CHALMERS

Green commitment in infrastructure projects

A case study of environmental processes in the construction industry

Master of Science Thesis in the Master's Programme Design and Construction Project Management

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CHALMERS UNIVERSITY OF TECHNOLOGY
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ABSTRACT

During the first decade of the new millennia environmental issues became a part of our everyday lives. One of the issues that have received most attention has been climate change, which is the change of the earth's climate over time. Climate change is partly driven by human activity and the release of CO_2. One example of human activity is the construction industry, which consumes great amounts of energy as well as emits large amount of CO_2. The construction industry has started to handle the environmental impacts, but there seems to be a difference in how the construction of buildings compared to the construction of infrastructure has handled the issue.

The purpose of this Master's thesis is to investigate how a construction company can ensure that their environmental strategy can be implemented in the construction of infrastructure. The aim is to present a possible next step of how infrastructure projects can decrease their environmental impact. The focus of the study has been on CO_2 emission from large infrastructure projects in Sweden and has been carried out as a case study at a construction company. The case study has included semi structured interviews and has been complemented by a literature study. The study has shown that greater attention needs to be put on the supply chain, which most of the CO_2 emissions from infrastructure construction can be related to. Furthermore, current roles and responsibilities for environmental issues were identified as a major obstacle for improvements of the environmental performance. Finally, the study identified that visualization of both environmental impact and the actual decrease of the environmental impact is a vital step for creating incentives for employees in construction projects to work with environmental issues.

Key words: Environment, Green, Management, Construction, Infrastructure, Change

Grönt engagemang i infrastrukturprojekt

Fallstudie av eventuella miljöförändringar i byggbranschen

Examensarbete inom Design and Construction Project Management

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SAMMANFATTNING

Under det första decenniet av det nya årtusendet har miljöfrågorna blivit en del av vår vardag. En av de frågor som har fått mest uppmärksamhet är jordens klimatförändring över tiden. Klimatförändringarna är delvis beroende av den mänskliga verksamhetens utsläpp av CO_2. Byggindustrin är ett exempel på mänsklig aktivitet som förbrukar stora mängder energi och släpper ut stora mängder CO_2. Byggindustrin har börjat hantera dess miljöpåverkan, men det verkar vara en skillnad i hur byggandet av byggnader och byggandet av infrastruktur hanterar detta.

Syftet med examensarbetet är att undersöka hur ett byggföretag kan uppnå att deras miljö strategi kan implementeras inom byggande av infrastruktur. Syftet är också att presentera ett tänkbart nästa steg för hur miljöpåverkan från infrastrukturprojekt kan minskas. Fokus för undersökningen har varit koldioxidutsläpp från stora infrastrukturprojekt i Sverige och har genomförts som en fallstudie på ett Svenskt byggföretag. Fallstudien har bestått av intervjuer och observationer samt kompletterats med en litteraturstudie. Studien har visat att mer uppmärksamhet måste läggas på leveranskedjan eftersom de flesta koldioxidutsläppen kan relateras dit. Dessutom har den nuvarande ansvarsfördelningen för miljöfrågor identifierats som ett hinder för förbättringar av företagets miljöprestanda. Slutligen visade undersökningen att visualisering av både minskad miljöpåverkan och verklig miljöpåverkan är viktiga steg för att skapa incitament för anställda på byggprojekt att utveckla arbetet med miljöfrågor.

Nyckelord: Miljö, Management, Infrastruktur, Byggbranschen, Förändringsprocess

Contents

Preface

During the sunny spring of 2010 this Master Thesis was carried out as the last part of our studies at Chalmers University of Technology.

Firstly, we would like to thank our examiner and supervisor, Ann-Charlotte Stenberg, for all help during the progress of the report. Ann-Charlotte gave us much support and helped us to realize and identify the real conclusions of our findings.

Secondly, we would like to thank the personnel at Skanska's office in Gothenburg, mainly Per-Anders Ericsson and Claes Roxbergh. Thank you Per-Anders for all the times you read our report and spent hours discussing it with us.

Finally, we would like to thank all persons taking time for our interviews.

Göteborg, June 2010

Karl Agestam & Martin Karlsson

1 Introduction

Today, in newspapers, in reports, in daily conversations, on TV, in business relations and in the education systems the issue of human impact on the environment is on the agenda. The issue has become part of our everyday lives, whether we want it or not. The concern for the environment in Sweden has a history that originates in the 1960's (Stenberg & Räisänen, 2006), with for example the debate concerning mercury. During the years, different focus has been addressed in the environmental debate such as chemicals leaking into nature, materials affecting humans' health and emissions destroying the ozone layer. However, environmental issues were for a long time only debated by persons with an exceptional commitment but during the first decade of the new millennia the debate became an issue for everyone.

The last decade the environmental debate has focused more and more on climate change, which is the change of the earth's climate over time. The change occurs due to natural reasons such as variations in the activity of the sun and geotechnical changes, but the changes can also be related to human activity. This debate during the last decade has mainly concerned the last reason, the human activity. The human activity has been verified by several research projects to have an actual impact on the environment, which has been reported by the Intergovernmental Panel on Climate Change (IPCC, 2007). Carbon dioxide (CO_2) emissions have received the most attention in this debate. CO_2 is a greenhouse gas that in the atmosphere hinders the sunrays from leaving the earth; thereby the temperature of the earth increases if the greenhouse gases increases. CO_2 is the most important greenhouse gas from a perspective of human activity and IPCC has concluded that there is a very likely correlation between greenhouse gas emissions caused by humans and the increase of the earth's temperature (IPCC, 2007).

On governmental level environmental issues are debated regularly and governments have tried to establish agreements, with varied success (Baltscheffsky, 2010; Barroso & Reinfeldt, 2008). On national level efforts has been made to decrease the environmental impact by for example trading with CO_2 emission rights and emission taxation (Finansdepartementet, 2009; Miljödepartementet, 2006). Companies that pay attention to these issues and try to decrease their environmental impact have increased in numbers. The number of companies in Sweden that are certified according to ISO 14001, which is an environmental management system, has increased from 1 001 companies in the year 2000 to 5 047 companies in the year 2009 (Babacus AB, 2010). However, standards are not an actual proof that the companies reduce their environmental impact, but the increase of certified companies at least shows that environmental issues have received an increased attention.

A sector that consumes great amounts of energy and emits large amount of CO_2 and consequently has an impact on the natural environment and on climate change, is the construction industry (Stripple, 2001). The construction industry includes everything from the construction of roads and railroads, dams and windmills to cottages and high rise office buildings and within the industry active work concerning environmental issues is performed (Gluch et al., 2007). Infrastructure construction concerns mainly systems for transportation such as roads and railroads, construction of such have an effect on the environment in several ways, e.g. resource consumptions, health effects and ecological effects (Stripple, 2001). Resource consumption and ecological effects include energy consumption and global warming respectively, which are the most important environmental impacts from road construction (Mroueh et al., 2001).

The construction industry has started to handle their environmental impact. Today 81% of the companies in the construction industry in Sweden have persons employed who have environmental issues as their main work task (Gluch et al., 2007). Of those companies, almost half have an environmental manager on top management level, who works with environmental issues from a strategic perspective (Gluch et al., 2007).

The three largest companies on the Swedish construction market are Skanska, NCC and Peab, all of which construct both infrastructure and buildings. These three companies have visions for their environmental commitment and demonstrate an environmental concern. However, looking at their web pages most of the products displayed as environmentally friendly are buildings and the main part of what is written concerning environmental issues is written from a perspective of the construction of buildings (NCC, 2010; Peab, 2010; Skanska, 2010). This is also the case when viewing the trade journals, most of the environmentally focused articles are from a perspective of the construction of buildings (Gluch & Stenberg, 2006). Research within the field also seems to be more focused on construction of buildings than construction of infrastructure. Although the industry has started to evolve towards more environmentally friendly operation, it seems as if there is a clear difference between construction of buildings and infrastructure regarding how environmental issues are incorporated.

There is also a difference in what kind of environmental measures are taken in the different fields. In the construction of buildings several measures have been developed that takes a lifecycle perspective on environmental impact of buildings (Ghumra et al., 2009). Furthermore, Ghumra (2009) conclude that there has been a focus on buildings in terms of government legislation and policies, which has created a gap between buildings and infrastructure construction regarding lifecycle analysis development. The overall perspective taken in the construction of buildings could be called a holistic perspective, meaning that the whole environmental impact during the lifecycle of a construction is more important than the single environmental impacts. The holistic perspective of construction of buildings is emphasized by the use of certification systems, which tries to take in most aspects of the buildings negative impact. For buildings, certification systems such as LEED (Leadership in Energy and Environmental Design) and BREEAM (BRE Environmental Assessment Method) has become internationally viable (Ghumra et al., 2009) and is complemented by for example EU Green building or the Swedish Swan. Altogether there are several systems both on national and international level for buildings, whereas certification systems for infrastructure projects are rare and there are none that is internationally viable.

1.1 Purpose

The above given background establishes that the construction of infrastructure lags behind the construction of buildings concerning environmental performance. The purpose of this study is to investigate how a construction company can ensure that their environmental strategy can be implemented also in the construction of infrastructure. In cooperation with Chalmers University of Technology and Skanska Sweden AB, a case study of four large construction projects was executed. The aim of the study is to identify measures that reduce CO_2 and to investigate were development of measures could be done to reduce CO_2 emissions, which is a part of the company's goal. Furthermore, the aim is to investigate how construction project personnel

perceive their responsibility for reducing CO_2 emissions. Finally, the study identifies incentives as well as organizational obstacles and bottlenecks that are perceived on project level, with the aim to make recommendations for the company to increase their environmental performance.

1.2 Delimitations

The study focuses on a large construction company operating on the Swedish infrastructure construction market. Within the studied company, the focus is on the project organization's point of view and specifically what project level management could do to create a product with less CO_2 emissions. The client's environmental involvement and how the client affect the company has not been included. The role of the client was not considered since the main client in infrastructure projects in Sweden is a newly formed authority, the Swedish Transport Administration, which begun its operation in the spring of 2010 (Trafikverket, 2010a). Since the client has recently changed its organization it is likely that the client's demands also will change shortly, which makes studies considering the demands short-lived.

Furthermore, the study focuses on the construction of infrastructure, where infrastructure is defined as systems that enable transport of goods, people, energy or information. This includes first and foremost roads, railroads, power distribution grids, sewage, water systems and other supporting components. Within the above mentioned definition this thesis focuses on road and railroad infrastructure and supporting structures for those, such as bridges and tunnels. The case study has been done on four larger infrastructure construction projects. Those projects are two traffic junctions including bridges, one road tunnel and one traffic junction combined with road and railroad. As these projects are quite similar in material use, contract sum, planned construction time and environmental demands, suggestions of possible developments can be made.

Finally, as increased environmental work can be seen as an organizational process of change, the choice of literature has focused on change and innovation together with strategy implementation and how individuals make sense out of this.

2 Methodology

In general this study is based on qualitative research, which focuses on understanding how persons perceive situations (Merriam, 1994). The methods used are basically a case study that focuses on interviews and a literature study that aims at creating a context and deepening the knowledge from the case study. The case study has been done from an inductive point of reference, meaning theory that supports the findings will be presented (Merriam, 1994). The qualitative approach was chosen to fit the purpose and aim of this thesis. Purpose and aim was defined in cooperation with the supervisors from Skanska and Chalmers. The delimitations have been developed along with the development of the thesis and originate in constraints regarding time as well as to ensure that the conclusions are validated and exact. The intended readers of this report are students on master's level, researchers and employees in the construction industry.

2.1 Literature review

The literature review includes both a literature study of environmental problems in the infrastructure construction sector and a study of management theories important for developing environmental performance. The study focused on CO_2 emissions, which is a global environmental problem with a great affect on the global warming (IPCC, 2007). CO_2 emissions were chosen as a focus of the study due to the alarming character of the problem and since reducing CO_2 emissions is a part of the studied company's goal. A literature study was done in the field of management, mainly change and innovation, strategy and strategy implementation and sense making were addressed. This aimed at finding reasons and solutions to organizational obstacles, to interpret the findings from the interviews and to facilitate conclusions and deeper knowledge.

2.2 Case Study

The foundation for this report is a case study, which is a depth study of a small number of organizations (Easterby-Smith et al., 2002). The case study was done on four large infrastructure construction projects that were chosen due to their similarity. Contract sum, construction time, organization, type of structure and the materials used were comparable, consequently leading to similarity in environmental impact in terms of CO_2 emissions. The projects' similarity were sought to enable conclusions that are valid for the type of projects. The study has been done mainly in the form of interviews. The interviews have been complemented by field observations, which took place at the same occasion as the interviews, and by analyzing written material from the studied company and the projects specifically. The observations were done to increase the knowledge regarding the projects and to put the data from the interviews in a perspective. According to Merriam (1994) observations create a deeper understanding of the findings obtained.

The interviews have been semi structured and both simple questions with fairly direct answers and more open-ended questions have been asked. Most interviews have also been concluded with discussions concerning the questions asked. The interviews were done in March 2010, took approximately one hour and were done on the construction site where the interviewee worked. Furthermore, the interviews were recorded and supported with notes taken during the interviews. The method was chosen since projects in the construction business are heavily influenced by verbal communication

(Gluch, 2005) and therefore a focus on interviews and observations is vital to map measures taken. Documented material from the projects has also been taken into account to support the interviews as well as to establish a description of the situation for the projects.

Mainly the interviews circulated around the following question:

- How do employees in the projects perceive action done to decrease environmental impact?
- What driving forces exist for persons in the project to work with reducing CO_2 emissions?
- Which roles are perceived as most important for this work?
- How is the responsibility perceived for working with reducing CO_2 emissions?

The projects and the persons interviewed are anonymous in the report. Instead, the projects are mentioned in general and persons are referred to in groups or in their formal role. The persons interviewed were chosen to provide a picture of how people on management level in the projects perceive work concerning the environment. All together 16 interviews were done, of which 12 with persons at projects, which included: project managers, production managers, work supervisors, purchase managers and environment health and safety officer (EHS). Those interviews were complemented by interviews with two persons in the Environmental Support Group and two experts in construction project management. The interviews with the persons on the projects followed a guideline with questions, which were similar on all interviews. The other interviews did not follow the same strict guideline, it was rather conducted as an open discussion, both on site and on telephone.

Environmental problems were addressed to create a context for the case study and the interviews performed, thereby for the discussion as well. The focus on CO_2 emissions from transportation and use of materials has in the case study acted as a driver of the discussion during the interviews. Furthermore, the focus has also acted as a basis for analyzing the case from a perspective of a global environmental problem.

2.3 Reliability and validity

The reliability and validity of a study is hard to measure for a case study in whole, instead the used methods for data collection and analyses has to be discussed (Merriam, 1994). The interviews have been analyzed through categorization of quotations and general ideas expressed by the interviewees. The main categories were “environmental measures”, “driving forces and obstacles” and “responsibility and follow up”. Those categories were divided into subcategories, within the subcategories conclusions was drawn based on the similarity or dissimilarity of the interviewees answers. In the end this made it possible to draw some general conclusions. But the study was only done on the infrastructure division in one construction company. Therefore, drawing further conclusions concerning the whole construction sector or the infrastructure sector should be done with caution and should be supplemented with further studies. However, the study describes the studied projects well and covers a sufficient part of the organization to learn from the results. The overall findings would most probably be found the same by a similar investigation done at the same time, but as time change the findings will hopefully also change.

3 Frame of reference

The purpose of this section is to explain the environmental context of CO_2 emissions in the construction of infrastructure. Management ideas important for an organization to understand, when exposed to external and internal factors of change related to environmental issues, will also be presented. Furthermore the purpose is to show the connection between environmental problems and management theory and how these ideas can work as a solution.

3.1 Environmental issues in a construction context

This chapter presents general ideas of how environmental issues are framed in the construction of infrastructure. Also the environmental impact in terms of CO_2 emissions that originates from the construction of infrastructure is presented.

3.1.1 Definition of the concepts environment and green

The debate concerning the environment and the human impact on the environment has diffused what environmental measures really mean. Environmental issues have been addressed by governments, companies, researchers etc. However, the concept is still not clearly defined and still depends much of the present actors (Stenberg & Räisänen, 2006). This study takes its stance in that the concept "environment" means the natural environment, which includes the natural world of land, sea, air, plants and animals (Collins Cobuild, 2003). "Environmental impact" is viewed as the negative impact that humans have on the environment, the impact being in the broadest sense. "Environmental measures" are referred to as actions done to reduce the environmental impact.

The term "green" has emerged as a concept of something that has a decreased environmental impact compared to similar products or processes. In the construction sector the term has been used together with "building", e.g. "green building" which has a reduced impact on the environment (Stenberg & Räisänen, 2006; Gluch, 2005). The concept "green building" in this report shall not be confused with building meaning a house, but rather building as the process of a construction project. Stenberg (2006) argues that the concept of "green building" in the construction sector is flexible and depends on the group that uses it, which makes the concept change over time and space. This also means that the flexibility of the concept can act as a driver of change and development (Stenberg, 2006). Furthermore, the group that uses the concept most rhetorically successful influences the present meaning of "green building" (Stenberg & Räisänen, 2006). Corporate greening, or simply greening, refers to the "process of adopting green principles and practices in as many facets of the business as it is possible to do so" (Clegg et al., 2008). Greening is becoming popular since both environment and economy has been addressed, following the argument that waste both is bad for the environment and also cost money. However, Clegg et al. (2008) argues that when the simple green measures are taken and the easy wins are won, it becomes harder to gain double dividends.

3.1.2 Infrastructure construction's CO_2 emissions

As mentioned in "Methodology" (chapter 3), CO_2 has been chosen as a subject for the case study when carrying out the interviews and has acted as an example of environmental impact. The impact of CO_2 emission is furthermore an example of global environmental impact, which has the characteristics of not just affecting the local surroundings, but the global system of the earth (IPCC, 2007).

Infrastructure in this report refers to road and railroad infrastructure. Research of environmental impact of road and railroad infrastructure in a lifecycle perspective, often emphasizes emissions from operation of vehicles, called direct emissions, in a too high degree (Miliutenko, 2010; Stripple, 2001). The indirect emissions, including construction of infrastructure and production of cars and fuel, contribute with a considerable part of the emissions (Miliutenko, 2010). The energy consumption related to the construction, maintenance and demolition of road and railroad generate approximately ¼ of the total energy consumption from the whole system, including direct consumption from cars and trains (Jonsson, 2005). Of this fourth, 80% is related to the construction of road systems and the corresponding figure for railroad systems is 50% (Jonsson, 2005). Jonsson conclude his report with that energy consumption generated by the construction of infrastructure is not negligible. Jonsson uses the construction of the South Link in Stockholm, a large road and traffic junction project, as an example. The construction of the project consumes approximately the same amount as the energy consumption of the total car travel during 10 years for the people living in Nacka and Värmdö (with over 120 000 inhabitants altogether), two communities that are likely to use the South Link. Chester (2009) on the other hand found that the construction of infrastructure for road systems has a fairly small impact compared to the operation of vehicles. However, for the construction of railroad system the construction phase has a significant impact (Chester, 2009). Despite the different opinions the construction of infrastructure seems to have an evident environmental impact in terms of CO_2 emissions.

Most reports reviewed in this study that has focused on infrastructure construction have addressed energy consumption and not CO_2. The relationship between those depends on to which degree fossil fuel has been used to produce the energy. The relationship between energy production and CO_2 emissions becomes weaker if the amount of fossil fuel decrease (Chester, 2009). The world is highly dependent on fossil fuel for the supply of energy (Näringslivets Ekonomifakta AB, 2010), due to that energy consumption and CO_2 emissions are often correlated.

Crushing of material, transportation of material and production of material, such as bitumen and cement, is the most significant energy consuming operations in road construction (Mroueh et al., 2001). Transportation is to a high degree dependent on fossil fuel as energy resource and thereby emits CO_2. Steel and iron products are significant for the consumption of energy in the construction of railroad (Svensson & Eklund, 2007). According to the Swedish Environmental Protection Agency, industry processes stood for almost 9.4% of the total CO_2 emissions in Sweden 2006. Those industry processes are dominated by iron, steel and cement production (Wrådhe, 2007), which is essential ingredients in concrete structures. Chester (2009) identifies the reduction of concrete or the use of concrete with less CO_2 emissions as measures that would significantly improve the environmental impact of infrastructure construction projects. As previously established CO_2 is an essential problem and might be the key for reducing climate change. However, Ghumra et al. (2009) questions if CO_2 really is that important as a single problem. Instead they emphasize that a general lifecycle perspective is more important since that takes in all environmental impacts. But, in terms of CO_2 emissions the most significant impact can be related to two areas; firstly, transportation of products and material and secondly, production of products and material in the supply chain.

3.2 Theoretical perspectives

Environmentally related research has mainly focused on developing managerial and measurement tools for improved operational efficiency to handle environmental problems (Stenberg, 2006). Specifically within the construction industry, research has focused on the actual product and minimization of the environmental impact from the industry. However, it is important to examine greening as a process of change, instead of a product (Stenberg, 2006). According to Stenberg, this calls for a greater attention to how people frame and make sense of environmental problems and how they act upon the problems. Stenberg & Kadefors (2000) suggests that greening may be framed as an innovation process since there is a need for more knowledge and technology as well as a need for new behaviours and value systems.

3.2.1 Change and innovation

Change is a fundamental concept and is defined as "a transition from one state to another" by Clegg et al. (2008). Change is a process that often fails due to communication difficulties (Clegg et al., 2008; Price & Chahal, 2006). In the process, top management involvement is essential to create a vision and accomplish change through "consultation rather than by diktat" (Price & Chahal, 2006), which emphasizes the importance of communication.

According to Hammer and Champy (1993), an organization must first understand their current situation before suggesting improvements. Answering "what needs to be done" before "how to do it" is a fundamental factor when companies undergo change (Hammer & Champy, 1993). Guidelines are often provided on how to identify a current state as well as what is needed for a change to become successful. Price & Chahal (2006) suggest some questions to ensure control of the change process: who owns the change?; who is supposed to implement the change?; who will the change have an impact on?. Furthermore, they state that it is widely recognized that every change needs a champion. According to Markham (1998) a champion is defined as a person "who adopts the project as their own and show personal commitment to it, contributes to the project by generating support from other people in the firm and advocates the project beyond job requirement in a distinct manner". Although, Markham (1998) found no evidence of a direct effect of a champion related to project success, only an indirect effect of champions on other people and processes in an organization has been observed. In an article by Stenberg & Kadefors (2000) a case study was made which emphasized the importance of personal commitment and the role of champions when working with "greening" in the construction industry.

The creation of a new product, service or process that affects the way the organization functions is called an innovation (Clegg et al., 2008). While Hekkert et al. (2007) focus more, regarding innovation, on the actual use of the organizations knowledge and the combination of knowledge into a successful result. Hekkert (2007) also stresses innovation as a factor that is decisive for long term economical growth. Innovation is often referred to as a process that is driven by several driving forces and influenced by many stakeholders. The difficulties surrounding the process are determined by the surrounding the organization exists in and what surrounding the innovation takes place in (Clegg et al., 2008). "Creative companies employ creative people" to enable innovation (Clegg et al., 2008). However, the creative persons have to be managed. When managing creative persons it is important to protect the innovation process to ensure that managers do not destroy creativity too early.

Deadlines are vital to ensure the innovation process and so is a defined ending (Clegg et al., 2008).

Communication skills are particularly essential when managing innovation. Everyone involved in the process has to understand other colleagues' view point, deadline, budget etc. However, organizations are often better at handling responsibilities for timelines, budgets and goals, than they are at communication and empowering creativity (Clegg et al., 2008). Empowering creativity is a balancing game between the tension of freedom and the responsibility that is given to the people working with the innovation. Managing creativity is also hard since innovation requires elements of surprise, which makes it a process that is unpredictable and hard to control (Clegg et al., 2008). One way of managing innovation is by "establishing safe playgrounds" (Clegg et al., 2008), where ideas can flourish without being nagged down by limitations when first articulated. To facilitate the processes of innovation, leadership skills are required by the responsible manager as well as involvement of top management (Clegg et al., 2008).

The construction industry consists of many project based organizations as everything built has a given start and end, limited budget and resources and people responsible for decisions made related to this. According to Gluch (2010) this will inevitably lead to a decentralized decision making culture within construction companies, heavily influenced by permanent processes enforced by top management. These two aspects influence the development of innovation and how a change of communication is needed (Fryer & Fryer, 1996).

Construction projects are known for preferring face to face communication to a high degree (Gluch, 2005). The project organization are often innovative, but the learning's from the innovations often stays with the person or persons concerned and is not widely shared (Winch, 2002). It is not obvious what the actual knowledge is, since construction projects and solutions to problems are difficult and complex, thus meaning that a lot of the knowledge is tacit, i.e. not spoken or written down. Thereby the key lies in the conversion of tacit knowledge to explicit forms to enable organizational learning and innovation (Senaratne & Sexton, 2008). The verbal culture of the construction industry means that a great amount of discussions and dialogues takes place and ensures knowledge and learning, but not until this knowledge and learning is learned, codified and used in upcoming projects has it become an innovation (Senaratne & Sexton, 2008).

3.2.2 Strategy and strategy implementation

The concept of strategy relates to the knowledge of an organization's interaction with its surrounding together with its use of resources. Features like long-term goal and market forces influence a strategy (Björnström, 2007). Furthermore Johnson et al. (2005) define strategy as: "The direction and scope of an organization over a long term, which achieves advantage in a changing environment through its configuration of resources and competences with the aim of fulfilling stakeholder expectations".

Working with strategy today has become referred to as strategic management (Björnström, 2007; Chinowsky & Byrd, 2001). Strategic management, according to Johnson et al. (2005), involves formulating strategies as well as implementing the formulated strategy. Many strategies fail to get implemented, which leads to that the implementation process can be done more effective (Björnström, 2007; Allio, 2005). It is widely supported by many researchers that communicating a planned strategy

correctly throughout the organization is important for implementation success. This depends on type of strategy, the structure of the organization and type of business (Räisänen & Björnström, 2007). Top management tends to communicate strategies with written documents which can lead to disregard of viewing communication as a dynamic process (Björnström, 2007).

The construction industry is project intense, which makes effective communication hard (Björnström, 2007; Fryer & Fryer, 1996). People in projects often comes from different companies and work in the project for a limited time. Communication is done verbally to a large extent and interacts with written documents (Gluch, 2005; Fryer & Fryer, 1996). Furthermore, the amount of information that needs to be communicated is large and people often produce too much or too little information, which makes information inaccurate and misleading (Fryer & Fryer, 1996). A gap in consensus between top management and management on operational level often exists (McDermott & Boyer, 1999) resulting in that strategy becomes hard to implement if communication is not changed throughout the organization to fit its context (Björnström et al., 2007).

Another aspect which determines the success of a strategy is that all people in the organization, from top management to the employees in the production, must be committed to the strategy. According to Björnström (2007) the individual member must feel that he/she is taking part of, and affecting, the implementation and not just following top management strategy. Understanding how a strategy should be incorporated in everyday work will lead to a better implementation of the strategy (Porter, 1996). Implementing a strategy can be seen as a continuous process with unclear beginning and uncertain end (Björnström, 2007).

Environmental strategy and management

The environmental performance of an organization has been defined as the total environmental impact the organization has on the natural environment (Klassen & Whybark, 1999). Environmental strategy refers to the measures a company takes to reduce the environmental impact, including both actions taken to comply with regulations and those taken voluntary (Sharma, 2000). According to Claver et al. (2007) there are some categories that influence the environmental strategy and its performance.

Regulations set by a government are one force of influence, which according to Claver et al. (2007) are seen as the main influence for organizations to work with environmental issues. Regulations today focus mainly on end-of-pipe solutions instead of preventive measures and end-of-pipe solutions do not create incentives for organizations to go beyond regulations (Brunnermeier & Cohen, 2003). The influence of stakeholders is another category that pressures the behaviour of organizations to work with the environmental impact an organization is responsible for (Claver et al., 2007). Environmental demands from clients on contractors in the construction industry can be seen as one example of pressure that influences organizations behaviour since companies want to remain competitive on the market.

Kolk (2000) argues that organizations respond differently to the external pressures mentioned above. Organizational response can be categorized in four different types: reactive, defensive, accommodative and proactive (RDAP-scale), see Table 1. It is hard to clearly categorize a company's overall performance and the scale should not be viewed as series of steps that can be taken. However, the scale can be useful for

classifying which approach an organization or part of an organization has at a given moment (Kolk, 2000).

Table 1 *RDAP scale* (Clarkson, 1995)

Type of reaction	Posture or strategy	Performance
Reactive	Deny responsibility	Doing less than required
Defensive	Admit responsibility but fight it	Doing the least that is required
Accommodative	Accept responsibility	Doing all that is required
Proactive	Anticipate responsibility	Doing more than is required

Three different types of categories can be assessed using environmental management as a strategic approach. Those are environmental risk, control of supply chain and green capabilities (Kolk, 2000). The risk of encountering an environmental disaster as a result of a company's actions demands companies to manage the uncertainties in the best possible way in order to try to avoid it, or if it occurs, handle them. Control of supply chain, analyzing the life-cycles and environmental impact, unfolds the dependency network and increases the strategic control over partners in the supply chain. Green capabilities refer to the company's possibility to seize market opportunities by developing the company's commitment and capability in relation to the environment (Kolk, 2000).

As companies realizes the importance of dealing with environmental issues environmental departments are created, environmental decisions are incorporated in logistics and purchase and companies strategically market themselves accordingly (Kolk, 2000). A method of managing environmental issues is by using environmental management systems, which are used to achieve and maintain a behaviour that will reduce the impact on the environment the organization operates in (Claver et al., 2007). Examples of standardized systems are ISO 14001, of the International Organization of Standardization, and EMAS, (Eco-Management and Audit Scheme) of the European Union. Those have been developed to display companies' compliance with laws and their environmental performance (Kolk, 2000).

Certification systems have furthermore been developed to increase the environmental performance, particularly LEED and BREEAM addresses the construction industry. These tools are well established and based on lifecycle perspectives, BREEAM addresses buildings, LEED do as well but is also applicable on infrastructure (Ghumra et al., 2009), but the applicability is not fully developed. In United Kingdom, Civil Engineering Environmental Quality Assessment and Award Scheme (CEEQUAL) has emerged as a tool for assessing infrastructure construction projects (Ghumra et al., 2009). CEEQUAL is based on a number of questions that evaluates a construction project, but is not based on lifecycle methodology. Ghumra et al. (2009) identifies that there is a need for a lifecycle based tool specifically designed for infrastructure projects.

3.2.3 Sense-making

Sense-making is the concept of "collections of people trying to make sense of what is happening around them" (Weick, 2001). Everyone is trying to make sense of everything surrounding them, all the time (Clegg et al., 2008). As making sense of

issues are highly based on individuals (Weick, 2001), understanding the meaning of different strategies should be facilitated through communication and interactions of individuals (Björnström, 2007). An organization is constantly dealing with how issues are framed, viewed upon and made sense of as an organization consists of individuals working together towards a common goal (Clegg et al., 2008; Stenberg, 2006). It is important for organizations that the members within the organization are making the same sense of core activities so that the organization is heading in the same direction (Clegg et al., 2008).

According to Stinger and Uchenick (1986) (obtained from Björnström & Räisänen, 2007) strategies do not fail due to poor strategies, but rather because the strategies is poorly understood by the members in the organization, which emphasizes the importance of sense-making. A strategy must make sense for everyone involved to become incorporated on an everyday basis (Porter, 1996). Björnström & Räisänen (2006) identified middle management together with project managers as key roles for implementation of strategy in a large construction company. Middle management is seen as gatekeepers with possibilities to influence both top management and project management. Project manager have an important translation responsibility in order to obtain commitment from everyone involved in construction projects (Björnström & Räisänen, 2006).

According to the presented theories, commitment is a vital aspect for achieving success during a process of change. Furthermore, the theories present the importance of sense-making during change and innovation as well as during the implementation of strategies. Finally is communication, specifically in the construction industry, expressed as an important aspect both for the process of strategy implementation and for the process of change and innovation.

4 Findings

This chapter presents the company and the studied projects as well as the most important findings obtained in the case study of four large infrastructure projects. Information of the studied company and the studied projects has been collected from the studied projects as well as from Skanska's intranet. The findings obtained through the interviews has been supported and compared with documents, provided by the company. Furthermore, environmental measures are identified as well as aspects like organizational bottlenecks, obstacles, driving forces, roles and responsibilities.

4.1 Description of the construction company

In Sweden, the studied company employs approximately 9 400 persons, and is one of Sweden's top three construction companies and has a history dating back to 1887 (Skanska, 2010). The company operates on the construction market including both infrastructure and building projects, the proportion of building and infrastructure projects are similar in terms of money (Skanska AB, 2009a, p.21). The size of the projects has the full range in terms of contract sum, time and complexity. The construction market has clients that are both public and private, where private clients originate both from Sweden and other countries. However, Swedish public clients dominate the construction of infrastructure.

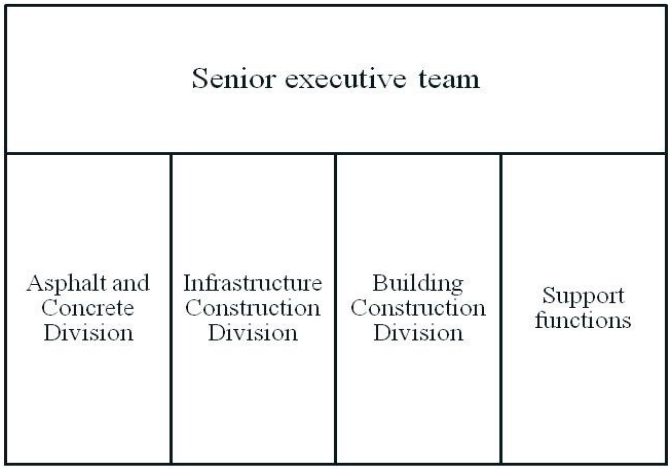

Figure 1 Simplified organizational chart of Skanska Sweden AB

In the construction company the senior executive team is on the highest level, as seen in Figure 1. The organization consists of different divisions and support functions. The divisions are Asphalt and Concrete, Infrastructure Construction and Building Construction, and within those the construction projects are organized. Support functions include for example Economy, Human Resources and the Environmental Support Group. The Environmental Support Group has the responsibility to support the production by creating opportunities for environmental business and to ensure that laws, client demands and the company's demands are fulfilled. Furthermore, the Environmental Support Group supports managers' formulation of the divisions' business plans, meaning identifying and setting goals regarding environmental issues within the related division. The Environmental Support Group is funded 70% centrally and 30% by acting as an internal consultant, according to the interviews. The Central Purchase Unit is also a part of support functions. The unit has the

responsibility to assist the projects with purchasing service and to provide the best price on products and material. In this report the senior executive team is referred to as top management. The managers for the divisions and their subordinates are referred to as middle management. Managers on project level are referred to as project management.

4.1.1 Environmental commitment

The studied company concerns environmental issues in their strategy:

"To be an industry leader in green building and sustainability, particularly in occupational health and safety, ethics and environment" (Skanska AB, 2010)

"To enhance green expertise throughout our operations" (Skanska AB, 2010)

The CEO of the company has expressed that the driving force for working with environmental issues is partly connected to a concern for environmental issues and partly for economical benefits. The CEO also expresses that the company is motivated by using less resource which is both beneficial for the environment as well as cost effective (Skanska AB, 2009b).

In the company's annual report a chapter is dedicated to sustainable development of which a part concerns the environmental impact related to the construction industry, such as CO_2 emissions and energy consumption. More information is given concerning the measures taken by the company to reduce the impact, such as the different environmental certification systems used and projects fulfilling those. In the annual report it is expressed that the goal is:

"To take the concept of green construction significantly further than is expected of today's construction companies" (Skanska AB, 2009a)

The company has made investments in different kinds of environmental certifications, such as LEED, EU GreenBuilding, the Swedish Swan and ISO 14001. In addition they have printed environmental brochures with the aim of putting more focus to environmental issues within the construction industry as well as marketing the company as green, as for example "Green thinking" and "Little green" (Skanska AB, 2009b; Skanska, 2008). The company has also held seminars for clients and suppliers to increase the environmental commitment within the construction industry in general, as presented on the company's internal network.

Furthermore, in the company's internal network a number of developed concepts has been observed. Concepts like "Green Workplace", "Green toolbox" and "Green solutions" are examples that support employees with their environmental work in construction as well as market the company towards customers. "Green toolbox" and "Green solutions" offers examples of production processes that have a decreased environmental impact. "Green Workplace" (further explained in chapter 5.2.2) focuses on decreasing energy consumption and recycling waste on the construction site. However, in those concepts most focus seems to be on different kinds of buildings; residential, office and industrial buildings are today available in an environmentally friendly design with a lifecycle perspective. Infrastructure constructions such as bridges, roads and railroads have, on the other hand, not received the same attention. They mainly regard activities during the production phase, such as wastewater treatment, excavation treatment and different asphalt techniques. Few examples of lifecycle perspective and no certification possibilities are offered. The measures that are connected to environmental issues related to buildings

are more developed and have a more holistic approach, meaning that the measures includes the total environmental impact of the construction phase and the operational phase, which is done in e.g. LEED. On the other hand the infrastructure construction tends to be more focused on single measures to specific environmental problems, such as asphalt with less noise level. Managers of the infrastructure construction division (middle management) experience that there is a difference of how environmental issues have been implemented between the construction of buildings and infrastructure. Furthermore middle management also agrees that the infrastructure segment is not yet developed to its full potential concerning decreased environmental impact and has a long way to go to reach the studied company's overall environmental goals.

To enable environmentally friendly construction the company has developed a "Green roadmap" to clarify the path ahead. The "Green roadmap" includes different environmental goals and timeframes for those. The detailed information concerning the "Green roadmap" is considered as confidential information and therefore not allowed to be printed in this report. However, the final goal is to have "zero negative environmental impact during the lifecycle" when it comes to: energy, climate/CO_2, material, chemicals, waste, water and ecosystems. Those aspects are included in what the company has defined as Green Construction, which could be both buildings and infrastructure. Green Construction should, according to the company, have a lifecycle perspective and have significantly better environmental performance than what is prescribed by laws and norms (Skanska, 2008). The company has also defined terms such as Green Buildings, Green Infrastructure and Green Production (Skanska, 2008). Green Buildings are houses that for example have low energy consumption and are built with environmentally friendly materials. Green Infrastructure should have a low environmental impact during operation and a small affect on the surrounding ecosystem. Track bound traffic and public transport is examples of this. Green Production refers to that the contractor should fulfil high demands set on construction sites and on offices. The demands includes that the energy consumption should be decreased and to use resources efficiently, a low environmental impact in the supply chain should also be included (Skanska, 2008).

4.1.2 Description of the studied projects

The four chosen projects are located in Sweden. The projects are similar in size, organization and in some aspects of the product being constructed. The contract sum of the projects stretches from 0.5 billion SEK to over 1 billion SEK. All projects include construction of concrete structures, the amount of concrete varies between around 10 000 m^3 to almost 50 000 m^3. Concrete structures also include reinforcement bars, which in the projects have been estimated from a couple of thousand tons to six thousand tons. All in all, purchase of materials and services constitutes a great share of the projects contract sum; one interviewee estimated that 77% of the project's total cost was spent on this. Huge amount of masses such as rock, sand and gravel has also been handled in the projects. The chosen projects have a construction time that lasts for several years. Furthermore, the projects are similar in organizational structure, see Figure 2. However, there are differences in the number of persons involved in the projects. For all projects the contractor is Skanska and the client is the Swedish Transport Administration, which is the authority for construction, operation and maintenance of public roads and railways (Trafikverket, 2010a).

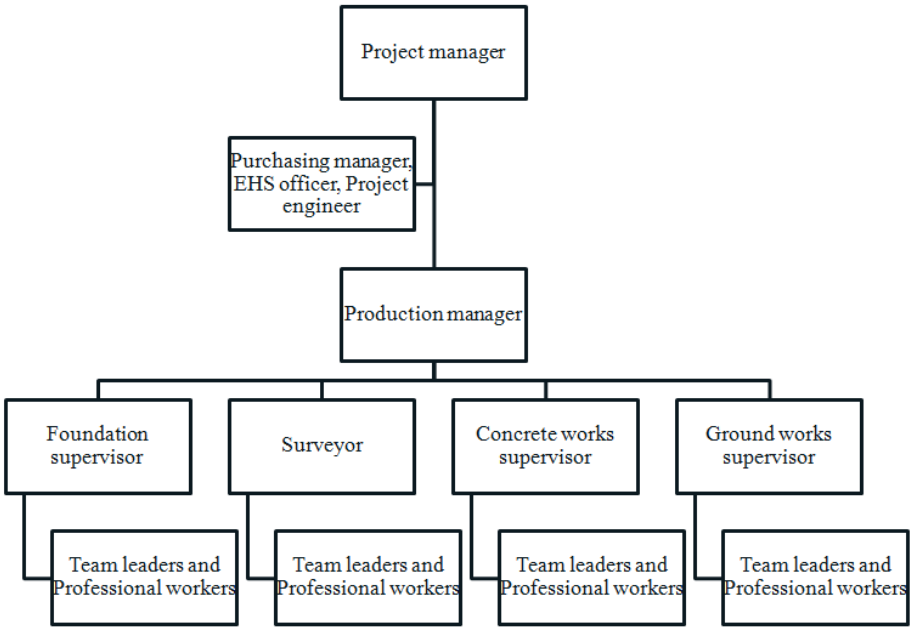

Figure 2 Simplified organizational chart of the studied projects

According to the company's "Project Organization and Responsibility Plan", the project manager has the legal responsibility for the project towards the client and other stakeholders such as municipalities and governmental agencies. The project manager also takes an overall responsibility in terms of economy, health, safety and environmental demands for the project. The production manager on the other hand has the responsibility to ensure that the production proceeds as planned. The projects are organized in sections, with certain areas of responsibility e.g. Foundation, Surveyor, Concrete works and Ground works, see Figure 2. There is also an administrative function which takes care of economy and overall structural issues. This also includes the EHS, which stands for Environment, Health and Safety Officer. The responsibility of the EHS, according to the "Project Organization and Responsibility Plan" includes employee safety, environmental impact and quality assurance.

Several aspects influence the environmental work in a project. Most fundamentally laws and regulations have to be complied with; often those are expressed in contracts with the client. This is documented in the Environmental Impact Statement (EIS), which is included in the contract for the project. This document should identify and describe effects that the project will have on humans and the environment (Trafikverket, 2010b).

One concept that the company uses to go further than what is prescribed in laws and regulations is "Green Workplace", which is mentioned on the company's internal website. This is a set of rules established by the Environmental Support Group that gives a project the right to call itself a Green Workplace. The set of rules involves seven different categories, which are:

- Waste – "At least 95% of all waste shall either be reused or recycled"
- Dangerous substances – "To replace substances that gradually should be removed from the company's chemical database with alternatives that are environmentally sound"
- Energy use – "Follow up energy use and ensure that storages without insulation are not heated"

- Information and communication – "Inform all new employees on site and communicate with the surroundings"
- Transportation – "Cars up to 3.5 tons should not be older than 12 years, heavy vehicles should at least meet Euro 2 emission demands and working machines should at least meet Euro 1 emission demands"
- Food and office material – "Environmentally labeled kitchen products"
- Own initiative – "Not mandatory"

In addition to these rules, every category is complemented with voluntary examples to increase the level of commitment. Providing personnel with a bicycle on site to lower the number of short car trips, as well as duplex printing are some of the examples offered. According to the Environmental Support Group these rules and examples are under constant development, thus making sure the bar is raised continuously. Hence, projects that are labelled as Green Workplace are encouraged, as constant development and change in rules occurs, to always strive for a more environmental friendly construction site.

4.2 Environmental measures taken in the projects

During the interviews, the interviewees were asked what they perceive as environmental measures performed and incorporated in the everyday work of construction projects. Below measures that the interviewees perceived as reducing CO_2 emissions are presented.

4.2.1 Measures related to transportation

The interviewees in all four projects expressed an awareness of the problem with emissions from transportation, both external (to and from the construction site) and internal (within the site). In two of the studied cases CO_2 emissions from transportation was calculated. In the first project the CO_2 calculations originated from the selection of transportation regarding reinforcement bars from abroad. The two options up for selection were using lorry combined with ship transport or train combined with ship transport. According to the interviewee responsible for this selection, train combined with ship was less expensive and consequently resulted in the best option. A supply chain specialist within the company, from the "Nordic Procurement Unit" which has expertise on procurement, was involved to help with the implementation of the selected transportation. After establishing the transportation method of reinforcement bars, the EHS for the project was involved and appointed the task of showing the environmental benefits regarding the reduction of CO_2 emissions. The EHS then contacted the Environmental Support Group to illustrate the reduction of CO_2 emissions. According to the interviewee the economical aspect was the first and foremost reason to why train instead of lorry was selected, even if the result also showed a significant reduction of CO_2.

In the second project the EHS tried to use CO_2 calculations as an incentive for the drivers to use as little fuel as possible when transporting masses around the construction site. The interviewed EHS investigated if a competition that would result in "driver of the month" based on fuel consumption was possible. But according to the road carrier company this suggestion would probably not work as well as intended, since it did not take loads into account. According to the road carrier company, not taking loads into account could result in drivers becoming reluctant to take initiatives, since heavy loads as well as transportation of material in both directions when possible, will increase fuel consumption. Instead the road carrier firm provided the

EHS with the total monthly amount of fuel consumed, combined with the resulting CO_2 emissions. These numbers was later used to inform the client and other projects within the company, which the client verbally commented as interesting, according to the interviewee. These two examples also show how CO_2 calculations can be used in two different purposes and originate from two different initiators.

One action done to reduce the CO_2 emissions was to optimize the load of every vehicle for transport. This has been done by ensuring that every vehicle is full, either in terms of weight or in terms of volume, which leads to fewer vehicles needed. Interviewees in all the projects mention that they work in this way, although the environmental factor has not been as important as the economical aspects. Another way of reducing the emissions of transports on site has been the use of cranes that cover large areas of the construction site. This was mentioned by two of the projects. Both of these projects had a construction site that was quite compact compared to other typical road and railroad projects which often stretches over a large area.

The choice of concrete producer has been a vital issue for all projects, due to the large quantities of concrete used and therefore transported. The issue has been a matter of internal discussion and disagreement in two of the projects. When the choice has been made the aim has been to find a producer that is close to the construction site and able to ensure punctual deliveries even in rush hour, when traffic is dense. Environmental issues have not been used as the key argument, but some interviewees mention that during the discussions around the choice, the environment has been a subject of concern. The company has an overall policy to use its own concrete producer, which has been an issue for discussion since those producers have not always been the closest and therefore not the most reliable in terms of delivering.

The choice of deliverer of timber products was highlighted by interviewees in one project as an action that lowered the release of CO_2. The chosen deliverer, with whom there was no frame agreement, was selected based on lowest price and closeness to the construction site which reduced the total amount of transport. Although the same interviewee questions if there really was a decreased environmental impact connected to the closer deliverer since they do not know how the timber is transported further back in the supply chain.

Interviewees in three of the four projects mentioned that they reuse dirt or rock masses to reduce the need for costly and CO_2 burdensome transportation of masses. The reuse was enabled by simply using the masses that they receive within the project. Sometimes the masses were crushed to another fraction that was possible to use and in some cases the masses were used in another project. It was also mentioned in one of the projects that existing concrete structures has been crushed and reused as filling. Those measures reduce the need for transportation of other earth masses better suited somewhere else, although these measures were done first and foremost for economical reasons.

The interviewees in one of the projects described that their construction site did not have satisfactory space to store large masses. An alteration of the time plan was made to enable masses that were received in one activity to be used in another. The other option would be to store the masses somewhere else until the project had the possibility to reuse these masses. On another of the studied projects the masses instead were owned by the client, which was perceived as a problem by the interviewees. This was a problem because they could not use the obtained masses on

the site since the client had made a deal with another construction company. Project management was forced to order the needed amount elsewhere.

4.2.2 Green Workplace

More than a hundred of the construction company's projects, both building and infrastructure projects, have the right to call the construction site a Green Workplace (Skanska AB, 2009a). The Environmental Support Group visualizes the number of Green Workplaces on the company's internal network, showing that it can be done and according to the interviews act as a driving force for other projects to follow. Two of the studied projects have fulfilled the rules for Green Workplace. However, many of the interviewees within these projects expressed a lack of visual difference, e.g. the interior of the site offices looks the same, between their own construction sites compared to a site that is not a Green Workplace. Nevertheless, almost all of the interviewees did experience a change mindset and approach to environmentally related discussions when working on a Green Workplace. One interviewee expressed the approach by: "It might affect us indirectly as I have noticed that we generally discuss environmental issues more today than we used to".

4.3 Environmental responsibility within the company

Many of the interviewees called for a "someone" to solve the environmental problem with comments like: "there is a need for someone to show us how to do" and "… needs the right person…". This person was viewed as a key for driving the environmental work and according to the interviewees the person should have "… the right interests", which implies that the person should be interested in environmental issues beyond the actual demand of work tasks. However, the opinions were somewhat contradictory, at the same time many of the interviewees indicated that "everyone" has the responsibility to work for less CO_2 emissions and some even feel a personal responsibility. At least most of the interviewees did in some way recognize a responsibility on the project organization, but the boundaries for this perceived responsibility differs. Most interviewees requested prerequisites in the form of more resources, such as time and money, from top or middle management. The opinion that environmental issues in general should be developed by the Central Purchase Unit in frame agreements was often expressed.

Some interviewees mentioned that the Environmental Support Group should provide environmental knowledge and software that helps employees with environmental decisions. Interviewees expressed that information received regarding environmental issues has been hard to relate to the interviewees work tasks, consequently leading to a failure of implementation. Project management seemed to be asking for more hands-on suggestions on how to improve the environmental performance that would be possible to implement in existing work procedures, which would lead to a greener construction. One interviewee also expressed the importance of an aim that is supported with parameters that ensures project success when fulfilled. Another interviewee had a bit more straight forward approach: "Show us how it can be done in reality and we will do it". The interviewee seemed frustrated over not knowing what measures to be taken and wanted guidance and examples of what to do.

Few of the interviewees seemed to be aware of the task the Environmental Support Group have. The Environmental Support Group has the task to create green business opportunities that enable the company to win contracts and secure that environmental demands, set by stakeholders and the company itself, are satisfied. This is achieved by

working as support, both in general and as specialists, for projects and by doing follow ups of the progress. The Environmental Support Group functions as an individual part within the organization meaning that their expertise is considered a consultant service towards the divisions. According to the interviews, the funding of the Environmental Support Group was changed in the beginning of 2010. Before, all expenditure was covered centrally, but has now changed into a combination of central funding and project specific cost. This change has, according to the interviewee, resulted in an increase of perceived gap between the Environmental Support Group and the production based divisions, due to that their expertise must be wanted and ordered by the divisions, and not initially offered from Environmental Support Group. Although, some services like CO_2 calculations or project specific questions regarding effects on environment is, according to the interviewee, still offered free within the organization.

4.3.1 Responsibility sharing within the projects

According to the "Project Organization and Responsibility Plan" the overall responsible for the project is the project manager. This also includes the overall responsibility for the environmental impacts due to the construction activities. This was also recognized by most of the interviewees. Within the boundaries of the project organization, the project manager together with the production manager was pointed out, during the interviews, as the main actors responsible for change of work procedures, both in general and for environmental issues in specific.

The EHS was seen, both by themselves and the people around them as a coordinator and the person that keeps track on external and internal environmental demands. Some of the interviewees' opinion was that the responsibility to follow-up environmental demands is mostly on the EHS. According to the "Project Organization and Responsibility Plan" the EHS has twelve different responsibilities and three different authorities. Basically an EHS is responsible for establishing, coordinating and following up of control programs for anything related to environment, health and safety. An EHS's authority on a construction site is monitoring both its own organization as well as the suppliers regarding all work related to environment, health and safety.

The EHS has the right to approve or reject environmental documentation relevant for the project, e.g. use of chemicals and machines located on site. However, the view of the actual impact of this authority differs. One interviewee expressed that aspects like productivity, economy and construction time interfere, which sometimes leads to that machines that do not fulfil the environmental demands set by the project is let in on the construction site. "Stopping a machine to enter just because the environmental standard of the machine does not fulfil the demands is quite a tricky situation… productivity is perceived as more important sometimes". A solution, according to the same interviewee, in order to avoid these quality errors, is that demands must be set early in agreements with supporting documents handed in prior to construction start. This would according to the interviewee avoid low standard machines to be sent to projects thus leading to an easier control and follow up.

The support of the project manager is also important for the environmental performance. One EHS stated that if the project manager is supportive, your tasks become easy to carry out. Another EHS expressed that at a previous project the project manager gave more room for environmental issues and encouraged

environmental work, which made both the EHS's work easier and also increased the environmental performance of the project.

4.3.2 Project responsibility for suppliers

The studied company attaches environmental demands in contracts with all suppliers used in construction projects. The demands relevant to CO_2 emissions are formulated under the sections transport and climate change. According to the document, all transportation should be performed so the environmental impact is minimized. The level of emissions from machinery used in construction is categorized with a Euro label. All heavy transports originating within Sweden must fulfil Sweden's environmental class 1 or its equivalent Euro 2 and if the contract reaches longer than one year every driver must learn "eco driving". "Eco driving" means e.g. driving a vehicle with decreased fuel consumption by eliminating hard breaking and quick accelerating.

On demand suppliers must present CO_2 calculations related to their activity, however only one example of this calculation was found in the case study. When the contract reaches longer than a year the supplier is obliged to develop an action plan to reduce the amount of CO_2 emissions released due to the activity of the company. During the interviews no information was found regarding such action plans, meaning no one of the interviewees had encountered one.

According to the interviews, none of the studied projects had any examples where they have reduced or added any demands, to better fit the project specifications, in contracts towards suppliers. The demands in contracts are general and are included since it is required by the company or the client. The responsibility to develop the relationship with supply chain and the demands forced on the supply chain was viewed by most interviewees to be on the Central Purchase Unit. Few of the interviewees feel a responsibility to ask questions to suppliers in order to create a pressure for new products or services with more environmentally friendly products or services. It was also believed by most interviewees that the possibility for the project to make other demands than the ones required by the company and the client is small and has very limited impact. The reasons for not doing more to ensure that companies in the supply chain decreases their CO_2 emissions were unclear, but reasons like lack of time and money were given. However, it might rather be related to lack of knowledge and unawareness of potential benefits in terms of increased environmental performance.

4.4 Perceived organizational obstacles for environmental measures

One evident result from the interviews was that changes towards more environmental focus needs to be established by top management, or as one interviewee said: "The development could originate from project level but must be sanctioned from a higher level". However, the interviewees perceived that top management viewed safety and economy as more important than focusing on CO_2 emissions.

Another result that was obtained during the interviews was that none of the interviewees had taken part in identifying major CO_2 emissions originating from the construction project. The interviewees also expressed it as hard to relate to CO_2 emissions and the effect the projects itself have on the environment. Aspects like lack of knowledge regarding CO_2 emissions and enough time was frequently given as

examples that hindered dealing with CO_2 emissions, as this work is not incorporated in demands of existing work procedures. Only some of the interviewees expressed a need for support from the Environmental Support Group.

Transportation on construction sites and the use of machines was something that the interviewees felt they have the possibility to monitor and influence. Though, the power to influence the transportation on site was only done to the extent where it did not have major influence on the production process, in terms of money and time. One interviewee stated that external transportation, the total distance covered is much harder to anticipate and therefore influence. Another interviewee stated that: "One has to assume suppliers plan their transportation efficiently". This seemed to be the opinion of other interviewees as well and it could be questioned how this trust in suppliers affect the environmental performance.

The relationship between the company's different divisions and the support functions was also an aspect pointed out by the interviewees as something that hindered the projects from making decisions solely beneficial, in terms of economy and decrease of risk. Some of the interviewees expressed their resignation to the policy that all concrete should be bought from the company's own concrete supplier, a policy that originates from top management. All of the projects examined, use the internal concrete supplier even if two of the four projects have tried to purchase concrete from another deliverer. The reason was that two of the four projects had another concrete supplier closer to the construction site. According to the interviewees from these projects, the benefits from using a closer situated supplier of concrete were increase of security of delivery as well as decrease of the environmental impact with shorter distance of deliveries. As one interviewee expressed, these arguments are not strong enough as the economical aspect of using an in-house supplier is more important.

The relationship with the concrete supplier was somewhat complex. The main view of the relation among the interviewees was that the relation is like any other supplier and that there is no difference. At the same time no environmental demands were followed-up by the project organization, since "it is the same company" as one interviewee expressed it. Another interviewee said that "we trust the company's own concrete supplier" and that "they [the concrete supplier] do a complete follow-up". According to the interviewees, despite the problematic situation, one of the projects has not yet given up the attempt to change the deliverer of concrete. The main reason for this, according to the interviewees, was that enough of top management showed a change in attitude, recognizing the benefits of secure deliveries and lowering the environmental impact, for this specific project.

4.5 Driving forces for environmental measures

When given the question what drives a project to work with decreasing the environmental impact in construction, eight of twelve interviewees answered that demands expressed in contracts by the client, such as what type of chemicals are allowed, or general policies from the company, such as what type of machines are allowed, are what drives them to work with lowering the environmental impacts. On the other hand, all the interviewees expressed the economical demands as obstacles to work with environmental impacts with comments like: "An environmental action is not of interest as long as it does not benefit the total cost" and "Environmental focus is okay as long as it does not cost any extra". There seems to be an opinion among the interviewees in project management that measures taken to decrease the

environmental impact would affect the projects total cost in a negative way. A measure is not taken unless a clear "win-win" situation is identified immediately.

The uncertainty for the future and next generation was expressed by some interviewees as a personal driving force to consider the environmental impact of a construction project. However, some of the interviewees did remark that: "I could do more but I don't want to" and another "the more you do the more is expected of you the next time [by the client]". Different views of ethical stand point were expressed during the interviews. Many of the interviewed EHSs emphasized the importance of that the project manager has a mind-set that gives room for environmental issues. One EHS said "It is easy to work with environmental issues if colleagues demand, listen and encourage". It was also found that the economical aspect was an important factor that motivates the interviewees to work with environmental issues. Statements like "Less material consequently leads to less environmental impact" and "increased market shares in the future" was mentioned during the interviews. Evidently economy was perceived as both an obstacles and a driving force depending on what approach or mindset the interviewee had.

One example of individuals that inspired others and shouldered the responsibility of a driving spirit was also obtained during the interviews. The example was merely for productivity reasons and not done for environmental benefits, but some interesting information still deserves to be mentioned. The idea, briefly described, was about developing the prefabrication of reinforcement bars that would benefit the production time, material use and the work environment for the workers on site. This procedure is now in use and according to the interviewee work as intended. According to the interviewee, time and resources provided by the involved manager and the possibility to select right personnel as support were key factors that enabled this development. Both the originator and the people around him saw this as an example of what a driving spirit can accomplish when the right conditions are provided.

5 Discussion

The theoretical framework revealed that even compared to emissions from vehicles, the construction of infrastructure has a significant environmental impact in terms of CO_2 emissions. The construction sector has a challenge ahead to decrease the environmental impact, a challenge that the studied company has started to address. The company has developed an Environmental Support Group as well as started to market themselves as a company taking the environment into consideration. Those are measures that according to Kolk (2000) are common for companies starting to realize the importance of the environment. Furthermore the company's environmental strategies and goals shows the level of ambition, emphasized through written material regarding their environmental work in published documents such as their annual report. However, the published material mainly concerned environmental work that has succeeded and do not include the actual impact. All in all this study shows that the company has taken on the challenge of reducing the company's environmental impact.

The case study identified shortcomings of the environmental work in infrastructure construction projects, which revealed that the strategy of the company is far from being fully implemented. The reasons for this might be found in Björnström (2007), who stated that dynamic communication is vital for strategy implementation. Furthermore, the structure of an organization also affects how a strategy should be communicated (Björnström & Räisänen, 2007). One aspect found in this study that enable implementation, is how the responsibility, for the projects' environmental impact, is framed and accepted within and outside the construction projects' borders. This is an issue that if addressed could increase the environmental performance of the company.

Top management involvement was identified as a decisive aspect for implementation of a change (Price & Chahal, 2006). In the studied company strategic decisions and the general objective originate from top management, who seems involved and motivated to decrease the environmental impact. However, the case study showed that infrastructure projects do not perform beyond what is prescribed by law in most cases and that only minor actions have been taken to reduce the CO_2 emissions. McDermott & Boyer (1999) concluded that a gap of consensus often exists between top management and people in the production, furthermore leading to the importance of communication and how it fits its context (Björnström et al., 2007). Implementing a strategy must be seen as a continuous process (Björnström, 2007) and something that takes time in order to achieve commitment among all members within the organization. This study shows that top management is involved, which is demonstrated by the strategies and goals, but the result in terms of environmental performance is not yet fulfilling the goals of the company.

Reports have emphasized the importance of viewing greening as a process (Stenberg, 2006; Stenberg & Kadefors, 2000), which is the basic approach taken in this study. The development towards less CO_2 emissions is viewed as a process of change. This enables application of theories for change, innovation and sense-making that can act as triggers of new ideas and create solutions for problems found in the case study. The following chapters will address the suggested next step for the company in the process to become greener in the construction of infrastructure.

5.1 Focus on supply chain

The interviews partly focused on what project management could do to decrease the project's environmental impact. Transportation was an issue that all seemed to have realized the environmental impact of, including CO_2 emissions. An explanation to this is likely that the public debate has concerned emissions from vehicles to a high degree, which has made most people realize those impacts. When people make the same sense of things the organization is heading in the same direction (Clegg et al., 2008).

During the interviews two construction projects gave examples of how CO_2 has been specifically addressed in the effort to reduce the emissions. The first example, where train and ship had been used for transportation of goods, derived from a person who had experience in how the company's expertise could be used for the selection of transportation solution. The example showed that there is a possibility within the company to calculate CO_2 and to use that calculation to make a decision that is based on figures and enable a decreased environmental impact. Even if this example of CO_2 calculation did not specifically act as a factor for decision making, the possibility exists for doing so. The example also revealed that it is possible to use train and ship for transportation, something that some interviewed persons did not believe in. One reason for the disbelief could be that project management does not have enough knowledge of alternative ways of transporting material. While some expresses lack of knowledge as an obstacle, others fill the gap with calling in expertise. The use of the company's knowledge and combination of such was argued by Hekkert et al. (2007) as a crucial step for innovation. The knowledge clearly exists within the organization and it is more a matter of spreading that information. Senaratne & Sexton (2008) argued that a key for spreading information is converting tacit to explicit knowledge and it is not until the knowledge is learned and used in future projects that it has become an innovation (Senaratne & Sexton, 2008). Therefore, the first example cannot be viewed as an innovation until the knowledge concerning the actions has been documented, spread in the organization and used in other projects.

The second example, in which CO_2 calculations were made after the transports had been done, did neither function as a decision making factor. The calculations were made by the transportation company. It seems as if the aim of making the calculations were not set in advance. If calculations are to be done, the aim has to be clear of what the purpose is in advance. Calculations are not an end in itself. One idea was to measure fuel consumption by trucks and to let truck drivers compete in terms of consumption, however it failed since the system did not take into account that fully loaded trucks consumes more fuel. This competition could have led to decreased CO_2 emissions if it also had taken the load of trucks into account. The idea is good and deserves more attention. The example could be seen as an attempt to find a win-win situation, but as Clegg et al. (2008) argued, after the easy wins are won it becomes harder to gain double dividends.

Most examples of actions done to reduce CO_2 emissions originated in economical reasons. Driving fully loaded trucks and distributing rock and sand masses within the project both reduces the CO_2 emissions, but first and foremost benefits the project in economical terms. Economy is fundamental for a company and its actions. According to the interviewees, economy has been the driving force for most environmental measures regarding CO_2 for the construction projects. The problem however is that ideas that could be economically beneficial for project management might be

abandoned or set aside if not a clear win-win situation is identified or achieved instantly (Clegg et al., 2008). Furthermore, the actions mentioned to reduce CO_2 were rarely documented, not spread through the organization and therefore not yet considered as an innovation (Senaratne & Sexton, 2008).

Transportation and production of materials was identified as the main CO_2 contributors in infrastructure construction projects (Svensson & Eklund, 2007; Wrådhe, 2007; Mroueh et al., 2001). The case study showed that the studied construction projects mainly focused on transportation. A vital issue for an infrastructure construction project to become environmentally friendly or "green" is to realize that the project, by its purchases, cause CO_2 emissions in the supply chain. This is vital since a lifecycle perspective has to be taken. However, if the responsibility for CO_2 emissions related to the supply chain should lie on project management level it has to function together with other demands such as time and cost constraints. The awareness of the CO_2 impact from the supply chain was low among the interviewees and there seemed to be a lack of acceptance from project management for the responsibility of the supply chain. The case study showed that none of the interviewees have been involved in an identification of CO_2 sources. To identify CO_2 emissions is to understand the current situation, which according to Hammer & Champy (1993) is central for companies that undergo change. When a common understanding is obtained the company can focus on how to decrease the CO_2 emissions.

The findings indicated that few measures were taken to reduce the CO_2 emissions. Furthermore, the interviewees seemed to be frustrated over their own lack of knowledge within the field. Together those findings seem to call for a number of new processes, products or services to be implemented in the way that the construction projects function. There are also other reasons for increasing the degree of innovation, such as long term economical growth (Hekkert et al., 2007). Clegg et al. (2008) highlight the importance of employing creative persons to become a creative company. Environmental problems, such as the awareness of CO_2 emissions, are fairly new for construction projects. A key for the construction company might therefore lie in employing persons that are likely to be more creative when solving environmental problems, such as persons with an education in an environmental subject. On project level this could lead to a successful combination of the knowledge of construction together with the knowledge of environment, as emphasized by Hekkert et al. (2007).

The findings from the case study can also be displayed from the perspective of the three categories suggested by Kolk (2000): environmental risk, control of supply chain and green capabilities. Environmental risks seemed to be handled well, since laws and regulations were followed and in some cases even higher standards were achieved. Control of supply chain, as mentioned above, must receive more attention as the largest emissions of CO_2 originates there. Kolk (2000) stressed that control over the supply chain will be beneficial for companies in terms of decreasing future risk and supplier dependencies. One example of the studied company's green capabilities involving the commitment of project management is Green Workplaces. As green capabilities means a company's capability to seize market opportunities, Green Workplace might trigger innovation or creative thinking among project management and create commitment among the project personnel as everyone has the possibility to contribute. According to Björnström (2007) the individual member must feel that he/she takes part of, and affects the implementation, and not just follow top

management strategy. If the company wants to be "an industry leader in green building and sustainability" (Skanska AB, 2010), project management has to feel that they take part of the implementation of the strategy.

5.2 Responsibility clarification

Viewing greening of the studied construction projects as a change process enables the use of the questions suggested by Price & Chahal (2006): who is responsible for the greening of projects, who is supposed to implement the greening and who will the greening have an impact on? The most obvious and first answer to the questions is everyone, but that is not a constructive answer. Instead those questions shed light on a very important aspect in the process of making the construction projects successful in their environmental work. The findings were evident in showing that the issue of responsibility concerning CO_2 emissions is a problem for achieving a greener product.

Addressing the problem with responsibility is one way for the company to manage and implement the environmental strategies in the organization. In the construction company, top management sets the direction by using strategies and goals. As suggested by Clegg et al. (2008) top management also needs to be consequent in that the strategies and goals are decisive for how resources are distributed and how decisions are made. Räisänen & Björnström (2007) identified middle management as gatekeepers, which is a role that has to be recognized more fully. Gatekeepers can either open the gate for information or not, which emphasizes middle managements role in change processes. Middle management also has the responsibility to enable actions that support the implementation of the strategies and goals. Furthermore, Porter (1996) suggested that understanding how the strategy should be implemented in everyday work is vital for the implementation, this is a matter were top and middle management has to cooperate to achieve success. Project management in construction projects has a large translation responsibility (Björnström & Räisänen, 2006) to ensure that actions are communicated in a way that creates commitment from all personnel involved in the project. Also project management has the responsibility to communicate the right information to the right personnel and not increase the level of information too much in total.

Clegg (2008) argued for the importance of members within an organization to make the same sense of core activities. Hence this issue needs to be addressed to clarify roles and responsibilities between project management and other entities within the company. The relationship between the studied projects and the internal concrete supplier was one example that did not work satisfactory. The fact that two of the four construction projects had for a long period of time tried to change the supplier of concrete to a supplier that is more closely located without success, reveals that time and effort has been spent on a process that has not added any value to the project. Between the different construction projects examined in this study, it is obvious that different views exist regarding the relationship with the concrete supplier. Some see the concrete supplier as any other supplier and some see the concrete supplier as one of their "own". How should the relationship be?

Another relationship that has to be addressed is the one between project management and the Environmental Support Group. Few of the interviewees were aware of the expert knowledge of the Environmental Support Group. At the same time the interviewees expressed a need of such expertise in the projects. A combination of the Environmental Support Group's environmental expertise with the project organization's knowledge of construction would increase the possibility for

innovation, supported by Hekkert et al. (2007). If the Environmental Support Group should be able to perform their work tasks and if the projects should be successful in decreasing the environmental impact this gap has to be addressed. The reason for the gap might be how the Environmental Support Group communicates and how they view their work tasks. As suggested by Gluch (2005) construction projects communicates mainly verbally and thereby written documents at least have to be supplemented by verbal communication. The communication between the Environmental Support Group and the projects was mostly done through the intranet or by written documents. Fryer & Fryer (1996) suggested that personnel in construction projects produce too much information, which also seems to be supported by many of the interviewees. Some of the interviewees felt overwhelmed by information and especially by written documents.

According to the Environmental Support Group, they market themselves mostly towards higher organizational levels in the company e.g. helping middle management formulate new environmental goals in their business plans. The interviewees at the Environmental Support Group argued that they do not have enough resources to support all construction projects. Therefore they try to increase the environmental work through middle management, who becomes responsible to further communicate the information and once again needs to take the role as gatekeepers (Björnström & Räisänen, 2007). Another aspect that has impact on the relationship between the Environmental Support Group and project management is the way the Environmental Support Group is funded. The idea is that project management should take more initiatives themselves and procure the Environmental Support Group as consultants. As the interviewees at the construction projects had a limited knowledge of what the Environmental Support Group does it was evident that a clarification of the role of the support group and its possibilities to assist project management needs to be told throughout the organization.

The interviewees reckoned that the frame agreements should guarantee that all the environmental demands are fulfilled and developed. To create possibilities for persons on project level to distinguish if their decision is environmentally sound or not could be done by visualization of environmental performance. E.g. by putting labels on products in the frame agreement in accordance with their environmental performance. Furthermore, materials and suppliers which fulfil higher environmental demands could be labelled in software programs, programs for planning, purchase and economy, to facilitate the selection for project management. Visualizing environmental performance in this way also increases the possibility for personnel to make the same sense of issues and thereby increase the possibility of implementation of strategy (Porter, 1996). The combination of the support functions knowledge, such as Environmental Support Function and the Central Purchase Unit, has the possibility to make it easier for the project management in their environmental work by visualizing. The combination of their knowledge could also lead to innovations for the production as argued by Hekkert et al. (2007).

On project management level, the project manager together with the production manager was identified as key roles when setting the level of environmental work. This is also supported by Björnström & Räisänen (2006) who identified the project manager together with the middle manager as key roles for the implementation of change of work procedure. The project manager is ultimately responsible for fulfilling all demands, including environmental demands. However, there is no person, role or entity on project level that has a clear responsibility to ensure that environmental

issues are considered beyond present demands, even if the strategy states this. Stenberg & Kadefors (2000) made a case study that emphasized the importance of personal commitment and the role of champions when working with "greening" in the construction industry. A champion was defined as someone who takes on more responsibility than is required (Markham, 1998). If the project manager or the production manager can shoulder the responsibility of being a champion for environment, the increase of environmental performance of the project would be high. Although the interviewees varied in their views regarding if project management should work for development and innovation of environmental measures or not, most seemed to be of the opinion that this should not be done on project level. But can construction projects of the size of the studied projects choose not to?

The EHS has work tasks concerning environmental issues in a broad sense. However, the role seems unclear and the work tasks are not followed up by responsibility for the actual result. Therefore the role was often viewed as a coordinator instead of a role that actually has the possibility of affecting the implementation of environmental actions. There seems to be a need to clarify the EHS role in some ways to increase the environmental work. Some EHS expressed that there is a great difference between projects where the project manager emphasizes environmental work and supports it compared to where the project manager is neutral in the question, which once again supports the vital role of the project manager (Stenberg & Räisänen, 2006). Finally, no matter what role the EHS has, it is vital that all members in the organization agree and view the role in the same way. An organization is always dealing with how issues are framed, viewed and made sense of (Clegg et al., 2008; Stenberg, 2006), which argues for the importance of making the same sense of the role of the EHS.

The supply chain and the environmental demands on the suppliers are not followed up according to the interviews. This is a great opportunity for the company to make a difference, by asking for specifications regarding suppliers CO_2 emissions and documenting this over time. Kolk (2000) also emphasized that this increases the strategic control over partners in the supply chain. Taking control over the supply chain, it has to be clarified who is responsible for doing the follow up and what is to be followed up. Contracts that are within frame agreements has to be given special attention. As previously mentioned, no information was found regarding documentation of CO_2 emissions related to suppliers and their activity. It is clearly stated in the company's environmental demands towards suppliers that when a report on CO_2 emissions, related to the company's activity, is asked for it must be presented. Furthermore, if contracts are longer than one year, an action plan for decreased CO_2 emissions has to be presented. None of the interviewees had asked for documents of this type, which could be due to lack of knowledge as well as not knowing what to do with the information.

The findings in this study often shows examples of "no one has" or "should not be on us" when working with change of environmental issues. The question is therefore "who should do it?" or "who is responsible for it?". Thus, clarification of roles and responsibilities is an important aspect that deserves attention in the organization during the process of greening the construction of infrastructure. To do this, understanding other people's limitations, demands and deadlines is important (Clegg et al., 2008).

5.3 Incentives are needed

During the interviews eight out of twelve stated that demands, either from the company itself or from the client drive project management to work with environmental issues. However, the construction company's environmental goal is to take construction further than what is expected of construction companies in general. The demands from the client have to be viewed as what is expected of construction companies in general and cannot be the driving force. Most of the demands from the client are also measures that can be categorized as end-of-pipe solutions, which according to Brunnermeier & Cohen (2003) does not act as an incentive for companies to go beyond the demands. Therefore the company's environmental demands have to raise the level of environmental work. Accordingly, incentives have to address both construction projects in general as well as employees in the projects.

None of the interviewees had taken part in identifying CO_2 emissions related to the activities performed in a construction project. Still, should this activity be done on project level? One answer is presented by Hammer and Champy (1993), who emphasized the importance of understanding the current state of an organization before suggesting improvements. Project management has to understand what should be done and why before understanding how it could be done. Strategies and goals from top management do not describe in detail what should be done on project level and according to Björnström et al. (2007) communication of strategies should be changed throughout the organization to fit the context. Project management has to identify CO_2 emissions that they can decrease to make the overall goal of the company possible. The reasons given by the interviewees for not working for decreasing CO_2 emissions were for example lack of knowledge and time. This shows that project management needs knowledge on why and how to identify CO_2 emissions related to construction activities. The knowledge the Environmental Support Group possess could therefore be shared to project management.

If not a clear "win-win" situation was identified early in a process in the construction projects, environmental friendly solutions was set aside or ignored. This corresponds to what Clegg et al. (2008) argued, that is when the easy wins are won the hard work begins, in the process of greening. To overcome this, rules has to be clarified regarding economical risks related to environmental issues. Economical reasons were in the case study identified as a driving force for project management to lower the environmental impact. Quotations like "less material consequently leads to less environmental impact" and "increased market shares in the future" were obtained. But at the same time the economical reasons were something that seemed to hinder people to work with reducing the environmental impact, as they believed that high environmental performance leads to increased construction cost. Somewhere in the environmental work a line exist where people start to see obstacles instead of possibilities.

To create a common mindset enables employees to make the same sense of core activities, which is vital for ensuring that everyone in the project heads in the same direction (Clegg et al., 2008). The mindset of the employees in the projects was identified as an important factor that determines the environmental performance of a construction project. Different mindsets exist within the studied projects. Some find no interest in working with environmental issues while others even have personal motives. This could be related to how people frame, view and make sense of issues, which Weick (2001) suggested is highly based on individuals. Björnström (2007)

suggested that setting the mindset should be facilitated by communication and interaction of individuals. Project managers and production managers seems to have an important role for setting the environmental agenda and contribute to creating a common mindset among the members of the project organization.

Personal commitment of the project manager and the production manager should also be emphasized for achieving greening in the construction industry, which was identified by Stenberg & Kadefors (2000), who also emphasized the role of a champion. In this study one example of a champion was found. The example was one individual that shouldered the responsibility of personal commitment and advocated to take the project beyond requirement. Even if this was done mainly for productivity reasons, and not decreased environmental impact, it is possible to use the same process regarding environmental innovations. This could be done by empowering the creativity of individuals with innovative suggestions, which is something that organizations in general could be better at (Clegg et al., 2008). For example, letting those persons develop their ideas, although within frames of time and money, could act as an incentive for those persons. Furthermore, new solutions that are found within a construction project needs to be shared and communicated. Not until the solutions are implemented on a general scale could the idea be called an innovation (Senaratne & Sexton, 2008). This is the key to organizational learning. Solutions that are under development could be tested in smaller parts of or smaller construction projects, before implementing them on larger and more complex projects and eventually implement them in the whole organization.

Development of new ideas can take place in what Clegg et al. (2008) referred to as a "safe playground", where ideas can be developed without being hindered by limitations. In one sense the concept Green Workplace acts as a safe playground, where ideas concerning environmental impact can flourish. The rules for achieving the label are not drastic, but a good start. One implication is that it takes the focus from other environmental issues that actually have a greater impact and a larger possibility for improvements. For example the supply chain is not mentioned as a category, which in this study was identified as a key to decrease the environmental impact of an infrastructure construction project and also emphasized by Kolk (2000). However, Green Workplace is a good way to show that there exist substantial actions that are possible to implement. Green Workplace could be viewed as a legitimization for project management to try measures that otherwise would need to be approved higher up in the organization. The different categories within Green Workplace, as "Own initiatives", could work as a legitimization by top management and increase the construction projects' own innovation. However, none of the interviewees viewed the possibilities of Green Workplace in this manner.

One way to display increased environmental performance is by the use of parameters, e.g. CO_2 emitted by a certain activity, that when fulfilled give project management the right to call the end product "green". Parameters were also something that the interviewees asked for and encouraged as something that could give them guidance in the environmental work and function as an incentive. Parameters could be developed by top/middle management together with the Environmental Support Group and used to differentiate environmentally sound construction projects and give a clearer aim of the environmental work. Parameters could be obtained by using a certification system such as LEED or CEEQUAL. Ghumra et al. (2009) also identified that there is a need for a lifecycle based tool for infrastructure projects. Using a certification system gives a broader understanding and trust for the certified projects.

All in all, environmental issues such as climate change are not visible on short term in our daily lives. To enable effective environmental work in terms of decreasing the emissions of CO_2 the impact has to be visualized so that people can make sense of the actions taken. In the construction of infrastructure the environmental impact have to be visualized, both the environmental performance of projects as well as the personal contribution to the environmental work.

6 Conclusions

One way to analyze an organizations environmental performance is to use the RDAP scale suggested by Kolk (2000). The result from this study shows that top management anticipate the responsibility for environmental issues and incorporate those issues in the strategic work of the company. On the other hand project management admits responsibility but have a hard time to realize the strategies, which leads to that project management do the least that is required. Top management is proactive and project management is defensive, which altogether results in low environmental performance. Most likely this is related to that everyone does not fully understands the strategy and how one's own work can contribute to the fulfilling of the strategies, which leads to failure of implementation as not everyone is committed.

It is absolutely vital for the implementation of strategies that everyone understands the strategy of the company. Maybe even more vital is that everyone understands why and how that person can contribute to fulfilling the strategy. During the interviews one interviewee uttered "show us how and we will do it". This quotation sums up the essence of the findings. Personnel on project level were aware of their responsibility for decreasing CO_2 emissions, but no one knew how to do it. In other words employees at project level were unable to see their contribution for fulfilling the environmental goal of the company. The quotation also indicates that there is a lack of knowledge of what to do, therefore an increase of innovation is needed to find measures that can decrease the environmental impact of the projects.

The studied company has defined what the concept "green" means. A definition can always be interpreted differently and therein might one of the strength also lie, since this enables discussions and development of what green means. The concept of green may be used as a driving force for improved environmental performance. Green Workplace is an example of this and could over time be developed to finally incorporate the full environmental impact of construction projects, which would make Green Workplace the carrier of the process towards greener construction.

Project management needs to be fully responsible for the project's environmental impact. However, as the result of this study shows there is a lack of knowledge and resources to enable an increase of environmental performance. Project management has to be supported in their responsibility. For example, the Central Purchase Unit could offer project management products and material, in frame agreements, that is environmentally sound and also distinguish between products with more or less environmental impact. Likewise, in all software programs that are used on project level environmental impact related to the construction project should be visualized. The Environmental Support Group needs to be the driving force for this change since the group possesses the expertise knowledge regarding environmental impact and how to manage environmental issues. Personnel in construction projects have to know that they make e.g. an environmentally sound material choice or that the frame agreement with a distributor is connected to a long-term environmental work. Furthermore, the project organization needs to sum up all the environmental gains; otherwise the success cannot be used as an incentive for employees to perform more than expected.

One way to visualize and collect all the environmental performance of infrastructure projects could be the use of certification systems. The company has great knowledge of LEED, but only for construction of buildings. However LEED is applicable for infrastructure as well and therefore it would be natural that the company develops

their knowledge of LEED, follows the development of LEED and ensures that it becomes fully applicable on infrastructure in Sweden.

Finally, to improve the environmental performance and achieve an improved environmental work that is based on a lifecycle perspective that takes in the supply chain, clarification of responsibilities and creation of incentives are needed. The findings are clear on that responsibilities regarding environmental work were unclear. It is also clear that employees on project level do not feel motivated to work with environmental issues and therefore incentives are needed. Lastly, visualization of environmental impact is the key for a successful environmental work.

7 Reflections

During the finalization of our studies at Chalmers we started to realize that infrastructure construction lags behind the construction of buildings concerning environmental performance. The idea of doing this thesis developed and was supported both by personnel at Skanska and our supervisor at Chalmers. We started the work with this Master's thesis aiming to find practical measures that would be implemented in infrastructure construction projects. However, as Hammer & Champy (1993) conclude, one must first understand the current state before suggesting improvements and so did we. We realized that the current state the organization was in, our time limits and the previous research did not make it possible for us to find practical measures.

The focus was changed to study how persons perceive environmental work. In the end that resulted in measures that are possible to implement for the company. However, the character of the measure was not the same as we first intended.

During the finalization of this study, we have come across some questions that we have not been able to answer in this thesis. The studied field has also been hard to investigate due to lack of research specifically addressing the construction of infrastructure. Therefore we have some recommendations for further research:

- Investigate how construction companies can ensure that actors in the supply chain ensure environmental demands and secure that those are developed. This study identified that most of the CO_2 emissions from infrastructure construction are related to the supply chain. Furthermore, most of the interviewees did not see how they could affect the suppliers towards less CO_2 emissions. However, this study did not investigate how projects can ensure control over the environmental impact related to the supply chain, which is where we recommend further research to focus.
- Continue to investigate what responsibility each role should have in a construction company to increase the environmental performance. This study mainly focused on project level and how the project organization can achieve increased environmental performance. We recommend further research to focus on the company level in general and to analyze how a company can use its environmental competencies in the best way.
- Investigate the differences in how construction of buildings and construction of infrastructure has handled the environmental issues. This study identified a difference, but the difference was mainly identified in terms of end result. However, there might be differences in how environmental issues have been handled in the organization during both the design and construction phase.
- Investigate an environmental decision making process in detail and analyze the involved individuals and the effect those have on the decision. This study only briefly touched upon the decision making process. Further research could focus more on the actual roles and communication channels related to environmental decision making.

Finally, the sunny spring of 2010 has been a long, developing and fun journey for us. We truly hope someone carry on the research with the aim to increase the environmental performance in the construction of infrastructure.

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