to track environmental performance (International Organization for Standardization, 2004). However, how to measure environmental performance within EMS is unclear and practice is generally poor (Emilsson, 2005; Brouwer & Koppen, 2008). Furthermore, specific tools for assessing performance in the public sector are largely lacking (Ramos et al., 2007).

According to the results of this study, SRA had not improved the practice of measuring environmental performance as a direct result of the implementation of EMS (Papers I and II). Analysis of the EMS and the procedures for measuring performance showed that the EMS is a separate and rather isolated management procedure, mainly used by the environmental administrators and the environmental co-ordinators (Lundberg, 2007). The situation is similar in the Swedish Road Administration where EMS has been described as something detached and separate from the general management (Tilling, 2008).

One of the reasons behind SRA’s EMS being detached is that no uniform EMS system exists. Instead, each Railway Region has its own adaptation of EMS (Papers I and II). Such partial use of EMS was also seen in the study of EMS in rail administrations in other countries (Paper I). Consequently, measuring environmental performance within SRA’s EMS is each Region’s own responsibility, while within the strategic and operational planning of the organisation there is a common reporting system for environmental performance. As a consequence, the EMS has no real management function on an overall organisational level.

Another problem with the EMS of SRA is the environmental aspects that are intended to function as benchmarks for environmental performance. The study on the identification of environmental aspects within the organisation (Paper II) revealed that the term ‘aspect’ is unclear and undefined. An aspect was generally perceived as the result of an activity, product or service, for example emissions to air or contamination of soil. However, the term environmental aspect was also commonly used as a synonym to activity, such as in the aspects ‘transportation’ or ‘heating’. In addition, environmental aspect is used as a synonym to environmental impact. Apart from problems in defining environmental aspects, only a few of SRA’s environmental aspects were quantified. The vague definition of environmental aspects, in combination with the limited amount of quantified data, makes it difficult for SRA to monitor its environmental performance and identify possible environmental improvements. At the time of the study, none of SRA’s Railway Regions monitored improvements in environmental performance in relation to the environmental aspects.
Nevertheless, several regional environmental co-ordinators of SRA believed that EMS is a good system that simplifies the environmental management of the organisation. For example, it has been used at regional level to put pressure on managers to include environmental objectives in the operational planning process, as reflected in the following statement:

‘In order to say that we have an environmental management system we need to have environmental goals and objectives, which is our pressure against our business managers and directorate, to include environmental objectives in the operational planning.’

In practice, EPM was not achieved within the EMS of SRA, but rather within the strategic and operational planning process (Lundberg, 2007). Strategic planning has been defined as ‘a disciplined effort to produce fundamental decisions and actions that shape and guide what an organisation is, what it does, and why it does it’ (Bryson, 1995). Similarly to EMS, strategic planning provides a systematic process for establishing a long-term direction for the organisation, and translates that direction into specific goals, objectives and actions. The strategic planning process generally begins by determining the organisation’s primary or strategic objectives, presented in a strategic work plan (Kloot & Martin, 2000). Based on the strategic work plan, operational planning is conducted, explaining how, or what portion of, a strategic plan will be put into operation during a given operational period. The strategic work plan of SRA included, at the time of the study, five strategic environmental objectives (see Table 2). The objectives in the plan correspond to the national environmental quality objectives, the transport policy goal, and the objectives within SRA’s annual Appropriation Directives.

Based on the strategic plan, SRA establishes an operational plan displaying organisational direction and budget for a period of three years. Subsequently, each Region and unit of the organisation identifies separate operational objectives. These operational objectives are generally found in the regional Balanced Scorecard and may include an operational environmental objective (Lundberg, 2007). The Balanced Scorecard (BSC) is a performance management tool, introduced to address the shortcomings of traditional performance systems and the reliance on financial measures (Kaplan & Norton, 1992). Furthermore, BSC is a concept for improving the alignment of operational activities and strategic objectives (Butler et al., 1997). The objectives of SRA presented within the BSC are broken down into targets and measures, mainly formulated according to the ‘specific - measurable - achievable - relevant - time-bound’ (SMART) concept (Morrisey, 1976; Poister, 2003). These tar-

<table>
<thead>
<tr>
<th>Strategic environmental objectives</th>
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<tr>
<td>1. Energy consumption and air emissions per train-kilometre on the state-owned rail network must be reduced</td>
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<tr>
<td>2. The number of people being disturbed by noise and vibrations from rail traffic must decrease</td>
</tr>
<tr>
<td>3. The number of contaminated sites that have a negative impact on people’s health or on biodiversity must decrease</td>
</tr>
<tr>
<td>4. The impact of the rail transport system on the ecological functions of the landscape as well as its cultural character and content must be minimised</td>
</tr>
<tr>
<td>5. The consumption of materials in the railway transport system must be energy- and resource-efficient and the pollution of the environment by the use of hazardous environmental pollutants in the infrastructure must decrease</td>
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Table 2. The five strategic environmental objectives of SRA in 2006
Monitoring as an Instrument for Improving Environmental Performance in Public Authorities

gets and measures thereby reflect the organisation’s strategic choices how to pursue the primary objectives of the organisation. However, SRA’s scorecard only includes critical and prioritised objectives.

'We have a management that is based on the idea of the balanced scorecard. This means that we manage the critical aspects.'

During the operational planning periods 2006-2008 and 2007-2009, no environmental objectives were regarded as critical and consequently no environmental objectives were included in SRA’s general BSC during this time (Lundberg, 2007).

According to the results of the focus group interviews, many individuals within SRA were critical about the use of the BSC (Lundberg, 2007). Most criticism concerned the EPM and the inclusion of only critical aspects in the scorecard, as according to the environmental co-ordinators and environmental administrators it is only the objectives within the scorecard that are properly measured.

'The aspects covered by the balanced scorecard are in focus, while the other aspects are invisible.'

'We have been struggling with the idea that it is only severely and critical aspects that should be included in the balanced scorecard /.../. With the current management we are only correcting faults. Instead we should work in a preventive and effective manner.'

However, according to the Financial Support Department and the Unit for Management and Control objectives and aspects not included in the scorecard should also be examined, although not as formally as the critical objectives (Lundberg, 2007).

'Due to the scorecard model, it is these objectives that we have chosen to measure and account for. The rest of the objectives and aspects should of course be checked, and if something is wrong it must be reported. But it is the critical objectives pointed out in the scorecard that we have to follow and measure.'

The reporting of environmental performance within the strategic planning process is based on two parallel measurement systems. First, the results from the units’ operations are continuously measured and reported to Head Office. Each unit is required to report on: (i) any discrepancy between unit-specific objective and result; (ii) the reason for the discrepancy; (iii) planned or achieved measures to correct the discrepancy; and (iv) a summary of estimated overall performance. Furthermore, each unit of SRA reports quarterly on its achievement of the objectives in the BSC, along with some specified environmental issues. These environmental issues include for example number of people disturbed by noise, measures for reducing noise levels, consumption of fuel, materials and chemicals, energy- and resource-saving measures, and description of mitigation measures for reducing impacts on nature and cultural areas. The results of the unit’s reporting are used as basic data in the Annual and Sector Reports.

'The result and the progress towards strategic objectives are annually accounted for in the Annual Report.'

5.1.2 Activity monitoring

In this thesis, the activity monitoring performed within SRA was structured according to where in the life cycle it occurred, i.e. within Planning and Development or within Operation and Maintenance (see Fig. 1). Decommissioning was not considered, as railway lines are seldom closed down.

Planning and development

Activity monitoring in relation to SRA’s action planning (Fig. 3), more commonly referred to as strategic planning, is to be performed as a result of the Strategic Environmental Assessment (SEA) (Paper V). According to the SEA Directive, monitoring is a requirement, introduced to ensure actions beyond the planning phase and into the implementation phase (Hanusch & Glasson, 2008). The requirements in the SEA Directive thus point to adaptive environmental management of the significant environmental impacts. At SRA, an SEA is established along with the national rail plan (Paper V). According to SRA’s documentation, monitoring of the SEA is to be carried out in the downstream planning phase through the EIAs, the Environmental Management Plans (EMP) of the projects, and in the final environmental account of projects (Paper V). In addition, the outcome of the plan is
to be monitored within the process of the management accounting and the Annual and Sector Reports prepared by the organisation. Activity monitoring is largely decided upon in Environmental Impact Assessments (EIA) conducted in the physical planning phase of railway infrastructure (Paper V). The importance of EIA follow-up is well recognised and widely discussed in the EIA literature (Arts, 1998; Morrison-Saunders & Arts, 2004) as it is through the follow-up that the EIA forecast during pre-decision stages can be considered and ensured during subsequent project implementation and management (Arts et al., 2001). Follow-up is particularly important for monitoring the effectiveness of implementation of mitigation measures. Mitigation encompasses measures such as design changes, pollution control and treatment, commitment to environmental restoration or enhancement, procedural management and compensation (Glasson et al., 2005; Slinn et al., 2007). Appropriate mitigation measures thus constitute the main means by which development projects can be made to focus on results and management of the ‘real, rather than the predicted, impacts’ (Noble & Storey, 2005).

In SRA railway projects, an EIA is established along with both the feasibility study and the railway plan (Fig. 3) (Paper V). The requirement for EIA follow-up and proposals for any follow-up programme are established as part of the EIA for the railway plan. Additional monitoring activities are stipulated in permits. According to the Swedish Environmental Code, permits are generally required for water operations and environmental hazardous activities within a project (Bengtsson, 1999). All monitoring activities planned within physical planning, i.e. within the EIA and within permits, are documented in an environmental programme and attached to the construction document (Paper V). The environmental programme includes the environmental requirements for the project and forms the basis for the subsequent project’s EMP, used during the construction phase. The EMP contains information on how the contractor will accomplish the required set-up in the procurement process, among other things the general environmental requirements and the object-specific environmental requirements. The general environmental requirements are standardised within the organisation (cf. Swedish Rail Administration, 2005), meaning that the general environmental requirements are the same for all procurement processes of SRA. They include demands concerning environmental training, risk assessment and readiness, noise and vibrations, the natural environment, chemical products and materials, waste and wastewater, and reporting. The reporting requirements call for documentation on how the environmental requirements have been taken care of, including monitoring and analysis results, products and chemicals used, as well as non-conformance reporting. The object-specific requirements, on the other hand, include commitments from the EIA process, conditions specified in permits, and other specific measures that are needed for protecting the environment. However, the EMP is the contractor’s document and can therefore contain additional monitoring activities needed, for example due to the operator control principle in the Swedish Environmental Code (cf. Bengtsson, 1999).

Most activity monitoring in SRA is carried out during construction of projects (Paper V). The monitoring is based on the environmental requirements presented in the EMP and in the project organisation’s EMS (Fig. 3). The monitoring and measuring within the project EMS are based on the project’s identified environmental aspects and environmental objectives and on the EMS’s requirement for audit. Common monitoring requirements in EMP and EMS are periodic sampling of levels of waste discharge or emissions to ensure stipulated requirements (Paper V). Another example is the number of times, if any, that construction noise emissions are above the legal level. Consequently, the activity monitoring in the construction phase generally involves compliance monitoring for ensuring regulatory requirements. Such focus on complying with regulations and traditional environmental
Monitoring as an Instrument for Improving Environmental Performance in Public Authorities

Monitoring has also been seen in Danish infrastructure projects, where mitigation measures largely mirror traditional regulation on e.g. discharge of wastewater, noise and air pollution rather than handling the broader concept of the environment, including landscapes and natural habitats (Kornov et al., 2005). However, other types of monitoring activities are carried out in SRA. Impact monitoring, for example monitoring water quality when working with water operations, is commonly required in permits. Finally, the contractor and the project organisations regularly perform environmental audits, checking conformance between project reality and SRA requirements.

Operation and maintenance

The activities of Operation and Maintenance projects are partly decided in a maintenance requirement analysis which is based on condition assessment and maintenance needs (Fig. 3). Based on the analysis, projects are planned and procured. If a permit is needed, the monitoring is specified in the specific environmental requirements and presented in the environmental programme.

The activity monitoring during the operational phase is mainly based on the project organisation’s EMS, the operator control principle, and the general environmental requirements stipulated by SRA (being the same as those for construction) (Paper V). EIAs are not commonly carried out, as operation and maintenance activities usually involve minor environmental impacts. Furthermore, the tradition of environmental management and monitoring within operation and maintenance is not as long as that within construction (Österberg, 2003; FaithEll, 2005). Therefore environmental management measures, including monitoring, are not yet equally visible and transparent within Operation and Maintenance as in Planning and Development. Instead, the management is primarily based on technical standards and detailed procedures.

'The activities within rail operation and maintenance are not typically managed by objectives. It is instead controlled procedures that direct the actions.'

However, SRA’s strategy for rail maintenance states that environmental requirements must be regarded in procurement of operation and maintenance (Swedish Rail Administration, 2007). The operation and maintenance must also ensure that the effects of environmental measures and mitigations are maintained during operation of the facility.

5.2 Monitoring problems identified

5.2.1 Environmental performance measurement (EPM)

The measurement of environmental performance in SRA is divided into two parts, relying on measurements against environmental aspects within EMS and measurements against objectives in the strategic and operational planning system. However, neither of the systems is really effective from an environmental point of view. The measurement of performance within SRA’s operational planning system is based on the five strategic objectives (Paper III). However, these objectives are overly general, vague and open-ended in terms of time (Lundberg, 2007). Furthermore, each objective involves multiple issues and types of environmental impacts. It is therefore difficult or even impossible to specifically display when, or to what extent, the objectives are fulfilled, and to determine environmental outcomes (Paper III). Secondary environmental objectives are principally absent within the SRA general management system, as it is only the prioritised objectives in the BSC that are broken down into targets and measures.

On a regional level of SRA, secondary environmental objectives are applied (Lundberg, 2007). However, the EPM of these objectives is not clearly connected to the strategic objectives. In the general performance measurement literature, the importance of having performance measures at different hierarchical levels of an organisation is widely reported (e.g. Atkinson et al., 1997; Tangen, 2005). The secondary objectives are fundamental for change and improvements, as they reflect the organisation’s strategic choices about how to pursue its strategic objectives and manage for results (Atkinson
et al., 1997; Kloot & Martin, 2000). However, without the connection to the strategic objectives the regional objectives cannot function as determining factors for the overall results of the organisation (Paper III). Furthermore, the environmental objectives of the organisation are not used as benchmarks for EPM. Instead, performance is mainly reported against the requirements specified in the Appropriation Directive. The measurement of performance within SRA’s EMS is based on non-operational aspects without connection to activities or objectives. Consequently, the key characteristics of SRA’s operations and activities that can have a significant impact on the environment are not being measured as stipulated in the ISO 14001 standard (Papers I and II). One of the reasons for the lack of EPM within the EMS could be that EMS is considered an additional system without real management functions, and measuring performance within the EMS is therefore seen as a waste of time and resources.

Feedback on results is an essential component of performance measurement (Poister, 2003). Despite well-formulated objectives and suitable indicators measuring progress towards the objectives, actual improvements are not reached unless employees are motivated and willing to work towards the objectives. There is evidence in the management and psychology literature that feedback or knowledge of results provide a feeling of competence and hence increased motivation to improve performance towards goals and objectives (e.g. Chhokar & Wallin, 1984; Luckett & Eggleton, 1991). Nevertheless, Horngren & Foster (1987) claim that many control systems are weak because managers ignore feedback.

According to results of the focus group interviews, the current feedback of the results from environmental performance in SRA is poor (Paper III). The results of the EPM are only presented within the Annual and Sector Reports and are mainly used for external purposes. Furthermore, the reports only cover progress towards objectives in the Appropriation Directive and the transport policy goal. The progress towards SRA’s strategic environmental objectives is not presented in the reports, nor is it presented internally. This deficiency is expressed in a comment by one of the environmental coordinators at regional level:

‘I think that the employees would be more motivated to improve performance if it was clear to them whether the organisation was performing well or badly. That clarity is, in my opinion, not present today.’

A similar statement was made by one of the individuals in the third focus group:

‘We work a lot with planning and do activity planning, inventories and mapping, but we are really bad at communicating the results.’

In conclusion, the lack of feedback in combination with an unclear structure of EPM has contributed to an overall belief within SRA that measuring environmental performance is a burdensome duty without any real and important function.

5.2.2 Activity monitoring

The main problem identified for the activity monitoring of SRA was a deficiency in transmitting monitoring information between different phases and projects within the organisation (Fig. 3). The limited transmission of monitoring data has resulted in poor utilisation of the environmental monitoring information obtained and thus also a difficulty in achieving an adaptive environmental management.

Monitoring in relation to SEA in the case organisation is intended to be carried out within downstream project planning and accounting, as well as within the Annual and the Sector Report. In other words, the actual monitoring is to be performed both during and after construction of specific projects as well as within the overall Administration and Management of the organisation, ensuring good use of the activity monitoring results. However, in practice the connection to the monitoring at project level is not observable and feedback on monitoring results within the project is not related to the national rail plan or the SEA. Furthermore, the reporting in the Annual and Sector Report is not consistent with the SEA of the strategic plan (Paper V). The monitoring reported in the
Monitoring as an Instrument for Improving Environmental Performance in Public Authorities

Annual Report is only done with regard to the requirements in the Appropriation Directives, while the Sector Report presents progress towards the transport policy goal. Consequently, a transmission problem can be perceived between action planning and overall Administration and Management of the organisation, and between the action planning and the physical planning phase (see Fig. 3, problem area A) (Paper V). Hence, a flexible and adaptive SEA process that contributes to the overall learning of the organisation is not being achieved at the moment.

Secondly, the study of the two rail projects revealed that the findings from the EIAs are not fully utilised for setting up the monitoring activities in the subsequent construction phase (Fig. 3, problem area B). Both rail projects studied conducted a great deal of monitoring activities but most monitoring was not a direct result of the EIA (Paper V). The lack of influence from the EIA has resulted in a lack of monitoring to check the effectiveness of the mitigation measures or monitoring to check the outcome of predicted impacts.

The only requirement for monitoring within EIA that we have is usually to check whether or not we have carried out the mitigation measures specified in the EIA. Instead the monitoring should of course measure the effectiveness of the measures. Then we

Fig. 3. Illustration of data transmission deficiencies between the different phases of a railway project. The specific problem areas are marked A, B, C and D.
could learn something. For example, whether or not it is the most suitable mitigation measure.

Monitoring was instead mainly carried out as a result of the environmental management plan, in which the general environmental requirements and monitoring conditions set in permits were highly influential. The lack of influence from the EIA in SRA’s subsequent project management can partly be explained by the lengthy planning of railway projects. When finally constructing planned projects and setting up the EMP, new management measures have been added and the EIAs are regarded as obsolete. The EMP and the project EMS, in contrast, are dynamic and continuously updated. The EMP and the project EMS are therefore considered more valid than the EIA.

On completion of rail construction, the project is formally delivered into administration. It is the SRA Administrative Data unit that is responsible for making sure that the information from Planning and Development is kept and made available for subsequent incorporation into the specific environmental requirements of Operation and Maintenance projects. However, according to the interviewees from the Administrative Data unit, environmental aspects are not usually included in that formal information transfer between construction and operation (Paper V) (Fig. 3, problem area C). Furthermore, the Administrative Data unit is not good at examining the project material and highlighting control programmes important for the operational phase, nor is the information gained through monitoring in the construction phase transmitted and used in other similar projects.

Nevertheless, a channel for transferring environmental data and information gained from monitoring during construction into the operational phase of the facility was identified in the Final Environmental Report, which is written and distributed on completion of construction (Paper V). Unfortunately, the report is merely stored in the overall document management system, resulting in poor utilisation of the information in the operational phase.

A consequence of the limited transmission of environmental monitoring information between construction and operation is that the effectiveness of management and mitigation measures is not being secured as stipulated in SRA’s maintenance strategy and in recommendations for EIA follow-up (e.g. Morrison-Saunders & Arts, 2004).

Finally, there is potentially a limited or even non-existent flow of monitoring information between Operation and Maintenance and Planning and Development (Fig. 3, problem area D). In order to close the loop and improve the planning of railways, data and knowledge gained during Operation and Maintenance must be transmitted and used in subsequent planning. However, transmission of this particular information was not explicitly examined here and the problem therefore cannot be completely confirmed even though indicated.

An important impediment to the wider usage of activity monitoring information is the feature of project management used for investments, and operation and maintenance (Paper V). It is the permanent organisation, SRA, that has the overall responsibility, but temporary project organisations manage the construction, as well as maintenance and operation measures. The project organisation is dissolved when the construction or maintenance project is finished. As a result, if information and knowledge gained in the temporary project organisation are not automatically transferred to the permanent organisation, that information and knowledge are lost to SRA. Liljegren (2003) studied the contracting out of road maintenance within the Swedish Road Administration and noticed a reduced exchange of information between the Road Regions after the contracting-out of maintenance. The conclusion of that study was that even if greater freedom at the various Regions favours the learning capability, the overall outcome of the division into a client–contractor organisation up to that point was negative for the Road Administration as a learning organisation. The problem of environmental information management in project-based organisations has also been observed by Gluch
(2005) who found that even though environmental impacts caused by the construction process extend beyond completion of the construction project, the boundaries of the environmental impacts are mentally restricted to the time span of the project.

Another reason for the poor usage of environmental information at SRA is the way the monitoring information is reported (Paper V). The monitoring results in e.g. the Final Environmental Report are generally not reported as environmental data, specifying water quality, emissions or noise levels. Instead, the information is presented as the number of times, if any, specified levels or limits were exceeded, i.e. the monitoring information is presented in the form of non-compliances. When such information is handed over to people within other parts of the organisation, it does not contribute any data that could be used for improving knowledge or for changing existing management. Instead, it merely provides information on whether the environmental performance within the project was good or bad and how successfully the project organisation dealt with different environmental issues.

5.3 Suggestions for improving monitoring practice

5.3.1 Environmental performance measurement (EPM)

Improving the measurement of environmental performance at SRA requires a defined criterion against which performance can be measured and a clear structure for the measures and indicators (Paper III). Furthermore, it would be beneficial to align the EPM with the other performance measurements of the organisation using an integrated environmental management approach.

EPM can most easily be aligned with other performance measurements of the organisation by using a clear definition of the term environmental performance, corresponding to the general management of the organisation. The definition of the term EPE, presented in the ISO 14031 standard, generally varies from being the result of an organisation’s management of its environmental aspects to being the state of the environment or the environmental efficiency (Ramos et al., 2009). The general definition of generic performance measurement is determining actual versus planned performance (Morrisey, 1976; Kneeen, 1997), implying observations on progress towards the accomplishment of objectives. Using a traditional performance measurement definition for EPM instead of the unclear definition of EPE would make EPM more analogous to other performance measurements of the organisation and thus also to strategic planning and BSC (Paper III). Furthermore, such a definition of EPM facilitates integrated environmental management (IEM), i.e. considering the environment, economy and society simultaneously. An integrative approach to environmental management has been highlighted by the World Commission on Environment and Development, as well as the Commission of the European Communities (Scrase & Sheate, 2002). Finally, measuring environmental performance against objectives complies with SRA’s responsibility for assessing performance in the railway sector by measuring progress towards national transport and environmental objectives (Paper III).

Furthermore, an improved EPM requires a clear structure or framework for the environmental measures or indicators (Paper III). A clear structure would improve employee understanding of the EPM and increase their motivation to improve performance. Such a framework must incorporate the organisation’s purpose of measurement, be adapted to the specific function of the organisation, and consider both the strategic and operational level of the organisation (Paper III). Paper III proposes such a framework, based on dual subsystems including strategic and operational objectives. Measuring and handling the two levels of objectives separately enables assessments to be adapted to the specific purpose and nature of each type of objective. At strategic level the public organisation-orientated framework of pressure-state-response (PSR)
Kristina Lundberg

is proposed to function as the indicator framework. Deciding the structure of the framework is more important than identifying specific indicators. The reason is that the framework will be stable over time while the indicators continually need to be improved and refined as more experience and insight are gained by the organisation and as the scientific understanding of environmental problems increases. In addition, the indicators will need to be changed or updated due to the fact that organisational environmental objectives are continually being altered and modified.

The PSR framework presents indicator categories for pressure on the environment from human or economic activities (e.g. emissions, consumption and utilisation), the state or condition of the resource or ecosystem as a result of the pressure, and the response by society to change the pressure and state of the environment (OECD, 1993). The indicators proposed for SRA (see Table 1 in Paper III), illustrating the suggested application of the framework, were designed to reflect the environmental performance of both rolling stock and infrastructure. The reason for using a broad set of indicators, i.e. not only focusing on the infrastructure, is due to SRA’s assignments, specifically the sectoral responsibility (Paper III). A further adaptation to the public organisational context is that the indicators are linked and correlated with the national environmental objectives whenever possible. These adaptations distinguish the proposed framework from frameworks appropriate for corresponding private railway organisations. Furthermore, the national reporting of the Swedish environmental quality objectives applies a similar framework for measuring environmental performance (Swedish Protection Agency, 1999). Applying the PSR framework for assessing performance in relation to the strategic environmental objectives of SRA would thus improve the structure and increase normalisation and facilitate benchmarking with other organisations. Furthermore, the framework facilitates an alignment of SRA’s EPM with the measurement of progress towards the national environmental quality objectives (Paper III).

The proposal for EPM on operational level presented in Paper III relies on management-by-objectives (MBO), the principal and most traditional approach to performance management (cf. Drucker, 1955; Poister, 2003). Despite having emerged in the private business field, the idea of MBO is now embodied in many public sector areas, such as education, health and environmental policy (Edvardsson & Hansson, 2005). The reason for suggesting the application of MBO at an operational level of SRA is that those objectives are developed according to the SMART concept to a higher extent than the SRA strategic objectives and are set in participatory agreements, which are crucial factors for MBO (cf. Morrissey, 1976; Rodgers & Hunter, 1992; Poister, 2003). The proposed structure for the operational level of the dual framework comprises five simple steps (Paper III): (1) Environmental objectives should be formulated according to the SMART criteria. (2) Baseline data must be collected or established as a point of departure for subsequent measurement of progress towards each of the objectives. (3) If appropriate, interim targets should be set up, preferably accompanied by a specified time frame. (4) Indicators that can measure progress towards the objectives (or the interim targets) should be chosen according to a set of agreed criteria. (5) Criteria for the accomplishment of the objectives (or the interim targets) should be defined.

EMS did not have apt functions for EPM in the case organisation, but could be beneficial as a tool for strengthening the communication and feedback on environmental results (Paper III). According to Burström von Malmborg (2002), EMS could be seen as a tool for communicative action and organisational learning. In fact, he argued that the main contribution of an EMS would ‘be its provision of an informational, structural and procedural platform for enhanced communication on environmental and sustainable development issues’. In the EPM proposal presented in Paper III, EMS serves as a structure or a toolbox, housing the strategic
and operational objectives as well as the tools for EPM (Fig. 4). Through this, the EMS links the two subsystems presented for EPM and provides overall procedures for communication, enabling better feedback on results (Paper III). The proposed EMS builds on ISO 14001 (International Organization for Standardization, 2004), presenting the same continual system consisting of the establishment of environmental objectives, implementation and operation of programmes to meet these objectives, checking and corrective action, and management review. The strategic objectives of the organisation function as a foundation for the proposed EMS, representing the overall aim of the organisation, while the environmental aspects are simply used in the process of determining environmental objectives. Thus, the environmental aspects provide the important link between activities, impacts and environmental objectives (Paper II).

Based on the strategic objectives, environmental management programme(s) present the responsibilities, activities, schedules, budgets, etc. needed to make progress towards the objectives (Paper III). The proposal advocates an EMS that encompasses the entire organisation, but containing specific, parallel EMS functions at each operational unit. The unit EMS is centred on the secondary objectives and focuses on unit-specific environmental management. However, the unit EMS should be closely coupled with the overall EMS, driven by the strategic environmental objectives, and pre-

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**Fig. 4. An EMS encompassing the two levels of environmental objectives, corresponding EPM, and procedures for feedback**
sent basic data for measuring progress towards the strategic objectives.

Consequently, in the proposed framework each management tool is utilised for its specific purpose, i.e. EMS for strengthening the management procedures and the communication on result, PSR for measuring the sectoral environmental performance and MBO for setting and reaching secondary environmental objectives as determinants for success.

5.3.2 Activity monitoring

A common suggestion in the environmental management literature for improving the transfer of information between different phases of a project and thereby improving the environmental performance during construction and operation has thus been to link the two management tools of EIA and EMS, using EIA follow-up as a ‘bridge’ between the two tools (Ridgeway, 1999; Eccleston & Smythe, 2002). According to these suggestions EIA should focus on predicting impacts, while EMS is the management tool for subsequent management of the real impacts. EMP is suggested to act as the interface between the EIA and the EMS (Marshall, 2002).

It could be argued that the EIA follow-up of SRA was performed in line with the suggestions on linking EIA and EMS, as it was the EMS rather than the EIA that was the operational tool for monitoring during construction (Paper V). Furthermore, an EMP, in which the EIA specifications for monitoring should be presented, was established in line with the recommendations. However, according to the study of the two railway projects, the environmental monitoring specified in the contractors’ EMP and reported in the Final Environmental Report of the projects did not correspond to commitments presented in the preceding EIA. For example, some monitoring of the effectiveness of mitigation measures and commitments for the operation phase had been omitted.

Furthermore, the linkage between EIA and EMS presented in the literature is not enough to improve the information transmission problem within SRA, as different organisational entities involved during the life cycle of a railway have separate EMS (Paper V). The permanent SRA in itself has several EMS (Lundberg et al., 2005), and each project organisation, i.e. rail construction project or rail maintenance project, has its own project EMS. The transmission of information between the various EMS is therefore a problem. Furthermore, a common critique of standard EMS is that they overemphasise the creation of formal procedures, which makes the actors in an organisation focus upon how to act in different situations, instead of focusing on what should be achieved by the action (Jacobsen & Thorsvik, 1998). As a consequence, new environmental problems, identified after the planning phase, that would have required new impact mitigations or management strategies in order to be solved, tend to be systematically ignored. Standard EMS thus seem to inhibit long-term learning and flexibility to deal with new environmental issues (Bürström von Malmborg, 2002).

Instead of using EMS for improving the transfer of information between different phases of a project, theory from organisational learning is suggested for improving the activity monitoring of SRA (Paper V). As for adaptive management, organisational learning involves new organisational knowledge being used as feedback into the planning process. However, according to Huber (1991) learning is incomplete until the individual discoveries, inventions and evaluations are recorded in the medium of an organisational memory. Stein (1995) defines an organisational memory as ‘the means by which knowledge from the past is brought to bear on present activities, thus resulting in higher or lower levels of organisational effectiveness’. The organisational memory contains information that would otherwise be scattered and inaccessible to the individuals of an organisation (Argyris & Schön, 1978). Using an organisational memory for the activity monitoring of SRA could improve distribution and display gaps in knowledge (Paper V). The input to such a system should be gathered within the active
operations of the organisation, i.e. during construction and during operation and maintenance of railway projects. In addition, data from baseline monitoring carried out within EIA processes should be added to the system. Data or information could be project-specific, containing for example information on resource consumption or emissions. It could also be site-specific, specifying an impact on e.g. biodiversity or landscape, or reporting on the effectiveness of a mitigation measure. The possibility of including site-specific data facilitates the reporting of impact and effectiveness monitoring, important for improving the conditions for EIA and SEA follow-up and adaptive management. In action planning along with the establishment of an SEA, the organisational memory can be used as basis data when establishing the environmental objectives used for testing strategic actions and alternatives. Furthermore, the data can be used later for SEA monitoring, checking progress towards the objectives as described by Partidário & Arts (2005). Finally, in the physical planning process the system can be used for establishing realistic project objectives, as well as identifying suitable mitigation measures and management strategies that have proven to be effective in the long run.

5.4 Monitoring as an instrument for improving environmental performance

The analysis in the thesis has hitherto separated EPM and activity monitoring, focusing on improving the function of each system separately. However, in order for an organisation to learn, and from that learning improve its environmental performance, both monitoring systems must be used integrated and in combination. Such integration would mean that important knowledge obtained in one system is incorporated and applied within the other.

However, the systems have slightly different purposes in the overall aim of achieving improvements in performance. As in single-loop learning described by Argyris & Schön (1978), the learning in activity monitoring can be connected to actions that add to the knowledge in organisation-specific routines without altering the fundamental nature of the organisation’s activities or environmental strategies. In contrast, the results from EPM, which is based on data gained in activity monitoring, can question and judge the success and failure of policies and strategies. Hence, EPM can be used as a barometer for modifying organisational policies and strategies, as in double-loop learning (Argyris & Schön, 1978). The modifications of policies and strategies may lead in turn to a change in focus of the activity monitoring. Consequently, only when EPM and activity monitoring are used in combination can the organisation use new knowledge for changing the environmental policies and management and realise true improvements in performance.

The results presented earlier in the thesis showed that SRA’s framework for EPM is not effective and feedback of results is regularly lacking. Furthermore, the results showed that learning from SRA’s activity monitoring is restricted, as the information flow between different projects and phases of activities within the organisation is limited. In addition to these identified difficulties, SRA’s EPM and activity monitoring systems are not sufficiently correlated. The transmission of information between the system for EPM and activity monitoring at SRA is restricted to the quarterly project reporting, which is subsequently used as basic data in the Annual and Sectoral Reports. Consequently, new knowledge gained in the process of activity monitoring is not sufficiently linked to the overall EPM, meaning that the organisation has difficulties in evaluating the overall environmental performance of the organisation and changing policies and strategies accordingly. According to McLain & Lee (1996), the ability of institutions to respond to new knowledge depends on whether they have access to new information and the will and capacity to act on that information. Therefore, the ability of SRA management to respond to new knowledge is currently limited.
5.5 Comparable organisations and international experiences

Environmental monitoring seems to be a problem for public authorities, as for many other organisations. However, few studies have focused specifically on environmental monitoring within the public sector. Some examples are Ramos et al. (2007) and Ramos et al. (2009), who studied environmental performance evaluation in the defence sector in Portugal. According to Ramos et al. (2009), formal EPE was not practised and only half the units surveyed used environmental indicators. Emilsson (2005) studied the strengths and weaknesses of EMS in Swedish local authorities and identified measuring environmental performance as a major weakness.

Some comparative research on the functions for environmental monitoring was also carried out within this doctoral project. First, rail authorities in other countries were examined. The study showed that the majority of the authorities had environmental goals and objectives (Paper I). However, as for the situation at SRA, the environmental objectives were not especially operational, as expressed in following statement:

'We have since 1999, from our board of management, accepted environmental goals, but in reality they do not have a very heavy weight in the daily business.'

Furthermore, the majority of the administrations had no system or framework for measuring progress towards their objectives. Even though many of the administrations had operational environmental indicators, the indicators did not seem to be linked to environmental objectives, measuring progress towards the objectives. The indicators rather constituted a separate management tool, parallel to the objectives. Furthermore, the implementation of EMS did not seem to have improved the arrangements for EPE (Paper I).

The use of monitoring in relation to Swedish regional infrastructure plan was studied here (Paper IV). An SEA should, as a rule, be established along with these plans. However, the long planning period means that current plans for the period 2004-2015 were established before the SEA Directive was implemented in Swedish legislation, and the monitoring requirements for the present plans have therefore been unclear. The study showed that Swedish regional transport infrastructure plans have not hitherto been accompanied by any environmental monitoring activities, nor has any monitoring been planned for the next planning period, 2010-2021. Furthermore, several respondents considered environmental monitoring in relation to regional transport infrastructure plans a pointless bureaucratic exercise. The focus on pre-decision assessment was described by one of the respondents as:

'The most important work is done during the establishment of the plan and the discussions around it, and of course the impact assessment. […] More important than monitoring is therefore to carry through the measures planned for.'

In order to improve monitoring, simple tools and methods were requested.

6. CONCLUSIONS

This thesis analysis of monitoring practice in public authorities revealed two different types of environmental monitoring, EPM, and activity monitoring. EPM involves gathering and evaluating data to determine whether the organisation is meeting the criteria for environmental performance set by the management of the organisation, while activity monitoring provides information required to ensure that project implementation has the least possible negative impacts on the natural environmental or on human health, and that the activities of the organisation conform with regulations. However, both systems experienced difficulties of various kinds. The EPM of SRA had an unclear structure with several systems in parallel. In practice, measurements were mainly determined from the conditions specified in the Appropriation Directive, rather than presenting progress towards organisational objectives. Furthermore, internal feedback on results was largely lacking. In contrast, SRA's activity monitoring was better developed and to a large extent regulated by the organisation, especially in the construction
Monitoring as an Instrument for Improving Environmental Performance in Public Authorities

Nevertheless, the utilisation of the information obtained was poor and limited to the specific project in which it was gathered. In addition, the type of monitoring carried out was strongly influenced by EMS and green procurement, implying a focus on compliance and conformance monitoring. SEA and EIA monitoring was limited or even absent which also resulted in a lack of impact monitoring and effectiveness monitoring. In practice, this means that inputs and outputs to the system, e.g. resource consumption, emissions and waste are generally monitored, while the environmental outcomes or the environmental condition of the system are not checked. This is especially the case for the operational phase of the railway facility. The consequences are that long-term effects of railway projects are not well understood or mitigated.

The main barrier to monitoring in SRA and the comparable organisations studied, was thus, in summary, poor utilization and learning from environmental monitoring information. The deficiencies seem partly to be a result of the contracting out and project-based structure of operations which largely is an effect of the NMR reform. The reform was intended to make Swedish public sector authorities efficient and effective, acting as self-governing organisations. However, the study of SRA shows that operation of the organisation is still strongly influenced by top-down control, while voluntary strategies and management measures are less effective. For example, business-inspired tools for measuring environmental performance are weak and monitoring within projects is mainly carried out to ensure compliance with regulations, while statutory monitoring within the Appropriation Directive is well operated and reported. Environmental management in SRA thus still seems to be in transition from the traditional ‘command and control’ system to a self-administered organisation managed by economic incentives and voluntary management systems.

The lack of monitoring means that the environmental management tools are mainly used for project justification rather than as instruments to better adapt in response to new understandings on the function of the biophysical environment and improve the performance. Furthermore, the shortcoming results in practitioners largely considering monitoring futile, as the monitoring activities do not lead to any direct changes in the organisational management or behaviour. Still, it should be noted that the individuals who took part in these studies showed a high desire to improve environmental performance. They were also very well aware of the importance of monitoring and adaptive management in such improvement. This willingness and knowledge within the organisations can be utilised in future work for promoting ecologically sustainable development.

Several suggestions on how to improve monitoring and make it more efficient have been provided in the thesis. Primarily, it is important to distinguish between EPM and activity monitoring in order to find methods and tools adjusted to the particular monitoring in focus. EPE can benefit from business and management theories on how to improve organisational performance. It would further be beneficial to use EPM more analogous to other performance measurements of an organisation, assessing progress towards strategic objectives and operational objectives. EMS should not serve as an EPM tool but rather as a structure or toolbox for overall environmental management of the organisation, housing specific public-sector adapted tools.

A system for activity monitoring must not only focus on inputs and outputs to the system but also include the effectiveness of mitigation measures and the environmental condition of the system. In addition, in order to improve communication and learning between projects, monitoring data must be better transmitted and utilised within the structure of the permanent organisation. Using an ‘organisational memory’ could improve learning by assembling data that otherwise is scattered and inaccessible to the individuals of the organisation. Hence, such memory or system can facilitate an iterative management process where the monitoring results and the knowledge gained are used
for making future plans and projects more adaptive and improving the environmental performance of the organisation.

7. SUGGESTIONS FOR FUTURE RESEARCH

The environmental monitoring concept is complex and can be further developed. This thesis distinguished between EPM and activity monitoring but the terminology can be elaborated and defined. Improvements of the EPM concept would benefit from close cooperation with management theorists, while the research on activity monitoring has much to gain from the natural sciences and different techniques for ecological environmental monitoring.

Practical experience on barriers and opportunities for environmental monitoring is limited, in particular experience from the public sector. This thesis contributed information on monitoring in central public authorities. However, there are many different types of organisations within the public sector, such as local government departments, agencies, and public corporations. In order to develop theory for environmental monitoring in the public sector, different types of public organisations need to be studied. Tools, frameworks and indicators specifically designed for the public sector must also be tested and evaluated in practice.

Instead of research based on existing practice, previous environmental monitoring research has mainly focused on developing tools and methods. This thesis shows that monitoring is largely considered a pointless bureaucratic exercise, in spite of the available tools. The understanding for essential incentives for organisational environmental monitoring must therefore be improved. Cooperation with e.g. organisational theorists could deepen the understanding on the behaviour of different organisations and its consequences for utilisation of environmental monitoring information. Furthermore, as monitoring largely concerns learning, adaptive management and organisational learning theories should be further integrated in order to improve the management of the natural environment.

Finally, this thesis contributed to a better understanding of the management of environmental aspects in rail operation and maintenance. However, the research is still in its infancy and little is known about the impact from operation and maintenance in the long run. In order to improve the overall environmental performance of transport systems, the impacts of operation and maintenance activities must be better studied and quantified, beneficially from a life cycle perspective.
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