Risk Assessment of a Sustainable Supply Chain. Case Study at Kuehne + Nagel Luxembourg

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ABSTRACT

“Green” or “sustainable supply chains”, have already been defined several times in many different ways, but the literature about its inherent risks is quite rare. In this paper, some of those risks have been defined and analysed via a case study. The latter is based on the validation and optimisation of Kuehne + Nagel’s internal CO₂ calculation tool.

Categories and Subject Descriptors

H.4.2. [Information System Applications]: Logistics

General Terms

Design; Management, Measurement, Performance, Verification.

Keywords

Sustainable Supply Chain; Risk; Risk Evaluation; Validation Process;

1. INTRODUCTION

“Sustainable” as well as “Green” topics are still at an early stage. Nevertheless, Sarkis et al. (2010) detected, that the minimisation of waste and industrial pollution was already an issue by the beginning of the 20th century, needless to mention that the authors they refer to, dissected this subject from an economic and not from an ecologic point of view. The “Green Idea” was, however, undoubtedly a consequence resulting from their analyses.

Nowadays, “Green” seems to be one of the most important keywords of the 21st century, gaining constantly in recognition and sense. The question if “Green” is a synonym of “Sustainable” is, however, still a controversial subject matter. Sure enough, many authors have explained, what they mean by “Green” or “Sustainable”, but up until now, researchers as well as mercantilists do not agree on any common definition of these keywords as yet. Nevertheless, many articles cite the Brundtland Report, where Gro Harlem Brundtland (1987) stated that “sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs”. According to Guiorg Z. et al. (2010), the idea of sustainable development is very close to the concept of green logistics, as in their point of view, the objective of green logistics reflects the notion of sustainable development. In addition to this, a sustainable supply chain helps a company to improve its performance from both an economic as well as an environmental point of view. (Narasimhan R., Carter J.R., 1998).

It has to be noted that the concept of sustainability has been extended by Elkington (1998), discussing the Triple Bottom Line (TBL). As a matter of fact, not only customers’ interest in sustainability and green working conditions are growing steadily, but [1] economic, [2] ecological and [3] societal issues are moving increasingly into the focus of governmental and European institutions. According to Seuring S. et al. (2008), “New (1997)1, Kärnä and Heiskanen (1998)2 and Sarkis (2001)3 are the first papers to integrate all three dimensions.”

Organisations are held responsible for the environmental and social performance of their suppliers and partners, as there are internal and external pressures (Seuring S., et al., 2008). In fact, “organizations have adopted ecologically responsible practices to meet legislative requirement […]” (Azevedo et al., 2011) In other words, business stakeholders are working out strategies to implement the concept of the TBL into their arrangements.

If a company wants to reduce its environmental risks, it has to manage its ecologic impacts in a proactive manner. It has to be mentioned that risks occur in each domain of the TBL. The existence of many risks has therefore to be considered. One challenge is to develop strategies designed to reduce those risks while other goals are focused. International trade agreements and treaties include requirements, complying with international environmental standards such as ISO 14000 or the European Committee’s Standard Eco-Management and Audit Scheme (EMAS), in order to prevent environmental risks.

McKinnon et al. (2010) analysed the environmental consequences of logistics operations, including the issue of how to reduce the financial externalities in order to achieve a more sustainable balance between economic, ecological and societal objectives. In fact, Norman et al. (2004) stated that the three elements of the TBL cannot be mutually supportive.

The case study is based on Kuehne + Nagel Luxembourg which makes use of a regional competence centre in order to fulfill the growing demand of customers for integrated logistics. The Integrated Logistics Centre (IL) manages “End-to-End” (e2e)

solutions, based on “Fourth Party Logistics” (4PL) integrating all transport and service modes and provides complete information which enables performance and cost control for its customers’ for the entire supply chain by ensuring its management.

Within the framework of this logic, Kuehne + Nagel, whose internal politics and strategies are based on top level quality services, thus work on the concept of continuous improvement and risk management, has implemented a validation process for the evaluation of a sustainable supply chain. The evaluation is based on CO₂ calculations and optimisations.

It has to be mentioned that Kuehne + Nagel Luxembourg provides tailor-made end-to-end (e2e) logistics solutions and owns a regional competence centre, fulfilling the customer’s growing demand for sustainable, as well as integrated logistics. Based on “Fourth Party Logistics” (4PL), the “Integrated Logistics Centre” (ILC) manages the e2e solutions, including all transport and service modes. In addition to this, the ILC provides complete information, which enables performance and cost control for Kuehne + Nagel’s customers’ entire supply chain by ensuring its management.

Inadequate management of environmental impacts due to intermodal logistics and multimodal transportation of companies’ operations raises serious potential risks for those enterprises (Berry and Rondinelli, 1998). For this reason, Kuehne + Nagel have defined risk management as being very important in designing sustainable supply chains for its customers, considering, inter alia Greenhouse Gas (GHG) emissions.

This paper is structured as follows: Section 2 explains the background of greenhouse gas calculation issues. The third section highlights the methodologies used, whereas section 4 presents the constraints and risks. A conclusion is given in section 5.

2. BACKGROUND

Nowadays, the comparison of enterprises’ GHG emissions becomes more and more important, as the European Union Greenhouse Gas Emissions Trading Scheme(ETS) will be applied in the near future. Consideration must, however, be given to the fact that up until now, there is no possibility of measuring a company’s real GHG production. For this reason, firms have to calculate the volume of their produced carbon emissions. The remaining problem is that entrepreneurs are still using different assumptions and methodologies in their calculation models. In other words, a real comparison of their GHG emissions and thus a successful operation of the ETS is, de facto, still not possible.

One has to be aware of the fact that “doing business has no profit without risk, rewarding those who best understand systems and take what turns out to be the best way to manage these risk” (Wu et al, 2013)

In order to meet its customers’ greater demand on sustainability and environmental friendly logistics practices, Kuehne + Nagel has set up an internal carbon calculation tool, named “Global Transport Carbon Calculator” (GTCC). It is evident that this tool can not be used before a validation has been performed. The accompanying validation process is shown in Figure 1 Process Chart: Validation Process.

The GTCC is supposed to give credible information about its GHG emissions as it is based on both, the European pr EN16258 standard (covering the calculation methodology for energy use and GHG emissions of freight and passenger transports) as well as on the ISO14064 standards (covering the quantification, reporting, monitoring validation and verification of GHG (AFNOR Normalisation, 2012)). In addition to this, concerning sea-freight transportation, the tool is based on the Clean Cargo Working Group (CCWG) methodologies. The CCWG is in fact a working group, which has defined the CO₂ and CO₂ equivalent (CO₂e) calculation methodologies and assumptions for sea-freight, which are used by each and every member of the CCWG.

The reasoning behind the decision to base the tool on the above mentioned standards and the CCWG methodology for GHG calculations is evident. De facto, if each logistic provider used the same standards, formulas and assumptions for its carbon emissions calculation systems, the comparison of CO₂ and CO₂e emissions of different enterprises would be greatly simplified. In this manner, companies could guarantee more transparency and consequently increase their customers’ confidence. The latter could obviously support buying decisions by taking provider’s GHG emissions into account. In this logic, basing the GTCC on the above mentioned calculation methodologies will undoubtedly increase Kuehne + Nagel’s credibility.

According to Michael E. Porter [Porter, 2011], companies adopting a sustainable strategy will benefit in a financial way by creating shared value. As a matter of fact, companies provide economic value by creating societal value. Correspondingly, Kuehne + Nagel will provide added value in both, financial and societal terms. Nowadays, the “green idea” as well as the perception of “environmental risks” become more and more important in customer’s buying decisions. As the company shows its interest in environmental and thus, in “green” domains, it will become more attractive to ecologically sensitive customers and increase their confidence.

It is evident, that being “green” is much more, than only considering GHG emissions. In this logic, Rondinelli and Berry (2000) have identified several risks linked to environmental hazards:

- Threats of increased regulatory control by national governments and international organisations present the most immediate risks.
- Financial risks: pollution prevention and elimination of waste resulting from logistics providers’ (LPs) or multimodal transportation companies’ operations can save significant amounts of money.
- Competitive risks and backlashes from stakeholders: damages to corporate image from environmental pollution or natural resource degradation.

The problems discussed in this paper are the identification and evaluation of a GSC design’s constraints and risks.

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4 The ETS is a system based on the same principles as the Kyoto protocol
5 Up until now, most customers esteem “environmental” being a synonym of “green"
Figure 1. Process Chart: Validation Process

1) Acquiring basic information
   - Identify basic information and raw data.
   - Organisation of data processing and definition of calculation method.

2) Risk Assessment
   - Identify risk of errors, based on the data acquired

3) Establishment of a verification
   - Review of documents (ISO Standards, Internal Documentations, ...) and records.
   - Interview pertinent people

4) Execution of the Plan
   - Definition of boundaries.
   - Definition of scopes.
   - Determine how to get supplementary information

5) Evaluation of the Results
   - Gap – analysis of the results provided by the different calculation tools

6) Creation of a Verification Report
   - Write verification report, including assertions

7) Review
   - Review of the process *(Has it been executed accurately?)*

8) Submission of the Report
   - Submit the verification report to the competent department / person

9) Approval of Report
   - Verification of the results.
   - Verification of the report.
   - Save the report as “Report – final version”
3. CASE STUDY AT KUEHNE + NAGEL LUXEMBOURG: METHODOLOGIES USED

As mentioned before, the GTCC had to be validated before Kuehne + Nagel could use it for calculating customers’ GHG emissions. In addition to this, since up until now, GHG emissions cannot be measured, it is evident what the company wants is that its tool provides the most realistic results possible. For this reason, Kuehne + Nagel wanted its calculation tool to be optimised via the validation process. In other words, for this project, it was absolutely necessary that the methodology used for validating the GTCC was based on an optimisation process.

Decision makers have to define their priorities, in terms of what they exactly want to optimise. In order to handle the lack of knowledge concerning the exact values of the parameters, Pishvaee M.E. et al (2011) chose the fuzzy mathematical programming approach, whereas Truschkin E. and Elbert R (2013) used the Random Utility Maximisation (RUM) to solve the problem of unknown factors. They assumed the consumer to be rational and quantities of each consumption to be nonnegative continuous variables. Thus, they based their analysis on a microeconomic approach, which requires utility function. The latter was estimated by the “State Preference Technique”.

Molnár et al. (2007) and Sloan T. W. et al. decided on standardized models and frameworks, and so providing a common language to communicate supply chain definitions that are important. For this reason, they used the SCOR methodology.

As “the green supply chain management is a powerful way to differentiate a company from its competitors and it can heavily influence the project success”, Thipparat T. (2011) evaluated the GSC management, using the Adaptive Neuro Fuzzy Inference System (ANFIS).

The methodology used in this paper is the “6σ-methodology”, as it is based on the “3.4 ppm concept”. Thus, its’ target is to reduce inefficiencies up to 3.4 parts per million (ppm). This methodology is also named “DMAIC” standing for “Define, Measure, Analyse, Improve, Control”. Hence, the case study and its (potential) risks were defined: in this phase, the most important task was to ensure the different stakeholders’ common understanding of the project. As the calculation process had to be measured, a study has been carried out. The gaps which have arisen out of this case study and calculations have been analysed in order to be improved afterwards. In order to control the calculation process and to evaluate the inherent risks, a continuous improvement process was implemented. Every process needs to be traced by a process chart. In fact, it is crucial to discover the different people one has to refer to, in case of questions, changes or inconsistencies.

<table>
<thead>
<tr>
<th>Milestone</th>
<th>Task</th>
<th>Subtask</th>
</tr>
</thead>
<tbody>
<tr>
<td>Define</td>
<td>Data collection</td>
<td>Project definition &amp; common understanding of the problem</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Project Charter &quot;GTCC - Validation&quot;</td>
</tr>
<tr>
<td>Measure</td>
<td></td>
<td>SIPOC Analysis</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Data collection - Case studies</td>
</tr>
<tr>
<td>Analyse</td>
<td></td>
<td>CD02 - calculation Case-study with &quot;CD02 Energy Processes validation 2013&quot;</td>
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<tr>
<td></td>
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<td>CD02 - calculation Case-study with &quot;D05 Transport Module - Calculation of emissions&quot;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CD02 - calculation Case-study with &quot;GTCC&quot;</td>
</tr>
<tr>
<td>Control</td>
<td></td>
<td>Assumptions for validated data</td>
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<tr>
<td></td>
<td></td>
<td>Interpretation of the results &amp; Gap-Analysis (of a calculation methods)</td>
</tr>
<tr>
<td>Recommendations of Improvement</td>
<td>Potentials of improvement</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Areas of improvement</td>
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<td></td>
<td>Continuous improvement process</td>
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<td></td>
<td>Calculation process documentation</td>
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</tbody>
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Figure 2. 6σ – Methodology

In Figure 2 6σ Methodology, it becomes apparent that each and every task contains several subtasks. The task “Define” manifests the performance of a SIPOC-Analysis. The latter requires the definition of the different parties involved in the project concerned, i.e. Suppliers, Input, Process, Output and Customers (SIPOC), as shown in Table 1. In this specific case, the project consists of the validation of the GTCC. Hence, the SIPOC analysis has to be performed from a point of view of the tool.

Table 1. The SIPOC Analysis

- **Suppliers**  As the GTCC uses the data stored on an internal IT-platform, its suppliers are Kuehne + Nagel’s customers, who are registered in this internal collecting platform
- **Input**  The data, Kuehne + Nagel’s registered customers have entered into the above mentioned internal IT-platform
- **Process**  Please see Figure 3. GTCC Calculation Process
- **Output**  The carbon emissions calculation, which are assumed to the most realistic as possible
- **Customer**  The end-customers, requiring carbon calculations and every involved internal department
4. CONSTRAINTS AND RISKS

In reality, a situation is not as rigorous as has been predicted in theory and therefore, several constraints and risks have to be envisaged. From a theoretical point of view, all data needed for calculation is provided but in reality, some data, such as the exact way in which the goods were transported, the exact tonnage of shipped merchandise, etc., is not available, and is thus included into the formula via assumptions and fixed values.

4.1 Internal and External Constraints and Risks

As stated above, most variables which should be included in the calculation are totally unknown. Factors such as topography, weather conditions, operator’s driving habit, etc. which have a strong impact on produced carbon emissions were not necessarily neglected, but general or industrial assumptions were used instead. Today, it is still unprofitable and therefore, from a company’s perspective “impossible” to implement real carbon emissions measurements. For this reason, every company fostering “green thinking” has to calculate its produced CO₂e emissions the most realistic way possible.

Table 2. Internal and External Constraints and Risks

<table>
<thead>
<tr>
<th>Problem</th>
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</thead>
<tbody>
<tr>
<td>Topography</td>
</tr>
<tr>
<td>No one knows the real shipping route.</td>
</tr>
<tr>
<td>The topography of a specific route is in most cases unknown</td>
</tr>
<tr>
<td>Meteorology</td>
</tr>
<tr>
<td>It is not possible to obtain data about the real meteorological conditions which reigned during a shipment</td>
</tr>
<tr>
<td>Aircraft Altitude</td>
</tr>
<tr>
<td>The exact aircraft altitude is unknown.</td>
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<tr>
<td>No company has an influence on it</td>
</tr>
<tr>
<td>Real Traffic</td>
</tr>
<tr>
<td>It is not possible to obtain the real data concerning the real traffic conditions (holdups, road works, etc.)</td>
</tr>
<tr>
<td>Fuel Type</td>
</tr>
<tr>
<td>The chemical composition of fuel differs from one country to another</td>
</tr>
<tr>
<td>Distances</td>
</tr>
<tr>
<td>As the real route of a shipment is unknown, the real distance is unknown too. Calculations can differ enormously from one calculation tool to another. In addition to this, if a tool is not up to date, it calculates unrealistic routes</td>
</tr>
<tr>
<td>Shipments</td>
</tr>
<tr>
<td>If the real route is not known, calculations are based on “End-to-End” shipments</td>
</tr>
<tr>
<td>Details</td>
</tr>
<tr>
<td>Pre and on carriages are considered by assumptions as the shipments are supposed to be “e2e” shipments</td>
</tr>
<tr>
<td>The operators’ driving habits are unknown, but can be improved by training</td>
</tr>
</tbody>
</table>

It is crucial to concentrate on so-called “normal cases”, and, not on so-called “secret shipments”. De facto, even the driver of these kinds of shipments does not know where he has to load or unload. He is guided by a GPS-system, and is just aware of the next 10 kilometres he has to drive. There are several route planners, who have to design one or two legs, but, just as the driver, they do not know the whole shipping route. Even the customer is aware of the fact that his products will be delivered from a point A to a point B, but he has to rely on his supplier(s) due to the fact that he too is not aware of the exact route. This method is usually used for the transportation of high value goods. In this case, the shipments are traced in an extremely precise manner, and thus, the production of GHG emissions could be calculated afterwards but this kind of shipments is, however, exceptional. The exact itinerary is normally unknown as it depends on many factors, such as traffic holdups, construction areas, etc.

4.2 Potential Risks

Every single piece of data has to be introduced into a program. It is evident that the very first record is introduced manually: since “errare humanum est”, every single data which has been put in manually exhibits a potential risk of mistake. Information and data provided by the customers are not always credible, sometimes not even realistic. For example, since it is possible that two different cities have one identical name, it is evident, that the risk of confusion is enormous. Each and every piece of data has, therefore, to be cleaned up before any calculation can be performed.

Another point to underline is that the distances are calculated by several distance calculation tools in compliance with the respective transport mode. The authenticity of the distance calculation tools is based on assumptions and can thus not be proven by calculations or measurements. In addition to this, it was found out that most carbon calculation tools are based on “Ton-
Kilometres” (TKM). If a distance provided by a distance calculation tool is given in a different dimension, the specific distance has to be converted into kilometres (“Nautical Miles should not be confused with “American Miles”).

Up to the present, it is not possible to compare the different legs. As they are carried out by several transportation modes, the distances and gross weight of cargo vary, and consequently the calculation formulas are based upon different units of measurement. While the GHG emissions of sea-freight are calculated in KgCO₂/TEU-Km, the formulas are based on KgCO₂/TKM in road-freight. For this reason, one has to concentrate on „Door to Door” shipments. This means, that all the results of the different legs of the whole shipment are summarised in order to obtain the total GHG emissions.

5. CONCLUSION
It is important to be aware of the fact that a calculation is always an estimation which can never replace real values or measurements. Since, nowadays, companies are working with GPS systems, electronic data transmissions, measured direct fuel injections, … it should be possible (at least in theory) to obtain all relevant information in order to calculate the “real” CO₂ emissions produced, or to measure the carbon emissions produced by the respective vessels. In reality, it is not as easy: even if a company would be able to record all this different data, it would be difficult to implement a correct calculation formula into its’ calculation software. Companies have to be aware of the risks, going along with “Green initiatives”, including GHG calculations: Most of raw data provided by the customers is not accurate, as their operating systems and reporting tools are not configured to retrieve it in an appropriate way. Recording, analysing and implementing this data into the calculations would require significant resources in terms of time and financial spending. In addition to this, companies will not invest in measuring devices, as these are still considered as generating no return on investment.

Kuehne + Nagel wanted to provide its customers with the most realistic CO₂ calculations possible. A calculation tool has been set up, validated and implemented. During the validation process, a non exhaustive list of risks has been analysed. It is important to be aware of the fact, that not all (potential) risks are controllable by a company, as they depend on many external factors and people. Nevertheless, in order to minimise the controllable risks, such as missing zip codes, port names or IATA codes, a so-called “Poka-Yoke” will be introduced. It will thus not be possible anymore to record a shipment into the internal IT-platform, if this kind of data is missing. In other words, the internal IT-platform will contain all data needed for calculating GHG emissions produced by transportation.

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Supported by the Fonds National de la Recherche, Luxembourg