Mat-2.4177 Seminar on case studies in operations research
Spring 2009

How to reduce CO2 emissions through better Supply Chain Management
ROCE Partners

Project Plan
February 10, 2009

Niklas Tapola
Oskari Eskola
Lari Järvenpää
Antti Koulumies
Maija Mattinen
Heikki Peura

# Introduction

*Supply chain management (SCM) is the integration of key business processes from end user through original suppliers that provides products, services, and information that add value for customers and other stakeholders (Douglas M. Lambert).* Successful SCM operations can lead to (among other things) faster delivery times, smaller inventories and a better ability to respond to quick changes in the market. As a result, profits can increase due to increased sales and customer satisfaction - and also a reduction in costs. SCM has grown to be one of the main competitive advantages for a manufacturing company in the world of increased competition, demanding customers and a fast pace of technological innovation.

One emerging aspect in all manufacturing is the increasing demand for environmentally friendly manners of production. Currently, manufacturing companies are directly impacted by the EU emission barter system, and very likely there will be more direct impacts in the future in form of regulation, taxation and other actions required from companies. In addition, companies are also under pressure from environmentally conscious consumers and stock holders, who require improved reporting and plans for improvement. Tightened focus on emissions affects the supply chain of most companies: even the ones with small direct greenhouse gas emissions will probably face some pressure, when indirect costs of business will be under scrutiny. In that case, the whole supply chain of a product needs to be "emission-lean", not just a part of it.

The purpose of this seminar work is to investigate how $CO_2$-emissions can be taken into account in supply chain modeling and what are the most interesting implications of the model for the whole supply chain emission structure. Interesting questions include e.g. "How to procure energy?", "Does the mode of transportation have a significant emission impact?" or "How big an emission effect can demand fluctuation and possible scrap products have?" As of yet, there are no global standards on supply chain models and how $CO_2$ emissions should be calculated. The field of research, however, is changing constantly and therefore a key issue is to capture the latest developments in the field.

The work will be done in cooperation with ROCE Partners, a management consultancy that specializes in supply chain processes by redesigning, integrating and optimizing their clients' supply chains and selecting appropriate IT/S solutions and vendors.

## Research Questions

The main research questions of this project are:

- What is the state and main trends of current research in the area?
  - As there is no standardized method for calculating the carbon footprint of a supply chain, we will explore different methods, analyze their consequences and try to figure out what is still missing with the methods.
- What are the most important $CO_2$ emitters in the supply chain case?

Based on answers to the above questions, the goal of the research is to:
- Establish a functional simulation model that provides information on how different supply chain decisions affect the total emissions of the system.
  - Using the model simulations of various scenarios with different parameter values and carbon footprint definitions will be run.

# Course of actions

The group will first be introduced to the subject with the help of ROCE Partners consultants and a literature review in the area. Then, a relatively simple supply chain model of one of ROCE's customers will be introduced, complemented with main CO2-sources identified by the group. The purpose is to utilize the model in simulation exercise with different scenarios (using e.g. Arena software) in order to find out how direct/indirect emissions behave with respect to different variables, such as plant location or used energy source. Finally, the results will be analyzed.

The research consists of two main parts: The literature review and the building and simulation of a supply chain model. The literature review is meant to provide input to the model building so that the model is in line with the latest developments in this field of research.

## Literature review

The literature review will be carried out by searching for the latest research in the field of life-cycle assessment, green supply chain management and ecological indicator systems. Articles will be searched for by using Internet based scholarly search engines such as Google scholar and ISI web of knowledge. In addition, materials and articles given to us by ROCE partners consultants will be used. Articles, such as Seuring's "Sustainability and supply chain management – An introduction to the special issue", that pull together and introduce the most relevant articles of the field will be valuable sources to gain a holistic view of the research in the field.

The articles found will first be screened according to their abstracts to establish relevance. The articles classified to be relevant will then be read, and their most important findings noted. The aim is twofold:
1. Formulate a general understanding of the major concepts such as supply chains and CO2- and other greenhouse gas emission sources in supply chains
2. Compile a list of factors to be taken into consideration when building and simulating the model

The list of factors is meant to be in line with the latest findings and consensus. In addition, annual environmental reports of public companies with complex supply chains will be used as benchmark data to see how industries currently calculate their greenhouse gas emissions.

After this, the pair responsible for producing the literature review will present the findings to the rest of the project group and they will be discussed. The result of this discussion will then act as the basis for the simulation. While it is important that the whole group is up-do-date with the literature review's findings, it is sensible that the work is divided into areas of specialization. In this case, the literature review will mostly be carried out by pair Eskola-Koulumies, and the work along with the presentation of findings is meant to be complete by 26 February. After this, the findings will be written into a report.

## Model building and simulation

Supply chains are complex operations and their analysis requires a careful approach. It is easy to get lost in details and spend large amounts of time and effort for the analysis. On the other hand, it is possible to develop too simplistic model and miss critical issues. One crucial aspect is to define the appropriate level of abstraction in the simulation model so that the key questions are answered.

Based on the results of the literature review, a supply chain model will be created for simulating the CO2 emissions throughout the chain. As a tentative plan, ROCE Partners will provide us a supply

chain model of one of their customers. Ideally; the case would be from the steel industry because it is a major CO2 emitter. Should ROCE not be able to share any convenient supply chain model, we will proceed with a case study based on the findings of the literature review. In that case, we will expand the model explored in the article by fitting in the factors discussed earlier.

The crucial first step is to determine an appropriate supply chain model that captures key elements related with CO2 emissions. This includes not only determining the system dynamics of the supply chain but also choosing the parameters that are essential for the accumulation of emissions (for example types of energy used and distances). After identifying the model, we will implement it using for instance the commercial discrete simulation software ARENA or Matlab/Simulink. The model will then be used to carry out simulations on a set of different emission scenarios. If possible, we will also try to search for optimised parameters using the simulation results.

# Project schedule

The planned schedule is presented on the activity chart (Table 1). It helps the team members to see how the activities are progressing. Same colors indicate a certain phase of the project.

Milestones are set by the course personnel and consist of the project plan, midterm report and the final report. Milestones are presented on the activity chart, as well, and deadlines are presented in Table 2
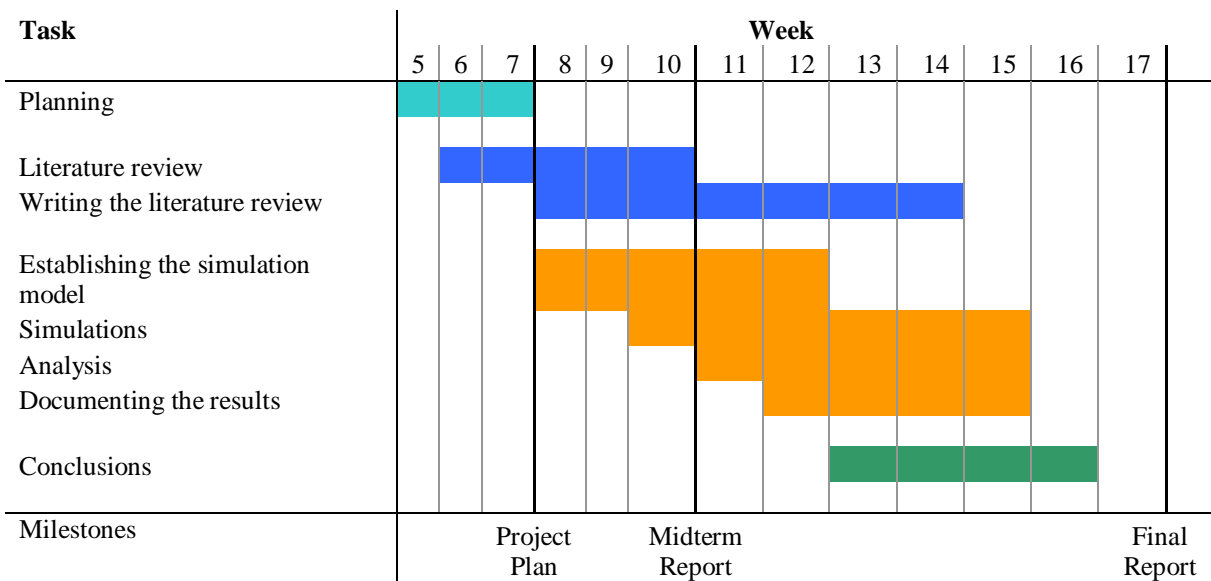
**Table 1  Activity chart**



**Table 2 The deadlines of the project.**

| Deliverable | Start | for ROCE | for the course |
|---|---|---|---|
| Project plan | Feb 4 | Feb 9 | Feb 11 |
| Midterm report | Feb 19 | Feb 26 | March 4 |
| Final report | March 23 | April 16 | April 22 |

# Resources

As the project group is fairly big for the course, it is important to pay attention to the team work of the group. Our aim is to divide the responsibilities clearly, work in smaller groups and follow detailed schedule. The smaller groups should help us to find convenient times for meetings and motivate us to work, as everyone has a well defined part of the project to do. The internal deadlines are increasingly important because some parts of the project are dependent of the results of the other teams. For instance, the different scenarios of the simulations require information about the possible alternatives and their $CO_2$ emissions.

Our group consists of six students and we have divided the key responsibilities as Table 3 shows:

**Table 3 Responsibilities**

|  | Activity | Responsible |
|---|---|---|
| Project | contacts with ROCE schedule | Niklas |
| Literature research | Literature review | Antti, Oskari |
| Simulations | Establishing the simulation model Simulations | Heikki, Lari<br><br>Maija, Niklas |

Our contact person at ROCE Partners will be Anssi Käki.

# Risks

The most likely risks of the project and their effects are assessed in Table 4.

**Table 4 Possible risks for the project**

| Risk | Effect | Probability | Preventive actions |
|---|---|---|---|
| We do not get any data from the steel factory | Large | Moderate | We are not able to prevent it but we can have a plan b which will be to build a case study related to one of our articles. |
| Schedule related problems | Moderate | Moderate | Preparing a precise schedule and continuous monitoring of the state of the project. |
| Problems related with the scope of the project | Large | Moderate | Careful defining and demarcating of the objectives. |
| Problems with simulation software | Moderate | Moderate | Explore the different simulation software IT services offer on their computers and find out the most suitable for our purposes |