Case study at ABB

A part of CPM project "Analysis tool for calculating environmental impact and efficiency of transport systems"

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CHALMERS UNIVERSITY OF TECHNOLOGY
Göteborg, Sweden, 2012
CPM Report No. 2012:2

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Introduction

This study has been conducted as a part of the CPM (Centre for environmental assessment of product and material systems) project "Analysis tool for calculating environmental impact and efficiency of transport systems". The overall aim of the project is to develop a tool that is helpful for improving environmental performance of the transport system in practice. The tool will include calculations of both the total logistics costs and the external costs raised from environmental impacts. By using the developed tool it will be possible to follow up logistical changes and identify economic and environmental improvement potentials in organizations.

The case study at ABB has been performed in collaboration between Northern Lead Logistics Centre and IVL Swedish Environmental Research Institute. It provides the project with knowledge from practice in terms of identifying variables that should be included in the tool as well as investigating what kind of data that is available in an organization. Furthermore, how different logistical decisions influence the logistics and external costs has been investigated. For ABB, the main goal with the project was to find new ways of structuring and making their logistics more efficient – both in environmental and economic terms.

Theoretical background

The total logistics cost model to be developed in the project is based on both theoretical as well as practical experiences; therefore a number of case studies are performed within the project, where ABB is one of them. However, in order to provide the reader with some background regarding the theory behind the logistics cost, a short summary is described below, both regarding logistics costs and external costs separately.

Logistics cost

The total logistics cost concept has been discussed and models suggested by several authors, e.g. (Zeng and Rossetti, 2003, Gunasekaran et al., 2001). There are similarities as well as dissimilarities between the different models presented in literature. However, there are some major areas to be commonly included in logistics cost models. These areas serve as the basis for the data collection in the ABB case study. A thorough theoretical description and motivation behind the choice of these areas is to be found in the report "Total logistics cost concept" (Santén and Andersson, 2012).
Areas to be included in a total logistics cost model are transportation, packaging, warehousing, inventory carrying, service deficiency, administration and customs.

Total cost = T + P + W+ I + S + A + C

T	Transportation
P	Packaging
W	Warehousing
I	Inventory carrying
S	Service deficiency
A	Administration
C	Customs

Transportation costs include freight charge, consolidation, transfer fee, pickup and delivery costs. Total transportation costs are the sum of transport costs for each shipment. All transport costs are included in this function, also costs that may have risen due to a delayed order administration resulting in extra distribution costs, i.e., emergency deliveries. Administration costs for organizing the transports is included in the category of administration costs and costs for packaging are included in the packaging category.

Packaging costs include those costs associated with the material used for packaging goods and processing of packaging and marking goods.

Warehousing is about *"…that part of a firm's logistics system that stores products (raw materials, parts, goods-in-process, finished goods) at and between the point of origin and the point of consumption, and provides information to management on the status, condition and disposition of items being stored"* (Lambert and Stock, 2001). The costs induced by these activities include the costs for the warehouse itself, the warehouse personnel and their equipment, as well as in-site transportation.

Inventory carrying costs is about those costs that vary with the amount of inventory costs. These costs can be grouped in four major sub-categories; cost of capital accumulation, risk costs, inventory service costs and variable warehousing costs.

Administration costs are related to order processing and information systems. A differentiation can be made between costs for processing orders, planning, making stock reports and procurement costs. Another post is about expediting costs, i.e., costs that occur when there is a delay in delivery. This is connected to extra administration when there is a mistake in the delivery procedure, it can be the time spent for pushing suppliers, tracking missing goods or searching delivery information and documents.

Service deficiency costs are mainly about costs, which arise due to lack of meeting the target of service level. Service deficiency is a difficult issue, since costs appearing due to lack in meeting the target of service level may arise in any of the other functions, and will often be "hidden" in other functions.

Customs costs may be an important issue in an international purchasing environment. There are three types of costs for customs: clearance fee (to be imposed by local customs), brokerage fee (to be imposed by an agent on behalf of the shipper) and allocation fee.

External costs

External costs or externalities are defined as costs that arise from an activity and are covered by others. In the case of freight transportation it can be costs that arise from health impacts, value of property, climate change, loss of time etc. In this work the following external cost categories are included: emissions of climate gases, emissions of toxic substances, noise, congestion, impact on ecosystems, accidents, up- and downstream costs.

To calculate the external costs generated by the transportation of goods, it is necessary to know the amount and type of substances that are being emitted from the transportation of a certain amount of goods, where these substances are emitted and what the impacts of these emissions cost the society. To derive these data, there are some parameters for which data are needed.

Emissions generated from the transport

The emissions are calculated using methods according to NTM (2012). Emission factors from vehicles and vessels are taken from established sources. For the calculations one must establish the type of vessel and its emission class. Further load factors and some information about the route are needed

Monetary valuation of impacts

The costs for emissions basically come from health impacts and are therefore depending on the location of the emissions. The values for external costs for the emissions are taken from Bickel and Friedrich (2005) and Steen (1999). The external costs for the other externalities are taken from the Handbook on estimation of external costs in the transport sector (Maibach et al., 2008) For further description of the methodology for calculating the external costs see Fridell et al. (2011).

Method

The object under study at ABB was the project of up-grading a rolling mill in Finspång, called the Luvata project. The study has been conducted in close collaboration with the staff at ABB. Data has been collected through semi-structured interviews as well as searched for in ABB's internal data-bases and documents. The authors of this report had the main responsibility of structuring the data collection, in collaboration with the transport manager at ABB.

Semi-structured interviews were conducted with ABB-staff that were involved in the project under investigation: the project manager, construction engineers and purchasing and logistics personnel. The interviews were made by telephone, including two researchers, the ABB transport manager and one to three employees from the Luvata project. After conducting a first round of interviews (with representatives from all major groups in the project) a second round of interviews were made in order to verify the first part of the findings as well as raise new questions that had appeared.

A data collection sheet was developed and continuously improved during the study. A number of variables were identified from literature as important for calculating the total logistics cost as well as external costs from environmental impact. These variables were included in the sheet and the data were searched for in the organization. The transport manager at ABB was responsible for finding data for each variable.

ABB case

ABB group is today a global leader within power and automation industry. ABB has a history, ranging all the way back to 1883, when Ludvig Fredholm founded "Elektriska Aktiebolaget i Stockholm". His company was merged into ASEA a few years later, 1890. ABB as a company was later founded in 1988, by a merger between ASEA and BBC.

ABB is a company that works with power and automation technologies that enable utility and industry customers to improve performance while lowering environmental impact for customers; industries as well as energy companies. The ABB group covers five different business areas; power products, power systems, discrete automation and motion, low voltage products and process automation. The business is located in more than 100 countries and employs about 117,000 people worldwide. In Sweden ABB has 8700 employees located in over 30 cities, having the head office in Västerås.

ABB offers a wide range of products, utility projects for the industry and services. The division of Process Automation mainly focuses on providing customers with products and solutions for instrumentation, automation and optimization of industrial processes. The industries served include oil and gas, power, chemicals and pharmaceuticals, pulp and paper, metals and minerals, marine and turbocharging. One of the business units within the Product Automation division is Rolling mills, which specifically works with electrical equipment and control systems for different kinds of rolling mills. In this study, the logistics in a project at Rolling Mills has been the object of study.

Description of the project

The object of study has been a project where ABB is rebuilding the control system in a rolling mill for Luvata Sweden AB in Finspång. Within this assignment, ABB is contracted to design, construct and install a new control system, install new engines to the spools and to optimise the production of the rolling mill.

The general process of the project can be described by the following stages; project initiation, basic design, detailed design, off-site construction, delivery to site, on-site installation and start-up/optimisation, see figure 1 below. The first phase of the project is the project initiation. During this phase, the main activity is to assign staff to the project. When that has been performed, the basic design starts. During this stage, the designers decide upon the main features of the system, for example which control system to use. The output from the basic design process is a list of parts and materials needed in the project as well as a wiring scheme. After the completion of this stage, necessary parts and material can be ordered. The detailed design stage follows after the basic design. At this stage, the design of the control panel, graphics and other details are decided upon.

After having completed the two design stages, the off-site construction stage is initiated. During this stage, the construction of hardware and software are performed in parallel at a test site in Västerås. When the construction is completed, the system is tested to see that it functions in accordance to given specifications. After that, the entire system is disassembled and delivered to the customer for installation. When completely installed, the operation of the rolling mill started up. First, the rolling mill is operated without any material in order to see that all functions are working according to specification. After having completed the first test, the rolling mills is then to be operated with material in order to adjust thickness and drag adjustment. When the operation of the rolling mills works according to specification, the mill is handed over to the customer to start-up the regular operation.

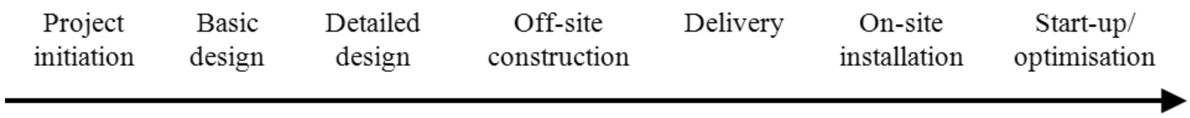

Figure 1: Time-line of the Luvata project

Decision levels in the project

There are three main roles within the Luvata project, the project manager, the construction engineers and the purchasing and logistics personnel, see figure 2 below. All of these people interact during the project, in order to perform the tasks at hand.

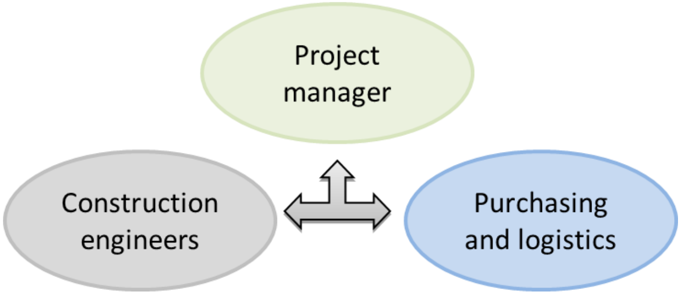

Figure 2: The decision levels within the Luvata project

The main tasks of the project manager are to create a project plan that specifies when in time different tasks need to be performed, to approve purchases and to monitor and evaluate the economy and time plan of the project.

The construction engineer's main tasks are to design the rolling mill, specify purchasing needs according to the design, help list appropriate suppliers and take part in the selection of supplier together with the purchasing department.

The purchasing and logistics personnel come last in the chain of work during the procurement of goods. They are dependent on information from both the project manager and the construction engineers in order to perform their tasks. The main tasks of the purchasing and logistics personnel is to compile all the purchasing needs specified by the construction engineers and create a purchasing plan that states when the different articles need to be ordered and delivered. Before the orders can be placed, the purchasing department selects appropriate suppliers together with the construction engineers by invitations to tender. Invitation to tender is not used for all orders, only for large orders where there is more than one supplier that can deliver the requested article. In many cases, there is only one supplier that can deliver to the specification requested by the construction engineers. When selecting a supplier, the most important factors influencing the choice of supplier are delivery security, quality, price and time of delivery. Often, these factors are assessed based on previous interactions with the suppliers but if a certain supplier has not been hired before, other customers' opinions are often used instead. When the supplier has been chosen, the purchasing and logistics personnel place the orders. Purchasing and logistics also manage all the invoices and order transports in cases when the supplier does not stand for the transportation.

Material and information flow

The identified activities that are related to the logistics costs within the case at ABB are either about the incoming transports, i.e. material flow, or about how information is handled regarding purchasing transports and reporting transport related data, i.e. information flow.

Material flow

The material flow within the Luvata project is about deliveries of products used for updating Luvata rolling mill in Finspång. The products are being transported from the suppliers to the test site in Västerås, to the warehouse in Västerås or directly to the site in Finspång. In addition to this flow, there is also one example of ABB being involved at ordering supplies for a supplier itself.

The material flow within Luvata project has been derived from ABB's database, which includes all orders purchased within the different projects. In total, there are 66 orders identified within Luvata project and these orders were identified to be distributed among approximately 50 deliveries. The reason for having fewer deliveries than orders is that there was more than one order placed to some of the producers at the same time; these orders were sent as one shipping, instead of separate shipments. However, there may be uncertainties in these numbers as it depends on how and what has actually been put in the database; this is an issue that will be further discussed later on. As pointed out before, the numbers of orders and deliveries are unusual small compared to a normal project. On the other hand it makes it possible to derive every single delivery in order to find data about it.

The products delivered to the Luvata project is of different types; standard range of products or special orders. Most common are standard range of products; products that normally are in stock at the suppliers, e.g., cables, computer screens and safety relays, while the special orders are specialized for the specific site. Often these are larger units. In Luvata, one example is a transformer. There are a wide range of suppliers; suppliers within ABB group or external ones. However, about half of the deliveries within Luvata project arrive from a supplier within ABB group. One exception is the case of the supplier of the cabinets. In that case ABB was involved in ordering supplies for the cabinet builder itself.

The transports are most often performed using the most common and large freight forwarders, such as DHL, Schenker, Swedish Post, UPS etc. However, in the Luvata project, one product required a special transport; the transformer was delivered from Spain by a dedicated truck operated by a small Swedish transport company. In Västerås, there is a local logistics company used for transporting goods within different departments at ABB. This company also handles storing, packaging, tagging and register deliveries and outgoing goods at a warehouse. The major part, about 70 % of the transports are national within Sweden, and about 30 % of the transports performed are international, i.e. delivered from a supplier abroad, all within Europe. The transports are almost entirely performed by road. The only exceptions are two transports being made by air, one document delivery outgoing from Västerås to Mannheim, and one incoming goods delivery from Zurich.

About 70 % of the deliveries are addressed to Västerås, either to the warehouse run by the local logistical company or directly to ABB test site. The test site is used to construct and test the system to be implemented at a later stage at the customer in Finspång.

The remaining 30 % of deliveries are transported to the site in Finspång, either directly from the supplier or from Västerås; this is the goods getting transported from the test site or warehouse in Västerås. The whole material flow is visualized in figure 3.

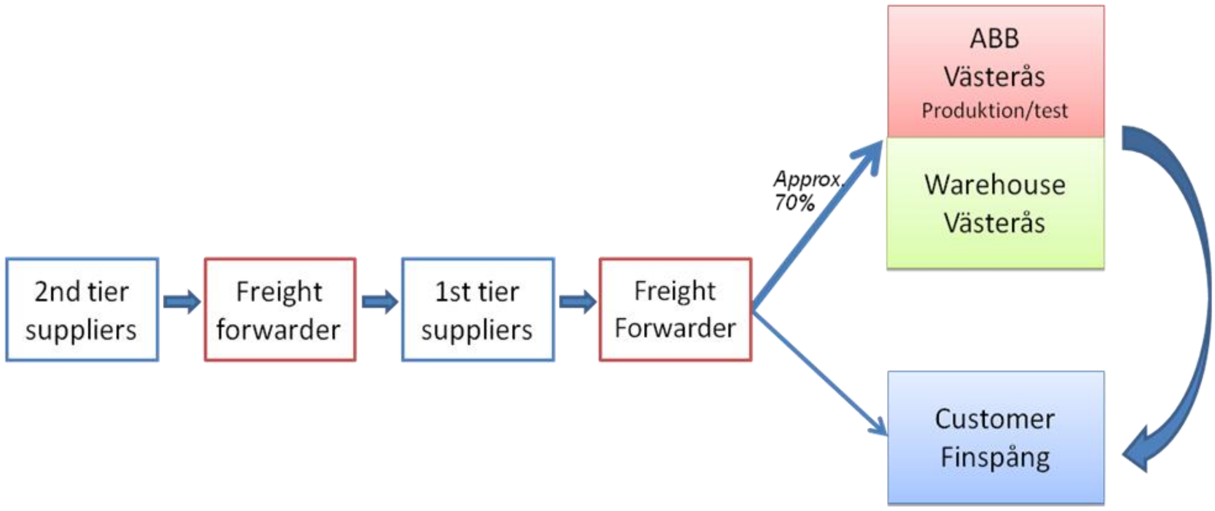

Figure 3: The material flow in the Luvata project

Information flow

The main information flow is, naturally, in between ABB and the first tier supplier and customer respectively, see figure 4 below. In the dialogue with the supplier the major requirements are about four aspects (no ranking in between them); availability of the right product, delivery security, time for delivery and the price[1]. Normally, ABB has supplier agreements with a number of different suppliers. When it is about the standard range of products the order process is not requiring any collection of different offers from a number of suppliers, which is the case of the special orders, e.g., the transformer and the cabinet.

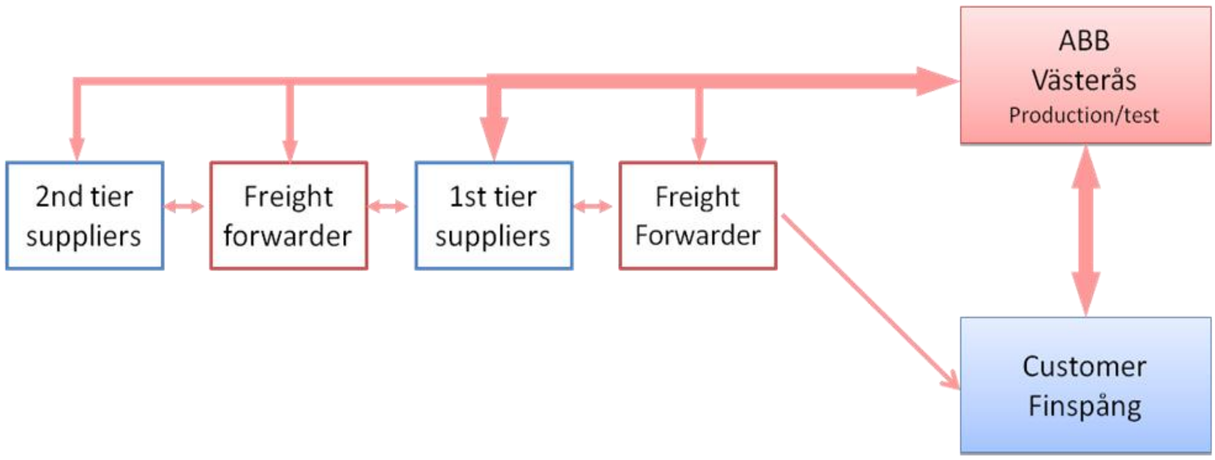

Figure 4: The information flow in the Luvata project

When it comes to the transport of the product itself there are a couple of different alternatives. When purchasing products there are different "Incoterms" used depending on the specific agreement with the supplier. About half of the deliveries are shipped according to FCA, which means that ABB have the main responsibility for the shipment. This is generally the case when using suppliers in the ABB group. Among the external suppliers there is a wide spread of different terms that are used, e.g. CIP, DDP, EXW. However, according to the data from this case study, it is more common that the external supplier organizes the transport and stand for the transport cost. So, depending

[1] Described by the project manager, Luvata project.

on the agreement with the supplier, ABB have more or less to do with the arrangement of the transport.

When ABB is responsible for purchasing the transport there are standard contracts used that are agreed upon on a national ABB level, thus this is not part of each project. In these contracts there are a number of freight forwarders to be used which make it easy to purchase a transport, when this is the case.

When an order gets delivered, information about what order that has been delivered and when should be reported in ABB's internal system. This registration can be made by the logistical company itself (as is the case with the local company in Västerås) or, as in most cases, by the purchasing and logistics department manually when receiving information from the supplier, the freight forwarder or the manager of the project. In the Luvata project there are examples showing that follow-up of orders can be time consuming. One reason is that there is no common system for all suppliers to follow when specifying an order and what is included in the delivery document. This means it can be difficult to track which order and products are included in each delivery. Also, there are different persons receiving the goods, at ABB or at the customer, which are more or less informed about how to handle receiving orders. This means that the order can be delivered without being reported in the system leading to time consuming searches for products. Another scenario is that the order gets delivered, reported in the system, but when the constructors should use the products it is not to be found; either it exists somewhere at site, or an incomplete order has been delivered. These are examples of challenges when handling the information about orders and deliveries at the different receivers of products in the Luvata project.

Collection of data for the total logistics cost model

In order to provide input to the total logistics cost model, the logistical and environmental variables that are of interest for the model have been investigated in the Luvata project: what kinds of data and which data are available have been studied.

Logistics cost

The logistics variables of interest for the cost model concern transportation, packaging, warehousing, inventory, service deficiency, administration and customs. For more information about the total logistics cost model, see Chapter 3.

In the Luvata project, there are three ways of dealing with transportation costs, which depends on what "Incoterm" is used in the agreement with each supplier. First, the cost for each delivery can be directly invoiced to ABB from the freight forwarder at a separate bill. In that case it is fairly straight forward to follow up the total transport costs for each delivery. Second, the transportation cost can be included at the invoice of the supplier, but stated separately. Then the transportation cost must be manually registered in ABB's system in order to follow up the costs from each delivery. Furthermore, it is not possible to know that the stated cost at the invoice is exactly the same as the cost from the actual transport since the supplier may use a template price for its customers. Third, the transportation cost can be included in the total price of the supplier. In that case, the transport cost is hidden in the invoice, and will be difficult to derive. Because of these three different types of transport cost arrangements in the Luvata project, it is difficult, or even impossible, to derive the exact transport cost for all deliveries. The transport costs from about two thirds of the deliveries have been found possible to derive in the Luvata project. What can be done in addition is to use a template transportation cost for those deliveries where the cost is missing.

Packaging and warehousing costs in the Luvata project are raised from the handling and packaging in the warehouse located in Västerås. These activities are outsourced to a local logistics company and are invoiced separately to ABB. From these invoices a few different costs can be identified: arrival clearance, packaging and wrapping, storage, package marking and loading. Other packaging and handling costs have not been identified separately in the Luvata project. However, there may be packaging costs included in the transport costs derived from the freight forwarder, or included in the total price from the supplier. When the goods do not arrive at the local warehouse in Västerås, but either at the test site in Västerås, or the final customer site in Finspång, the goods get handled manually by ABB staff, or by customer's staff. These costs are difficult to set a price for and are not included in the final summary of costs.

Inventory carrying costs is a complicated issue. Today, these costs are not measured nor calculated within the project.

Service deficiency is about costs that arise due to lack in meeting targeted service level. For ABB, in the case of Luvata project, this can mean costs that arise from being delayed in the project, such as fees towards its customers. However, that this happens is very uncommon according to the project organization. In the Luvata project, there were no such delays. However, it is more common that delays occur from the suppliers, which may raise unexpected costs to arise. This can be extra administration costs or extra distribution costs. These costs are included in the categories of transportation and administration.

Administration costs are connected to planning orders and shipments, placing orders for suppliers, administer invoices, follow up deliveries etc. In ABB, the purchasing and logistics organization are working with these issues as explained in chapter 4.2. In total, time spent within purchasing and logistics amount to about 3 % of total hours in the Luvata project. The distribution between different functions within purchasing and logistics has been estimated roughly by the staff at the department. However, administration costs may also arise in other parts of the organization as well: the designers are occasionally also placing orders, when there is, e.g., components found missing in the test phase and there is a need for a quick delivery. According to ABB there is also much time spent on expediting deliveries, i.e. to find out that a delivery has actually occurred according to an invoice specification, or to search for delayed deliveries. This work can involve both the purchasing and logistics department and the project manager. The administration cost that is possible to derive from the Luvata project is those costs associated with the purchasing and logistics department. Administration costs raised from other functions are difficult to estimate due to that those functions have other main activities in focus, thus, it is a risk of a high level of error in the estimation.

External cost

During the investigation, it was found that all information necessary to calculate the external costs are not available for ABB to derive. Information is scarce regarding some of the parameters needed.

This is mainly an issue for the **type of vehicle used** for the transports as well as the **load rate**. For many of the investigated transports, it was possible to find out that "a XX sized truck of the brand XX that uses XX type of fuel" was used, but specific data needed to derive emissions factors, such as weight of the vehicle and Euro class, was often not available. Though, it is possible that such data can be obtained if it is requested when the transports are ordered from the freight forwarder. Information regarding the load rate has not been possible to obtain at all. This is either due to lack of knowledge or due to the fact that the freight forwarders do not want to share this information.

Information regarding the route of transportation, including transshipment and information about which modes of transport (air, road, sea etc.) that has been used was found by using the freight forwarders tracking systems. By using these tracking systems, it was also possible to get information about the length of the transport.

Data collection - some examples from the data sheet

An extraction from the developed data sheet including samples of the collected data is shown in Table 1. The data sheet was structured according to each specific shipment and the table shows data from one international, one national and one local shipment. In addition, also one international shipment done by air cargo is exemplified. Data concerned type of supplier, purchasing information such as when the order was created and when the order got delivered and specific transportation data.

Table 1: Examples of data collected – an extraction from the data sheet

Type of shipment ***Type of data***	**International**	**International - by air**	**National**	**Local**
Supplier	ABB Oy BAU Drives	DHL	Leine & Linde AB	ABB AB
Document number	4570554018	n.a.	4570513799	4570522816
Order created	2010-07-05	n.a.	2010-04-09	2010-04-28
Requested delivery day	2010-07-09	n.a.	2010-04-26	2010-05-05
Invoice date	2010-07-09	n.a.	2010-04-26	2010-05-05
Delivery date	2010-07-15	2010-02-11	2010-04-27	2010-05-06
Inco term	FCA	n.a.	FCA	FCA
Transport mode	Road	Air	Road	Road
Freight Forwarder	Schenker	DHL	UPS	AA Logistik
Address of sender	Helsinki	Zurich	Strängnäs	Västerås
Address of receiver	Västerås	Västerås	Västerås	Västerås
Real weight	33 kg	19,5 kg	2,5 kg	1,5 kg
Volume/ Weight on invoice	33 kg	19,5 kg	8 kg	n.a.
Transport cost	240 SEK	1135,22 SEK	105 SEK	n.a.
Route	Helsinki Stockholm Västerås	Zurich Leipzig Stockholm Västerås	Strängnäs Västerås	Nätverksgränd 11 Kretskortsvägen 5

As seen in the examples it has not been possible to derive exact data from all areas in the performed shipments. Furthermore, you need to be critical to the data that are put in the system, as also been discussed in previous chapter.
In the international example, the requested delivery date is set to 2010-07-09, while the actual delivery date is set to 6 days later. However, the invoice is dated also 2010-07-09, which normally is the day for delivering the goods. Therefore it is reasonable to believe there was no delay in this case; rather the delivery date got registered later in the system.

The air transport data is derived directly from the freight forwarder, therefore there is no information regarding supplier and order dates. Because of shipping the goods from Zürich (head office of ABB) it seems reasonable to believe there is a shipment coming from a supplier within ABB group. Also air transportation is normally performed when there is an emergency, the time frame is short. The shipment cost is also much higher.

The weight of the shipment is an important factor for the calculation of environmental impact and external costs. Therefore it is important to separate in between real weight and weight on invoice, which can be related to volume as in the case of the national example: 2,5 kg real weight is related to 8 kg paid weight.

Discussion

It has been studied in the Luvata project which logistics data is possible to derive easily, how exact the data is, what level of detail there are on data, which data that can be found by some investigation, and which data that must be estimated. What is also important to highlight, is what may be required in order to find the exact data, who is involved in this process and how time demanding it will be. Also, how different kinds of estimations are likely to be made will affect the robustness in the calculations.

Data availability

Transport costs are available for about half of the delivered goods in the Luvata project. It is surprising that only two thirds of the costs for deliveries are known, especially since the missing costs to a large extent originate from deliveries delivered according to "incoterm" FCA (which means that ABB have the main responsibility for the shipment). . The purchasing and logistics department may be able to find this information, although it is required to go back to purchasing documents. However, the transport costs are commonly purchased according to specific tariffs depending on weight/volume and distance, which means that a reasonable estimation of the costs should be possible to derive.

Packaging and warehousing costs are available for those shipments handled by the local logistics firm in Västerås. These data are directly put in the system. The warehousing costs performed by the local logistics firm are also the only costs connected to warehousing in the Luvata project. Other warehousing costs are "hidden" in that sense that storing is not intended, it is only made sporadically and not in an organized way if products are delivered before the time for usage. Other packaging costs are not possible to separate; they are included in other costs, probably in the total cost of the supplied product or in the transport costs. Hidden warehousing and packaging costs will be very difficult to derive on a detailed level, thus very time demanding to do so. To estimate the packaging costs on all products will also be very difficult, since packaging costs are very variable depending on product delivered, and there are a wide variety of different kind of products delivered within the Luvata project.

Inventory carrying costs have shown to not be available. This can though be counted for, presumably by controllers not necessarily involved in the project. Still, the inventory carrying costs are a cost that is widely discussed and also being of more importance when handling an inventory, which is not the case in the Luvata project. However, the costs concerning capital accumulation can be connected to the warehousing in Västerås and the transport in the Luvata project.

As mentioned earlier service deficiency costs is not identified in the Luvata project. If there were to appear costs connected to e.g., lost of sales, the project manager would most naturally be the person to identify these costs.

Administration costs are available from the time spent on e.g. purchasing, follow-up and reporting by the purchasing and logistics (P&L) department in a general and not very detailed level. If the model needs more detailed level of data, such as costs for each specific activity within the department, it will be difficult to make an exact measure of that since the routines are to report time on the project as a whole, not on each specific activity. If follow up is wanted regarded the administrational routines etc. more detailed level of data had been preferable. It is possible to make rough estimations regarding time spent on different activities in the Luvata project by the staff at the P&L department.

Most of the information needed to calculate the emissions and thereby also the external costs caused by the transports lies with the transport providers. That is information regarding weight/volume of the transported goods, length and route of the transport, type of vehicle used and the load factor.

In the Luvata project, data regarding weight/volume of the transported goods, length and route of the transport is only partly available. To obtain these data for all transports, an information system where transport providers can fill in information would be preferable. By having such a system, the manual work that otherwise would have to be performed by the purchasing and logistics personnel to collect these data could be minimized.

Regarding the vehicles used, it appears that the transport providers do not currently have any system that registers which vehicles that is used for which transport. This information could therefore be a bit difficult to obtain. Since it is a very crucial piece of information, it would be interesting to have a discussion with the transport providers to see how this issue could be solved.

As mentioned before, it has not been possible to obtain any information on the load factor, which could be due to lack of knowledge or the fact that the transport providers do not want to share this information. As for the type of vehicle, this information is very central in the calculations of emissions per transported amount of goods. Here, it is probably necessary to make estimations in the total cost calculations.

Information about how large fraction of the transports that take place in urban versus rural areas have not been obtained so far in this case study. It would be good if the program could generate such information based on the route of transportation.

Usage of the tool

From the experiences in the Luvata project there are some possible usage areas of the total logistics cost tool identified. The tool can be used internally within ABB in order to improve efficiency of routines within projects. This means that using data from specific projects being performed, different improvement areas can be highlighted and routines and/or rules of thumb can be created for how to e.g. make the administration and transport more efficient. Also, the tool can be used when purchasing transports on a larger scale. In that case, different transport scenarios can be tested in order to find the most cost efficient solution, or the most preferable transport provider. Finally, the tool could be used for follow up and reporting on logistics cost, external costs and environmental performance. These usage areas can be handled by different management levels (such as strategic, tactical and operational) in ABB. The following suggestions are made:

- Company management (strategic)– development of routines within a company, selection of transport provider
- Project manager (tactical) – more efficient transports, more efficient administration
- Purchasing and logistics (operational) – simplified version or rules of thumb

There are most likely several other usage areas as well. However, we do not see that the tool is beneficial for usage in the daily operational decisions within the project as such, since it may be too time demanding to find all data needed. Therefore, using it as a strategic tool for identifying more efficient routines and rules of thumbs seems more efficient in the case of ABB's projects, like Luvata.

Identified challenges/future work

There has been identified a number of areas to further investigate in the project. First, the case study shows difficulties in finding data for all parameters that are of importance for the calculations of logistics costs and/or external costs. To further investigate how these data can be found is of importance as well as how to handle lack of data, i.e. to what extent estimations can be used and how that affects the accuracy of the calculations. Second, it is important to further investigate what usage areas that will be appropriate to use the analysis tool for. Different usage areas may set different requirements on what type of data needed, e.g. aggregated data or detailed data. Third, the analysis tool needs to be adapted so it is possible to use based on the type of data and key parameters that are available from the user's companies as well as matching identified usage areas for the tool.

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