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**SUSTAINABLE
SUPPLY CHAIN MANAGEMENT**
– A preliminary study



A Collaboration Between



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A THINK Executive White Paper

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EXECUTIVE SUMMARY

‘Sustainability’ is the new must have – not only because it helps to gain a fresh perspective on the internal efficiency and external exposure of your supply chains, but also because of increasing pressure from various stakeholders. Where does sustainability in supply chain management actually start, and when does it become just plain and costly ‘green-washing’? More importantly: How should we discover and profit from the ‘right’ kind of approach which may lie somewhere between these extremes.

The Logistics Institute – Asia Pacific adopted a fresh approach to tackle these issues: Working with the methodologies of modeling, analysis and the collection, interpretation and integration of expert knowledge, key elements and trends in sustainable supply chain management were identified and contrasted to traditional concepts in supply chain management. This enables us to anticipate a wider range of scenarios and their implications for financial, environmental and social developments that are crucial to the long-term performance. These are discussed in this Whitepaper.

INTRODUCTION

Motivation

The term 'Sustainability' is widely used in virtually every industry nowadays. Even during the recent economic downturn, being sustainable and developing sustainable business models seems to remain an important topic that can't be ignored, even – and especially – when it comes to supply chain management. But as one expects when dealing with such a broad term, several major issues appear immediately:

First, the term 'sustainability' isn't defined in a common way, but used for sometimes completely different categories, ranging from 'Carbon Footprint' to 'Fair Trade' or even some sets of marketing strategies. This results in different approaches and scopes in academia and industry when it comes to research and implementation.

Second, there is a general lack of measurability and comparability, especially regarding monetary measurability. Often, the missing comparability of financial measures, non-standardized quantitative measures for environmental emissions and often purely qualitative measures for social impacts prohibit the integration and therefore overall valuation of different sustainable practices and projects in supply chain management.

As a result, when looking at research and R&D activities, Sustainability is mainly tackled by narrowing the focus on rather isolated areas (e.g. carbon footprint, corporate social responsibility, reverse logistics, green purchasing). These can be described as bottom-up approaches, where one has always the risk of getting stuck in local optima, but missing a global optimum. As sustainability comes in so many different forms, the core of our recent efforts in this area was to conduct expert interviews with stakeholders from different sectors. The resulting findings were integrated into traditional supply chain management methods by using system-theoretic modelling. This holistic and result-driven approach will be described in this whitepaper.

The limitations of this preliminary study do not allow the consideration of every aspect and finding into a level of detail where direct decisions can be made. This study rather aims to show how to identify relevant concepts, how to structure them, and how to integrate them into a quantitative model that enables

decision-making based on financial numbers. By doing so, this study is a first step to develop a generic reference model to analyze and improve sustainability in supply chains.

Our Approach

The topic of sustainability in supply chain management is relatively diffuse with a lot of different approaches and concepts in the literature. In addition, supply chains vary from industry to industry and between countries and regions, making it even harder to come up with a unified set of measures and best practices. When dealing with such a complex system, one has not to access crucial information, but first of all, to identify really interesting and important information (and topics).

The scope is narrowed the scope to a manageable focus mainly on supply chain management issues of multinational corporations that source from Greater China and ASEAN electronics and high-tech industry.

Initial effort was put into the analysis of the situation: findings from literary research are structured by obtaining different perspectives which are offered by different stakeholders¹ of today's supply chains. Obtaining different perspectives can not only help to structure elements of traditional supply chain management, but also to structure the huge amount of topics and practices that are mentioned in the context of sustainable supply chain management in the literature. Based on this, the current situation is analyzed, and a SWOT analysis conducted to identify the need and implications for solutions.

A SWOT analysis provides a list of strengths, weaknesses, as well as threats and opportunities of the current system under the assumption that the current strategy remains unchanged. This analysis will therefore indicate the need for actions, as well as provide some starting points to look for solutions.

Therefore, following the top-down approach, and in order to be able to cope with the sheer amount of topics and practices that are discussed when it comes to sustainability, expert interviews were conducted to access the knowledge and opinions of experts and decision-makers from different industries.

¹ Stakeholders of supply chains are not only the directly involved companies with their suppliers and customers, but also banks and insurers, governments and NGO, as well as logistics service providers.

The expert knowledge is distilled in a list of key findings that are structured by a graphical mind mapping approach and transferred into a system-theoretic model that allows us to draw hints of how to integrate these aspects of sustainability, from the triple-bottom line of financial, environmental and social sustainability to the impact of risks and trends.

A more practical case study in the appendix will demonstrate how the integration of carbon emissions – in contrast to service level improvements – can impact the layout of a distribution network

Definitions and Key Concepts

This section defines and provides an overview of the key concepts that are in the scope of this study. This is not only a working definition of sustainability, but also aims to emphasize on the role of risks, trends, as well as (monetary) measurability that are indispensable when trying to achieve true sustainability.



Figure 1: Sustainability that involves economical, environmental and social aspects and is influenced by risks and trends

A Working Definition of Sustainability

As the term 'sustainability' is widely used, but with different – and sometimes even contradicting – interpretations, we need a working definition that can be used for internal and external communication.

The definition of sustainability should include the following three aspects:

- **Financial sustainability:** Financials are the bottom-line of any business activity. Usually, financial aspects of business activities are relatively easy to measure.

- **Environmental sustainability:** As companies and its stakeholders interact with the environment, all related effects of business activities (e.g. externalized costs like carbon emissions) have to be taken into account. Costs and benefits of activities that affect the environment and its absorption and regeneration rates are often not easy to measure and value. Nevertheless, there exist some promising approaches like the European Emission Trading Scheme (EU ETS) that try to put a number on the environmental costs of such activities.
- **Social sustainability:** Business activities not only affect the environment, but also society. To measure and value social impacts of business activities seems to be the hardest, especially when considering long-term effects. Nevertheless, in the discussion about how to 'go green', social aspects of sustainability should not be overlooked in order to measure sustainability in an all-embracing way.

We define 'Sustainability' as follows:

'Business activities are sustainable when they yield positive financial profits, positive social outcomes and an environmental balance that complies with its share of the global carrying capacity. Sustainability is regarded in financial, social and environmental net present values in a perpetual timeframe, and as being part of the whole economy, environment and society.'

Here are some additional explanations of key concepts of this definition:

- ***'An environmental balance that complies with its share of the global carrying capacity'***: This addresses the fact that the global environment can absorb a certain amount of emissions and regenerate certain raw materials. This leads to the conclusion that raw material extraction and emissions can still be considered as being sustainable as long as it complies with these regeneration and absorption rates.

- ***'Sustainability is regarded in financial, social and environmental net present values in a perpetual timeframe'***: Here, we apply the concept of 'net present value' (NPV) not only to the financial dimension, but analogue to the environmental and social dimension. In analogy to cash flows in Finance – business activities might also have different environmental and social costs and benefits at different points in time that sometimes even cancel themselves out. Considering an infinite timeframe should ensure that in the end, the balance is positive for each of the three dimensions.
- ***'... as being a part of the whole economy, environment and society'***: When considering financial, environmental and social effects of business activities, one should not focus exclusively on single business activities (or companies) but consider the whole picture. This allows that effects of different business activities can cancel each other out. An example is the offsetting of carbon emissions: the negative financial aspects of having to pay for emission allowances can help cancel out a negative environmental balance.²

Considering Risks and Trends

For this study, we define risk as any probability-based perturbation of the system that is under investigation. As we will investigate economical, environmental and social aspects of sustainability, it is obvious that we also have to integrate risks that are associated with these three dimensions: business and economical risks are complemented by environmental and social risks.

In order to be sustainable, a supply chain needs to have a certain resilience to cope with corresponding risks. This is already done in current supply chain management, for example by introducing safety stocks that mitigate the risks of demand fluctuations in a make-to-stock scenario, or multi-sourcing in order to reduce the risk of supply chain disruptions due to an interruption at one supplier.

² There is a general uncertainty as to whether emission allowances should be considered as being sustainable, because this doesn't change the fact that the company is still polluting the environment. Our definition would consider such activities as being sustainable, as long as the business activities 'comply with their share of the global carrying capacity'. But in the end, the question is just shifted to the measurability of a company's 'share of the global carrying capacity'; this surely depends on the industry and the relevance of its activities for the 'well-being' of mankind.

Like risk, growth and trends can affect all three above-mentioned dimensions of sustainability. Growth can be defined as a status-quo-trend – as long as there is no long-term recession. Therefore, we will only use the term ‘trends’ for now on.

Trends change factors that impact the supply chain in the medium and long term. These might be changes in demand and demand patterns, oil/fuel prices, but also more subtle factors like the economical and regulatory environment in different countries. A risk is a sudden, usually unpredicted, event whereas a trend is a gradual change in external factors that is usually predicted or can at least be anticipated in its beginning. The main difficulty is estimating the precise speed and magnitude of trends.

Hence, a supply chain needs the ability to adapt to the gradually changing economic, environmental and social situations in the countries and regions it is involved in before it can be called a sustainable supply chain.

Measurability and Valuation

When looking at the three dimensions of sustainability – financial, environmental and social – one immediately sees the issue of how to measure and compare these quite different impacts. Usually we are only looking at the financial dimension: costs and benefits are quite clearly stated in monetary units. This is what we usually feel comfortable dealing with.

But when considering environmental and social aspects, there might not only be a problem in putting a dollar value behind each cost and benefit, but even measuring them in a meaningful and quantitative way at all. The saying, ‘you can only manage what you can measure,’ applies in this case. Therefore, one task within this study is to show and discuss ideas of how to measure such costs and benefits. This should preferably be in monetary terms in order to make financial, environmental and social dimensions of certain activities comparable. Having defined these possibilities to measure the impact on sustainability in a monetary way enables one to weigh alternative actions/practices according to their overall outcome.

The basic approach of this task comes from the basics of market theory: people value all kinds of resources in order to be able to trade them efficiently or to

generate value (e.g. by comparing opportunity costs when deciding whether to do something internally or to outsource it).³

³ When it comes to environmental and social impacts, the main problem lies in the missing markets for a lot of related impacts. This often results in externalized costs, like emissions that does not affect the company directly, but instead the environment in which it operates. But progress is made in different areas like the European Union's Emission Trading Scheme (EU ETS), or institutions such as insurance companies and banks whose business model widely relies on the ability to value such 'uncertain elements' in an economically viable way. Literary research and especially interviews with experts from banks, insurance companies and regulatory agencies should help to prepare a collection of different methods to measure (and value) the impacts of a supply chain on the different dimensions of sustainability.

Situation Analysis

The Importance of Obtaining Different Perspectives

Supply chain management involves not only different companies during the value creation process (like suppliers, manufacturers and customers), but also third parties such as logistics providers, banks, insurers, governments, NGOs, shareholders and other stakeholders that directly or indirectly shape the (business) environment in which the supply chain is operating.

These stakeholders continuously interact more or less directly with a supply chain: Governments introduce regulations that have to be implemented by companies; suppliers and manufacturers are connected via products and contracts; and the conditions of global and domestic financial markets determine the extent to which banks and insurers can facilitate the (financial) transactions and risk sharing between legally independent supply chain entities.

In order to handle such a complexity, we look at different possible angles at a prototypical supply chain and confront traditional supply chain management with new Sustainability-related elements.

The Product Perspective

The most basic element and a good starting point in analyzing supply chain activities is surely the product or product group itself. The creation – or value-adding process – of a product that exists within a supply chain can be illustrated by a product tree: The inputs of the supply chain are raw or input materials that come from natural sources or suppliers. Manufacturers will transform these inputs into intermediate or final products. Intermediate and final products can be stored in warehouses (buffers), before acting as input to the next manufacturer or finally the consumer.

Traditional elements like raw material, intermediate and final products, as well as their price and quality have to be complemented by topics like **hazardous elements** and **eco-design** (e.g. **recyclability**, **energy efficiency**) and **packaging**.

The Geographical Perspective

This perspective highlights differences in costs, capacities and quality between physical facilities in different geographical locations. A physical facility of a supply chain can be a supplier, a manufacturing site, a warehouse or a distribution centre.

A facility itself has traditional attributes like capacities, quality and costs – and not to forget distances, but they need to be expanded by aspects like **certifications, workplace safety, energy efficiency, emission levels** and associated **reputation risks**.

Despite being heavily influenced by political and economic circumstances, it can often be observed that certain geographical locations yield different advantages and disadvantages due to economies of scale, learning curve, local stimulus, etc. This can be observed very well when considering production clusters that usually heavily benefit from these advantages.

The Market Perspective

The delivery of finished products to consumers generates revenue, but traditional elements of supply chain management like prices, demand patterns and trends have to be reconsidered when it comes to consumers' **sensitivity for green and social acceptable products** and the subsequently emerging needs when it comes to adjusting the marketing mix and the whole communication process.

The Logistics Perspective

When it comes to logistics, we mainly talk about transporting raw materials, intermediate and final products from one location to another. Determinants in logistics are typically costs, capacities, speed (including mode of transport and transshipment choices) and reliability. Some advanced approaches also include consolidation, and other value-added services like documentation, customs (import/export tax) optimization, storage and tracking.

When it comes to Sustainability, the logistics industry is faced with **carbon emissions, alternative packaging**, but also **social issues** and a growing

demand for affordable **reverse logistics** solutions. In addition, logistics depends heavily on infrastructure and existing transportation routes.⁴

The Regulatory Perspective

Regulations impose restrictions, limitations, and even incentives along today's supply chains. In a globalized world, regulations in the US and EU markets immediately affect suppliers around the world, predominantly in Asia to where substantial production was outsourced over decades.

Beside governmental bodies, semi- and non-governmental bodies also introduce standards and associations that represent sometimes even more regulatory pressure than local governments.

This has the consequence that in addition to traditional elements of regulations like import/export quotas and tariffs, taxes, and general legal requirements to doing business in and between countries, there are more and more **environmental taxes and regulations** like **carbon trading schemes** and **restriction on the usage of hazardous materials** (e.g. **RoHS** and **WEEE** in the EU), **labor and workplace safety laws**, **reporting/disclosure standards**, **take-back regulations**.

On the other side, different governments might deploy different **incentives and stimuli to boost sustainable practices**.

At the end, all these legal aspects and standards can basically be interpreted as drivers and inhibitors: they impose additional costs or benefits that have to be investigated and – as much as possible – measured. Especially the risks that arise from sudden regulatory changes have to be taken into account in a monetary term.

The Finance Perspective

Parallel to the flow of goods (and information), each supply chain is complemented by a flow of money as well as monetized and transferred risks.⁵

⁴ The concept of Logistics Performance Indicators (LPis) can be used here: (The World Bank, 2007). These indicators are often measured country-wise, and therefore mainly depend on regulatory spaces and country specifics.

⁵ An example for monetizing and transferring risk is when receivables are factored, and therefore the default risk is passed to e.g. a financial institution for a corresponding discount.

To label concepts like working capital management, hedging (of commodity prices and foreign exchange risks), impacts of credit ratings on the cost of capital, and benefits from international portfolio diversification as ‘traditional’ might sound inappropriate, since they are even in today’s supply chains not implemented by default, but often only by best-in-class multinationals

When talking about financial sustainability – as one dimension of the triple-bottom line – these elements have to be taken seriously in globalized supply chains, especially when considering the implications of the recent financial crisis and the still ongoing reactions of financial institutions and regulatory bodies.

Nevertheless, two perspectives are clearly associated with Sustainability: First, the **rising sensitivity of financial institutions and investors** to finance when it comes to sustainable sound practice; and second, the **superior share price performance** (and therefore more shareholder value) of companies that are considered as being sustainable.⁶

The Environmental Perspective

For every physical process in the supply chain, the effect on the environment should be assessed, quantified and monetized. A lot of associated costs are typically externalized, but from a Sustainability point of view, one should be aware of the theoretical costs of these activities.

Are **natural resources exploited** (in fear of depletion) because they are needed as input materials? What **emissions** (like carbon emissions) occur at which levels, structured by air, water and soil? Are there specific **impacts on flora and fauna**, e.g. on the (local) **biodiversity**?

The Social Perspective

Similar to the environmental perspective, the social perspective is often even harder to monetize, even traditional elements like employee satisfaction, turnover and costs (like insurance premiums) due to accidents and compensations for accidentally exposure of humans to unhealthy/hazardous environments.

⁶ See reports on superior share price performance of companies that are listed in the Dow Jones Sustainability Index or in similar indices, e.g. (Economist Intelligence Unit, 2008).

Determinants range from the **standards of labour laws** (e.g. existence and enforcement of child labor), **social security**, **work place safety** and development aids to the long-term impact on local citizens and their **economic situation** (and sometimes even the **general health** in proximity to factories and along main transportation lanes).

The 'Traditional' System and Additional Elements of Sustainability

When considering the different perspectives on a supply chain, with its traditional elements on one side, as well as new elements regarding sustainability on the other side, we can put these perspectives together into one model that allows us to see how we would need to widen our focus when integrating these elements of Sustainability. And with a growing number of elements that are in our direct scope, the number of impacting external factors will rise.

We start by defining the current, traditional system, which will be contrasted by a modified version that contains elements of Sustainability. The current and a future system will then be the basis for a SWOT-analysis of the current approach, i.e. not having integrated these elements of Sustainability into supply chain management.

The 'Traditional' System

The most important elements of traditional supply chain management are time, costs, capacities and quality. Additional elements that are too important to be ignored are safety stocks and mode of transportation, as well as working capital management (here as costs of inventory) and packaging.

All these factors typically depend on the available infrastructure (facilities and transportation), oil/fuel prices, markets and demand patterns, and import/export regulations as well as taxes.

These elements are not all the factors that are considered when making decisions regarding the structure of supply chains, but they are typically the most important ones when applying the process of abstraction and generalization.

Additional Elements of Sustainability

The following figure shows a sample set of elements that were identified in the literature review and already mentioned when talking about different perspectives above. Elements that mainly impact the social dimension are highlighted in yellow, elements that mainly impact the environmental dimension in green and elements that mainly impact the financial dimension in blue. The remaining elements are examples of concepts and practices that are often mentioned when talking about sustainability, whereas they are already broadly perceived as elements of traditional supply chain management.

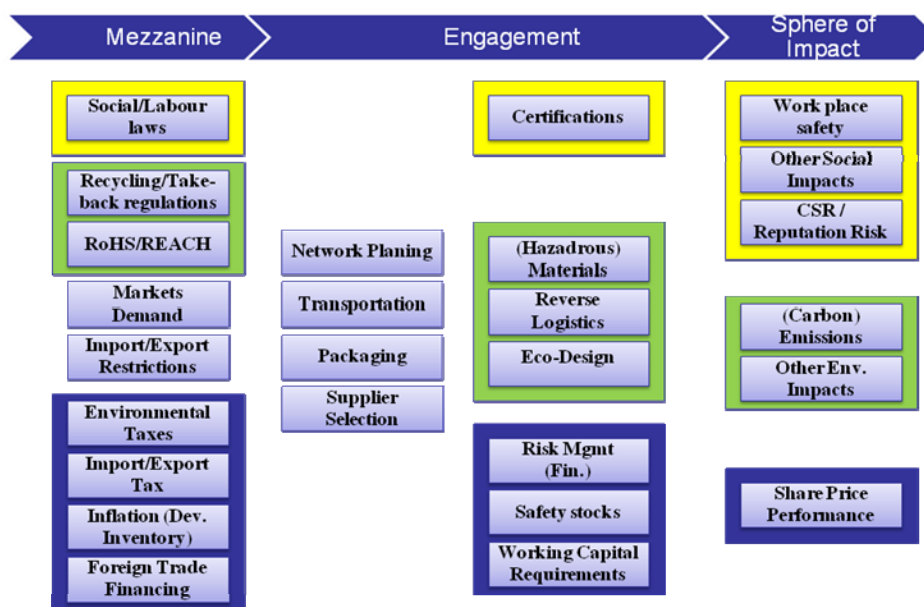


Figure 2: Elements of sustainable supply chain management: social (yellow), environmental (green) and financial (blue) aspects have to be integrated with traditional supply chain management

The following figure attempts to show the whole system – in a very simplified way. The so-called engagement space represents the part of the real-world system that can be influenced by decision making processes, and can be split into two parts: the orange part shows only the elements that supply chain management focused on traditionally, whereas the yellow part adds sustainable concepts. One can see that some concepts like packaging and working capital overlap both areas, implying that these concepts were not used consistently and continuously in traditional supply chain management – often depending on the sophistication of the involved companies.

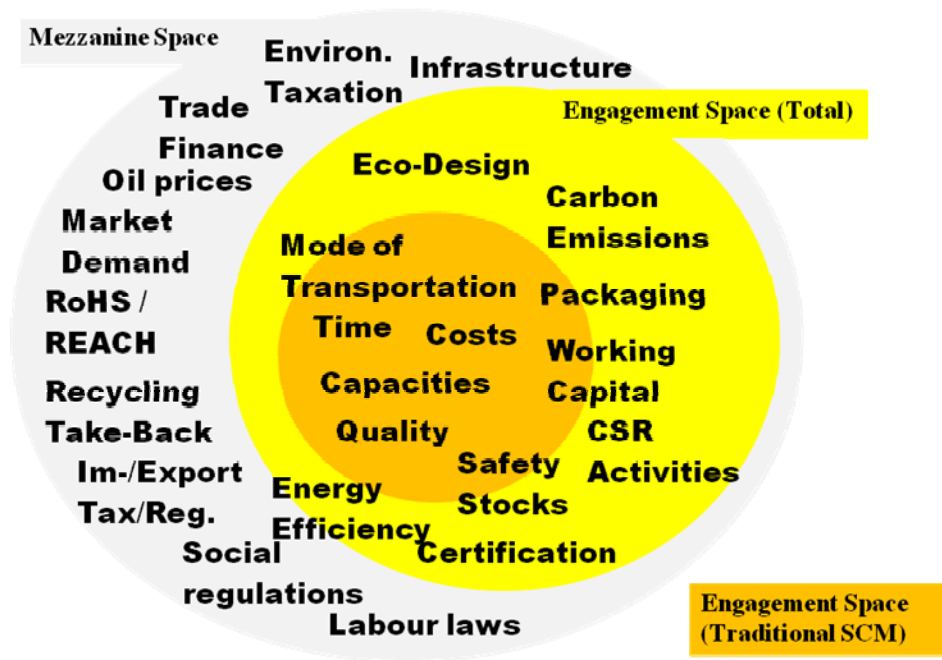


Figure 3: Traditional and extended engagement sphere within the system definition. (Several elements cannot be categorized easily and may therefore overlap spheres)

It is obvious that the definition of the system is rather abstract. There are some elements missing, as well as their relationships. All this illustrates that sustainability in supply chain management is a very complex issue – mainly, because it becomes clear that traditional supply chain management is very complex when highlighting it from different perspectives, like on different time-frames and considering trends and risks.

SWOT Analysis

Obtaining different perspectives on supply chain management and trying to merge traditional and sustainable concepts and practices was the starting-point for defining the system.

The purpose of the SWOT analysis is to identify strengths, weaknesses, threats and opportunities of existing approaches in supply chain management – assuming that there is no integration of elements of Sustainability into decision-making. This is very important to understand: Up to now, we just collected evidence on what would change (in terms of additional elements to focus on) when integrating Sustainability into supply chain management. The SWOT analysis has now to indicate that there is a need to actually do so. This need can arise from discovering more weaknesses than strengths, as well as more

threats than opportunities when leaving the traditional approach in supply chain management unchanged – i.e. not integrating elements of Sustainability.

It is important to justify the pressure to become sustainable – not solely because it's a buzz word and there are many economically sound single practices to green the supply chain, but rather because it makes sense when systematically analyzing the implications of not doing so.⁷

Strengths & Weaknesses

There are several strengths in the traditional approach which do not consider factors of sustainability. As there are a relatively limited number of factors involved, (production costs, transportation costs, capacities, etc.), it is **relatively easy to collect necessary data** or to make robust assumptions. Another strength arises from the fact that related methods and tools like network optimization (e.g. by linear programming) or gap-analysis (e.g. when evaluating potential suppliers) are widely used and even taught in academic settings. This facilitates the **ease of doing such projects as well as the ability to communicate and collaborate with supply chain partners** with this shared knowledge basis.

Another strength that is often forgotten, but is gaining importance in the recent economic crisis, especially, is the ability to reduce costs by not investing into an improved set of methods for supply chain management. This might initially sound counter-intuitive, as one idea of integrating sustainability into supply chain management is to improve financial performance – but this is only true for the medium- and long-term. Like most investments, the improving of methodology has certain costs in the short-term that are meant to be offset (and ideally exceeded) in the longer term. With many industries struggling at the moment, the **short-term cost savings**, compared to a more sophisticated methodology, can be interpreted as strength for affected companies.

When considering weaknesses, one will easily find a whole range: **financial performance can't be calculated correctly** due to a lack of integrating measurable (even financial) effects of a range of supply chain activities that are beyond the scope of traditional methods. This is becoming even more obvious

⁷ By doing so, the SWOT analysis can be interpreted as a qualitative version of the quantitative (statistically) testing of hypothesis, where the null-hypothesis typically describes the status quo that is supposed to be rejected in favour of the alternative hypothesis – which in our case would be the need for the integration of elements of sustainable into supply chain management.

when one has to admit that traditional methods are **hardly able to value the benefits of environmental and social activities and investments especially**. These inconsistencies have not only direct negative impacts due to incorrect valuations, but also indirect ones: banks and insurers tend to offer good terms and conditions to the cases where they see that 'their client has done his homework' by being aware of aspects of sustainability. Hence, sticking to traditional approaches puts more and more **stress on financing and insurance terms**. Finally, not only supply chain partners like banks and insurers, but also **customers demand more and more sustainable business practices**; companies that are involved in supply chains that are not prepared for the already ongoing 'green' trend in consumer markets have a weaker position in their marketing efforts – B2B (business-to-business) or B2C (business-to-consumers).

Threats & Opportunities

Not considering and integrating issues of sustainability in traditional supply chain management imposes several serious threats:

A famous example is a case where Sony had to replace peripheral cables for 1.3 million PlayStation game consoles after the Dutch government blocked sales of the machines due to a violation of EU policies on the maximum amount of cadmium in these cables.⁸ This is a typical example for a supply chain disruption, caused by **non-compliance with regulations**.

Similar are threats from scandals and other **reputation risks** that arise from spills, child-labor and sweat-shops in a supply chain. Without a proper methodology, it will remain a constant threat for companies to ensure that these threats are mitigated.

It is not only the rising environmental and social awareness of institutions and consumers outside the company, but also from employees that impose a threat to companies that do not integrate sustainability into their business practices. This is true especially as top-employees are attracted by companies that are associated with a high level of sustainability. The threat is therefore **the loss of the best employees** to more sophisticated competitors.

⁸ The consoles were already in a warehouse in the Netherlands and were supposed to be sold in the pre-Christmas sale of 2001; it took Sony until mid-December to resume limited shipments due to the necessary time for swapping the cables. (The Centre for Sustainable Design, 2006)

Even **traditional threats to the business can be amplified** when they fail to integrate a broader, sustainable perspective into supply chain management: oil price volatility and other trends in factors that impact the business can have an indirect impact which cannot be revealed until it is too late. This can be avoided if additional elements and relationships are integrated into traditional methods to enable sustainable decision-making.

Finally, **issues of sustainability are leveraged more and more by governmental projects and regulations** such as investments in infrastructure and technology or free trade agreements (FTAs). Without a methodology to evaluate these potential increases, a threat exists for company of being left behind the competition.

Concluding the Situation Analysis

It is quite clear that the weaknesses and threats far exceed the strengths and (non-existing) opportunities of sticking to traditional methods in supply chain management. The following conclusion can be drawn when examining the SWOT analysis further:

- The weaknesses of the traditional approach imply that due to a lack in measurability, suboptimal decisions cannot be avoided. This implies not only suboptimal financials, but also environmental and social performance. Hence, in general, **returns are systematically lower** than they could be.
- When focusing on the threats, the traditional approach, a lack of integrating certain elements of the real world into the methods of supply chain management increases the likelihood of missing trends that become more and more important. This increases the exposure to threats as these **growing risks** are hard to mitigate.

Solutions must precisely address these two above-mentioned issues:

- The weaknesses can be eliminated by trying to **identify and integrate relevant additional elements**. It will be crucial to discuss and possibly **enhance the (financial) measurability** of these additional elements. This should enable a systematic increase in financial performance.
- The threats can be mitigated by identifying the most important **trends** that affect the supply chain in each dimension of sustainability – not only regarding the traditional elements of costs, capacities, time, quality, but also when it comes to new elements that need to be

integrated and that may play a crucial role in the future. This will not eliminate all risks, but should significantly simplify the installation of a proper risk management.

As we have seen, there is a large number of concepts and practices that can be considered as being related to sustainable supply chain management. To enhance traditional methods and tools completely would not only exceed the limits of this study, but also the scope of any reasonable project. Therefore, the next step must be to limit the number of elements and trends considered in order to make such an approach feasible and manageable.

Asking the Experts – 50 Key Findings

The Expert Interviews

Sustainability in supply chain management can involve a huge amount of concepts and practices, and we already showed that it can be highly dependent on the perspective one applies.

When confronted with such a situation, expert interviews can be an excellent method, as experts have already structured parts of this complex system – and thereby created an (explicit or implicit) model from their own perspective with which they work.⁹ This is clearly an advantage, but we also have to keep in mind that every model is subjective and might serve another purpose. One can say that expert knowledge is like pre-processed (interpreted) data from experiments (experience) with the real world system.

As supply chain management usually deals with several fields of business on one side, and our working definition of sustainability demands the integration of financial, environmental and social dimensions on the other side, we surely won't be able to identify a single expert who covers it all. Therefore, we have chosen different stakeholders as experts which should be able to provide detailed insights into the real world aspects of traditional and sustainable supply chain management from different perspectives.

As we have seen in the previous parts, the key to tackling sustainability in supply chain management is to include additional elements – in a preferably quantitative way – to improve the valuation and therefore the comparability of concepts and practices in supply chain management. A second task is to mitigate risks and identify trends that affect the sustainability of a supply chain. The resulting questions are therefore:

- What are the most important elements that affect the sustainability of supply chains and that must be integrated into traditional models to capture them?
- What are the trends and risks that impact this new extended model, and how will they impact it?

⁹ Expert interviews are a well known methodology in academic research. The guidelines that were used in designing the expert interviews of this study are based on (Belting, 2008).

In our effort to gain these insights, a series of expert interviews were conducted: nine face-to-face and one telephone interview.¹⁰ A typical interview took around one hour; the shortest interview was around 30 minutes and the maximum duration was about one and a half hours. A transcript was written for each interview, based on notes and voice recordings.

The interviews did not follow a specific questionnaire or detailed questions based on an existing model. The idea of the expert interviews was to get the experts' perspective as unfiltered and unbiased as possible. Therefore, the absence of a pre-determined model or approach was essential. The only guideline was a list of high-level topics that are repeatedly mentioned in the literature and by previous interviews. The idea of having such a guideline was more to have an initial set of topics to talk about in case the interview stalled. Therefore, the main task of the interviewer was to ensure that the interview focused on topics of sustainability.

In order to avoid reduce ambiguities – and avoid hard to interpret phrases like 'this depends on what you're exactly looking at' – the interviewees were asked to think in terms of a high-tech/electronics supply chain that sources and manufactures heavily in Greater China and ASEAN and has its main consumer markets in the US and EU.

The expert interviews resulted in a large number of findings. These findings have been structured according to their topic and relevance: The first step was to collect and synthesize findings. The resulting key findings (representing the synthesized expert knowledge) were then used to directly support the further modeling process.

The next step was to derive new elements that need to be integrated into the definition of a basic system, modifications and extensions that need to be made with existing elements, as well as external or meta-findings that are not a part of the system itself, but provide information about current and expected trends, as well as other background information that might help for the later stages like when developing scenarios.

¹⁰ The interviews took place between April and June 2009 and were conducted by Mr. Christian Würzebesser. Ms. Maya Kumar, at this time also a research manager at TLI, facilitated most of the interviews.

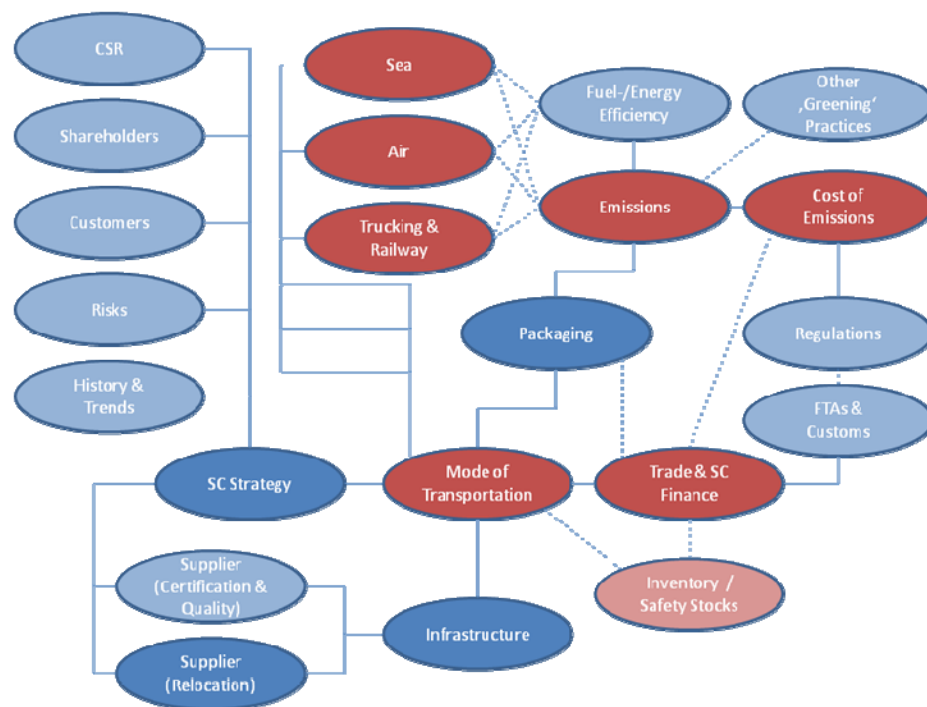
Mind Mapping the Interviews

Another step of processing the results of the interview was to try to map them graphically according to their relationships. After having gathered a set of unsorted and unstructured elements, this is an essential step when approaching complex system by modeling techniques.

The clusters represent the most prominent topics that the interviewees discussed. There exist a number of key findings for each of these topics that can be used to evaluate and to eventually improve the traditional methodology.

The following figure shows the map that was then used as basis for developing a system-theoretical model. In addition, such a graphical representation can facilitate the communication process between researchers and experts, as well as between researchers themselves. The darker and more red, the more findings were collected for a topic. The connections indicate when topics are mentioned in the same context, or topics that are 'naturally' in close proximity.

Finally, this approach makes it also easier to spot differences and potential blind spots when comparing academic literature with expert opinions from industry.



Integrating Elements of Sustainability

In this part we will show how aspects of sustainability can be integrated into traditional supply chain management models by using findings that were gathered by the expert interviews.

Our starting point is a basic model that captures the most important aspects of traditional supply chain management, as identified by literature review and expert interviews. This basic model has later to be extended by concepts and practices regarding sustainability – as identified by the expert interviews. For this whitepaper, the integration will only be described in an abstract way by first presenting relevant findings, and then by describing how these findings could in general modeled as extensions of the basic model.

The Basic Model of Costs, Speed and Working Capital

The basic model should capture the existing, rather traditional method of supply chain management, but also be simple, so that further extensions will not result in an overly complex model that cannot be handled in a reasonable way.

Key Finding 1

The electronics industry manufactures according to make-to-order or an extremely short-period make-to-stock ('make-to-forecast') model in order to keep the supply chain lean with limited work-in-progress. This results in the need to regularly air-lift the products to fulfil make-to-order demand, or when facing incorrect (underestimated) forecasts in a make-to-stock scenario. Nevertheless, parts of a high-tech OBM's (original brand manufacturers) products can still be shipped by sea, so that two different fast-moving supply – or distribution – networks can exist at the same time.

Key Finding 2

Financial requirements can impact the physical supply chain: lead time and financial requirements/commitments are contrary forces in supply chain management. The current strategy is to hold back inventory (and therefore the financial commitment) to the last possible moment: They only hold (certain) components, and even try not to hold this inventory on their own, but by their suppliers. Sometimes, they even try to avoid that their suppliers are holding inventory, by making commitments to buy certain volumes, but at the same time telling them not to produce them yet – in order to stay flexible and reduce the required financial commitment of the supply chain. The downside is the mismatch of the resulting lead time (make-to-order) and the days the customer is willing to wait. This is forcing the companies to air-freight the products.

For the basic model, we have decided to focus on the mode of transportation as the core concept, as its optimization is on one side a core task of supply chain management, as well as a major source of environmental emissions due to the use of fuel-driven vehicles.

Both findings 1 and 2 indicate the importance of transportation mode in the high-tech industry and how transportation mode is affected by necessary lead times and implied financial commitment – both crucial elements in this class of supply chain. These elements will be the core of the basic model.

Key Finding 3

To make shipments by air freight reasonable, cargo typically needs to have a high value-density so that it represents a large amount of working capital and/or quickly becomes obsolete.

Key Finding 4

The difference in costs between sea and air freight may not be as conclusive as one might think. The longer transit time, as well as different additional costs, can have a significant influence on the so-called 'total cost of supply chain', such as cost of working capital/inventory needed for inland transport. Many companies take these issues only insufficiently into account.

Transportation from fabrication and warehouses in ASEAN and Greater China to markets in Europe and the US is predominantly done by sea or air, as there are no real alternatives. Findings 3 and 4 show that (rather expensive) air freight is often a feasible option for these supply chains, especially when considering value-density and cost of working capital.

Key Finding 5

(International) Trade finance is only taken into account by the most sophisticated companies when it comes to supplier/location selection and network planning.

Finding 5 indicates that many of today's supply chains still struggle with the implementation of concepts which have been well known since before sustainability gained broad attention: trade finance affects the financial dimension of sustainability and can be directly measured in monetary terms, but is not consequently integrated into current approaches. Therefore, the basic model should explicitly include aspects of working capital management like (international) trade finance.

To sum up the above-mentioned requirements, the basic model has to consider typical trade-offs in terms of transportation costs, transit time and the resulting implications for working capital requirements.

Different modes of transportation offer different speeds at different costs. In general, the faster the shipment, the higher the transportation costs. This is mainly an effect of the economies of scale: a container ship can transport up to more than 10.000 TEU, which results in lower fuel consumption per TEU and km.¹¹ Differences in transportation costs are typically contrasted by different durations of the shipments: the cheaper the mode of transportation, the longer – in general – the time in transit.

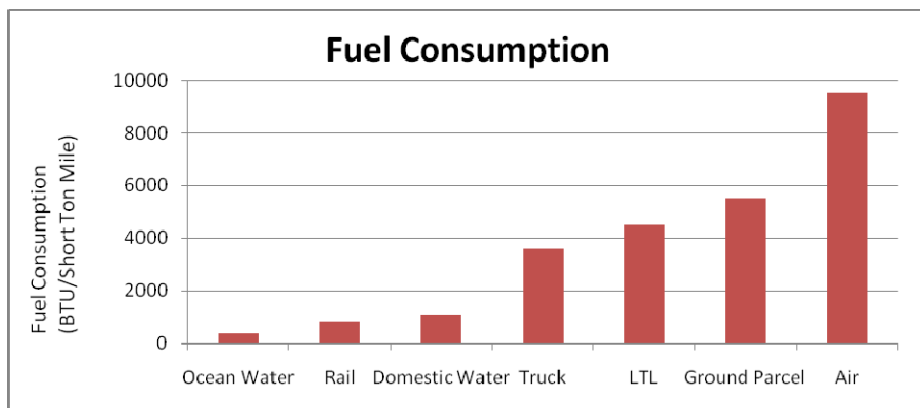


Figure 4: Fuel consumption per mode of transportation (Tompkins)

Shorter lead times can have two benefits. First, the penetration point can be shifted upstream, resulting in the elimination of inventories along the way. Second, the number of units (products or work-in-progress), that are in transit at a specific point in time is decreased. Hence, both of these effects impact working capital requirements but usually come with additional costs for the faster transportation.

¹¹ In addition, the bunker-fuel that is used by container vessels is cheaper than the kerosene that is used by planes. Fuel consumption by trucking is somewhere in between.

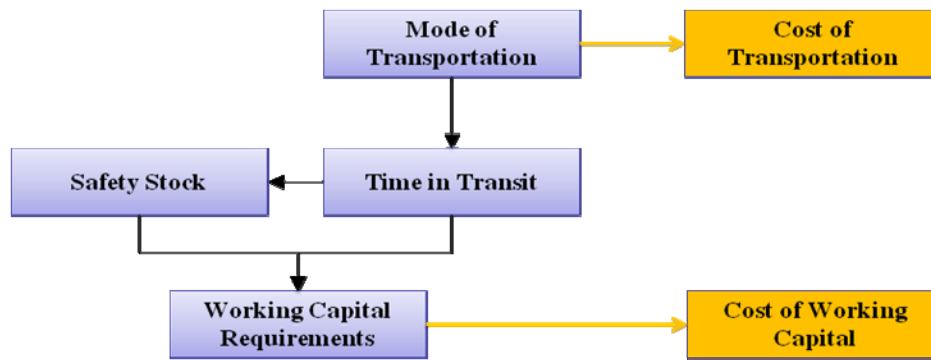


Figure 5: Basic model (The rather 'traditional' system)

The figure above shows the basic model: the mode of transportation affects the time in transit (of the goods). Time-in-transit defines the working capital requirements to finance these goods in transit, as well as the resulting differences in necessary safety stocks.¹² In this model, the only costs are the costs of the transport itself, as well as the cost of working capital.

Especially when shipping from ASEAN and Greater China to Europe and the US, ocean and air freight are the only feasible options, such that there are basically two quite distinct alternatives in terms of transportation costs and implications for working capital requirements. Nevertheless, it is possible to achieve transit times and transportation costs in between these two extremes by using transshipments. This is a change in mode of transportation to combine advantages – or avoid disadvantages – compared to a single mode of transportation. The aim is to get a combination that offers the lowest overall costs for the given type of product.

- Example: When shipping from Asia to Europe, one can ship via ocean to Dubai and change there to air freight. This strategy utilizes the good ocean connection, while avoiding more expensive ports in Europe, and reducing the need for inland transportation as airports are geographically more evenly distributed sea ports).
- Still, one has to consider additional constraints like maximum lead time (e.g. when an Asian manufacturer is producing make-to-order for the European market, and air freight is indispensable).

¹² A longer transportation time results in a higher safety stock, as the real demand can deviate more from the estimations at the same given probability (e.g. of daily deviations) when looking at a longer time period. This has to be compensated for by adjusting the safety stock in order to achieve a constant service level. These changes in safety stock result in changes in working capital.

These considerations can easily be covered by this basic model.¹³

In the subsequent sections, we examine how easy or hard previously identified elements of Sustainability can be integrated into this basic model – selected on basis of the key findings from the interview process.

Easy to Integrate: Optimizing Packaging

Key Finding 6

Optimization in packaging is a well-known concept of saving transportation costs. Even minor adjustments in the transportation process, like the usage of different materials for pallets or slip sheets, can have a significant impact due to its sheer economy of scale. 3PLs can play an important role when it comes to diffusing these innovations across the industry in order to leverage efficiency and therefore create value and sustainability. Savings in costs by optimization of packaging and selection/reduction of packaging materials also results in reductions of CO2 emissions.

Transportation costs are determined by the volume and weight of the cargo, whereas the cost of working capital depends on the value. These different measures are integrated in the term 'value-density'. Products with a high value density have a typically low average of cubic volume and/or weight, but at a high value. Examples are consumer electronics (laptops, LCD-panels) or fast-moving fashion items.

Finding 6 describes how packaging can affect transportation when packing and packaging materials affects the value-density of the freight. The impact on the environment is not only determined by changing CO2 emissions due to variations in cubic volume and weight and therefore fuel, but also by the waste that results out of the packaging itself.

Reusability is an important concept here, and much has already been achieved by using standardized containers in air and sea freight, as well as pallets and slip-sheets in trucking and warehousing.

Summarizing, one can easily say that the impacts of changing packaging can easily be measured and translated into monetary terms. Therefore, integration into the basic model is straight forward by directly adjusting transportation costs and costs of (required) working capital.

¹³ (Kim, 2002) presents a model that integrates all these aspects (including the impact of different value-densities and fuel prices) in a generic way.

Harder to integrate: CO2 Emissions and their Valuation

Due to underlying technical aspects and different economies of scale, the environmental impact of transportation differs strongly between different modes of transportations. The most prominent measure for the environmental is currently CO2 emissions. They are relatively easy to measure and have the biggest impact on the environment when considering all kinds of emissions from different industries.

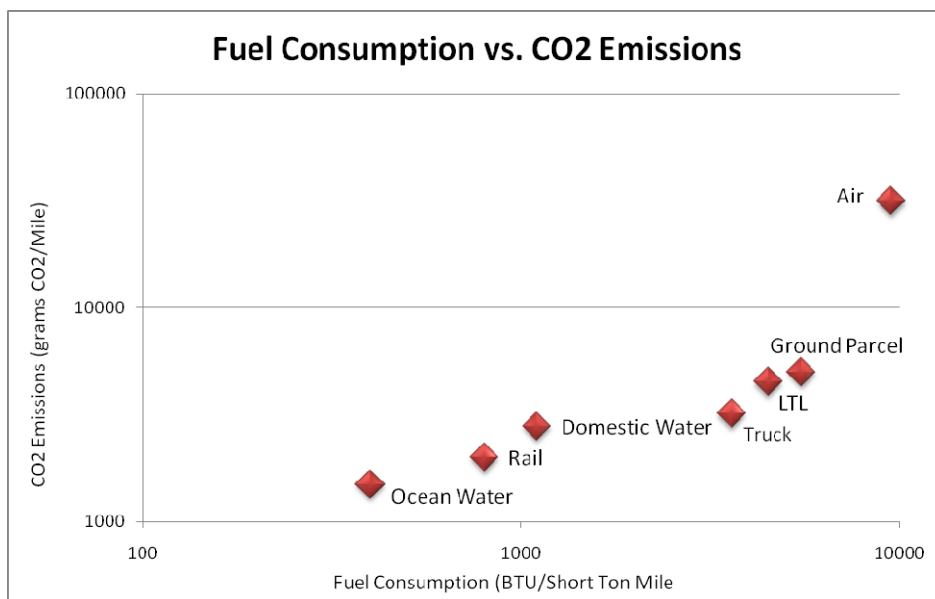


Figure 6: Fuel Emissions versus CO2 Emissions per mode of transportation (Tompkins). Be reminded of the logarithmic scale of both axes.

The following figure shows how to extend the basic model by CO2 emissions: the mode of transportation causes specific CO2 emissions. These are traditionally externalized costs for which the supply chain does not have to pay for itself. As this figure implies, we will have to take these costs into account – which will be done in the following parts.

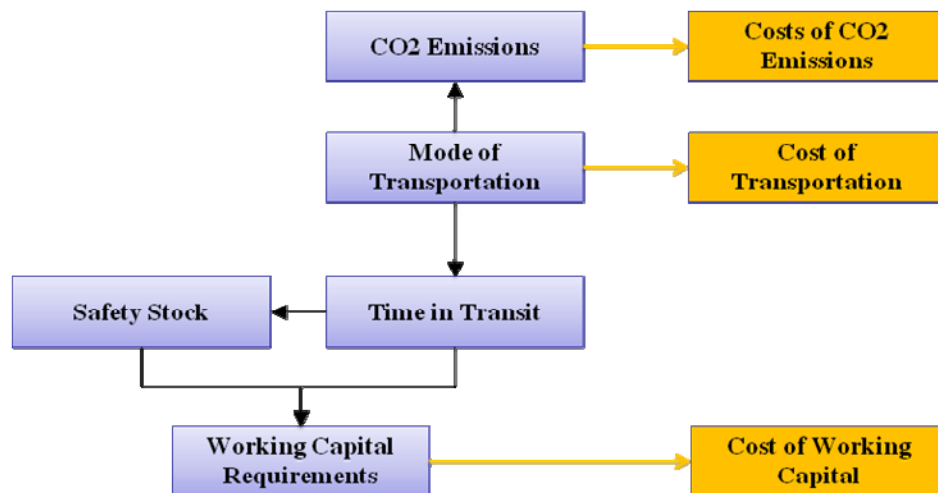


Figure 7: Extended model (including CO2 emissions)

It is also important to not forget that in the logistics industry, CO2 emissions are not only caused by vehicles that are used for the long-haul transportation, but also at warehouses that need to be heated/cooled or by re-arranging inventories, etc. In the case of transshipment, the switch from one mode to another, activities might include unloading, storing, trucking, and finally the loading, all of which cause emissions of their own.

In addition, there can be other forms of emissions (other than CO2 emissions) that have a heavy impact on the environment; but they can be integrated into this model as an analogue to CO2 emissions.

Key Finding 7

Ocean freight causes more emissions that harm the environment than just emissions from burning fuel. Such additional factors like pollution of the water or biological contamination should be considered when comparing the environmental impact of different modes of transportation.

Finding 7 gives an example of additional emissions that won't be captured sufficiently by calculating only the direct CO2 emissions. Nevertheless, there are ways out there to approximate CO2 emissions by transportation and storage along the supply chain with a satisfactory accuracy – at least when comparing to the ambiguities to other variables in the process of decision making in typical supply chain management scenarios.

The Costs of CO2 Emissions

After including CO2 Emissions in our model, the crucial question is now, 'what is the impact of these emissions in terms of monetary costs for the supply chain?' It is obvious that this is a direct environmental impact that has, at first sight, nothing to do with the financial dimension, since these are typically 'externalized costs'. When talking about measurability and comparability, we concluded that non-monetary measures have to be translated into monetary measures in order to enable optimal decision-making. Following the results of our SWOT analysis, CO2 emissions have to be valued in financial terms, as there is the threat that they have to be internalized. Finding 8 emphasizes the current need among experts in the industry to overcome this issue:

Key Finding 8

Companies would appreciate if they had a methodology to convert carbon emissions into financial numbers in order to establish comparability, but currently they have no methodology to do so.

Key Finding 9

More and more customers are asking for their carbon footprint and want to improve the situation, but despite the fact that some 3PLs are capable of reducing the carbon footprint of their customers, few are actually willing to pay for such additional services.

Key Finding 10

Measures have to be designed in a way that reflects the business activity and gives you the opportunity to make operations more efficient. (e.g. Warehouse emissions per kg of cargo handled instead of by square meter)

These findings show that there is a strong demand to know about these emissions in order to satisfy customers' needs on one side, and to improve efficiency on the other side. This can only partly be achieved through purely environmental measures.

The following findings 11 and 12 provide some insight into the role that environmental emissions play at the moment when it comes to dealing with logistics service providers and suppliers.

Key Finding 11

Most logistics providers can give you very precise information on their carbon footprint. Some have very detailed data, some just simple numbers, but only very little can't give a qualified response. In general, air service providers are more sophisticated, whereas railway and trucking is harder to assess as the related forwarders are focussing rather on the transit time than caring about the modes of transportation.

Key Finding 12

Environmental factors seem to be 'nice to have' rather than a factor that is equally weighted to others when it comes to supplier selection. The difficulties in obtaining a standardized and shared definition of Sustainability, as well as the lack of a clear methodology to deal especially with environmental impacts hinders the setting-up of a code of conduct for environmental impacts by suppliers that could provide a strict criterion for supplier selection and assessment.

Having shown the motivation for measuring and translating environmental impacts into financial measures, we will now discuss different possibilities. We will discuss three ways of valuating environmental emissions: set costs via governmental regulations, quasi-market prices by emission trading schemes and subjective costs of emissions that depend on a company's characteristics and can therefore vary between companies and supply chains.

Non-Market Based Costs: Regulations on Emissions

Regulations that introduce costs on environmental emissions like CO₂ emissions can come in different forms. Caps can limit the maximum emissions for a company and impose fees for excess emissions. Another form is that of taxes on every ton of CO₂ emissions.

Key Finding 13

The government should promote sustainable business by setting clear (financial) benefits and costs. This would facilitate the companies to take these factors into account (as they are now more directly and strongly associated with financial implications). Care has to be taken to not make these subsidies and penalties too complex.

Such regulations have advantages and disadvantages: as indicated by finding 13, the main advantage for a company is that it can directly and clearly work with these numbers. This is probably the easiest way of assessing the financial costs of emissions. Nevertheless, the disadvantage is that there is a certain risk

that these regulations might change. In these cases, a positive NPV or an investment can easily become negative if the government decides to change the tax scheme. As governments have the same problems in assessing the 'true' costs of such emissions too, such adjustments are rather probable.

Therefore, we judge this approach as being of no great importance: At the moment, there is no such regulation in place in ASEAN or Greater China, and even more developed regions like the US, Europe or Australia go another direction by introducing emission trading schemes.

Market-Based Costs: Emission Trading Schemes

Carbon trading schemes are already introduced for several industries in the European Union. It is also possible to trade allowances for CO₂ emissions voluntarily in the US, and Australia is currently in the process of introducing related legislation. The starting point of these efforts was the Kyoto protocol from 1997 and the basic idea is to introduce a maximum for CO₂ emissions (by industry and country) that is reduced year by year in order to achieve specific targets. Each country has a share of corresponding allowances that are distributed to the companies in these industries. Each affected company now has several options. They can try to stay below their allowance by reducing CO₂ emissions – the final goal of these efforts. Another option is to buy additional allowances to meet their exceeding CO₂ emissions. This mechanism resembles a market for CO₂ emission allowances, where companies as participants value CO₂ emissions, based on supply and demand, as well as the potential fines for excess emissions that are imposed by the governments.

This mechanism provides the most promising way of valuating CO₂ emissions, because it is based on a market mechanism which adapts to changes in technology and trends, as well as the behavior and strategy of different participants in the market.

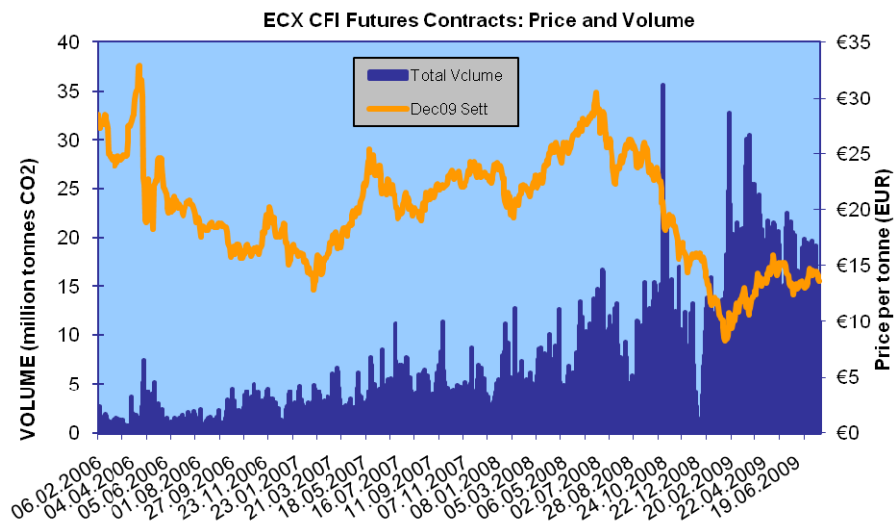


Figure 8: Prices and Volumes of emission allowances (futures) from the European Union Emission Trading Scheme. Source of figure: (European Climate Exchange)

This approach means to use prices for emission allowances to value the costs of own CO₂ emissions. The advantage is that it is a rather objective way of enabling the comparability between environmental and financial measures. The disadvantage is the lack of implementations of such schemes in Asia Pacific, so that this might hurt the competitiveness of a company when it treats these still externalized costs as internalized ones in contrast to peers in the industry.

One could argue now that such market-based approaches introduce certain risks too, as prices for emission allowances may fluctuate and thereby the viability of certain projects and investments as well. But as we will see later when dealing with fluctuations on oil/fuel prices, such risks can be mitigated by certain hedging techniques. There is surely a long-term trend of rising prices for emission allowances as the continuous reduction of emissions is the whole driver behind the implementation of emission trading schemes.

Key Finding 14

There is a clear expectation among experts in the industry that there won't be a carbon trading scheme set up in ASEAN or China in the short- or medium-term.

Unfortunately, as some of the findings 14 from the expert interviews indicate, emission trading is not really considered to take place in the Asia Pacific region – at least in the medium term.

Nevertheless, it is still possible to apply a ‘what if’ scenario and use such prices from the trading schemes in Europe or the US in order to introduce the costs of CO₂ emissions of different supply chain layouts or other related decisions/investments. Due to the current lack of implementation of such a scheme (together with the corresponding legislation) in ASEAN and Greater China, such financial measures should be weighted stronger in the medium and long-term if and when the probability of an implementation by some governments eventually increases.

Introducing Subjective Costs of CO₂ Emissions

Another approach for valuing the costs of CO₂ emissions arises from analyzing what these emissions actually mean for a specific company. As already mentioned above, companies in ASEAN and Greater China probably won't have to internalize the costs of emissions in the next year. Still, a lot of companies want to do something beyond solely saving on fuel costs.

Key Finding 15

Companies – especially logistics providers – are in the focus when it comes to ‘going green’. Some of them, like DHL, made self commitments and even make attempts to integrate it into their business models.

One mechanism is the self-commitment of a company to reduce its emissions. Especially large and publicly exposed MNCs are committing themselves more and more by providing exact numbers they can be measured by.¹⁴

Assuming that self-committing companies will reach these goals provides the possibility to value their emissions. Dividing the minimum costs of achieving these reductions by the amount of emission reductions gives an idea about how much a company has to spend on emission reduction. These reductions do not have to be explicit as a company can also commit to not increasing their emissions at the same speed as in the past. The key in assessing the reductions is to measure the reductions that arise by being forced to fulfill the commitment, in comparison to ‘business as usual’.

Having assessed the reduction in emission that is needed to meet a self-commitment, the next step is to assess the minimum costs that are needed to achieve these savings.

¹⁴ A good example is the logistics service provider DHL. The company made a public self-commitment to reduce its carbon footprint by 30% by 2020.

Key Finding 16

There is a general tendency in the context of sustainable business practices, to first go for investments that provide the best ROI (return on investment) at a low risk. Increasing energy efficiency is one of the first options that many companies focus on. (e.g. investments in energy-saving or energy-reducing techniques)

The highest minimum necessary costs can be calculated by using again the market prices of an emission trading scheme. Any company can simply buy emission allowances from any emission trading exchange worldwide in order to offset its own emissions. (This might not be the goal of a self-commitment, as this is usually made to improve the perception of the company among its stakeholders: that the company is environmentally aware and efficient rather than 'buying itself out' of its own self-commitment. Anyway, it would be a logically feasible solution.)

Offsetting emission by allowances is therefore the worst-case. Usually, a company will look for internal, cheaper ways to reduce its emissions starting with the cheapest actions; the costs are increased until the actions are sufficient to reach the desired reduction.

Usually there is a huge range of options available to lower emissions. Several options already have positive NPVs (net present values), and these options are commonly performed today. Typical examples are saving on fuel costs or the substitution of old lighting systems to more energy-efficient systems.

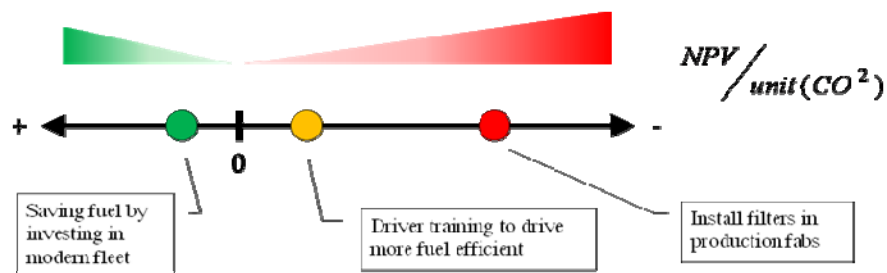


Figure 9: Example for emission reduction activities - ordered by NPV per unit of emissions

Therefore, the first step is to now calculate for every option the financial costs (in terms of the net present value) per unit of emission reduction. This results in a list of options that can be sorted from the cheapest to the most expensive.

Options that have a positive net present value even provide direct financial benefits instead of costs.

The next step is to attach the estimated amount of emission reduction to each option.¹⁵ This enables us to now calculate the highest net present value of the reduction of any amount of emission by integrating starting from the options with the highest single NPV along the ordered list until the desired amount of reduction is achieved.

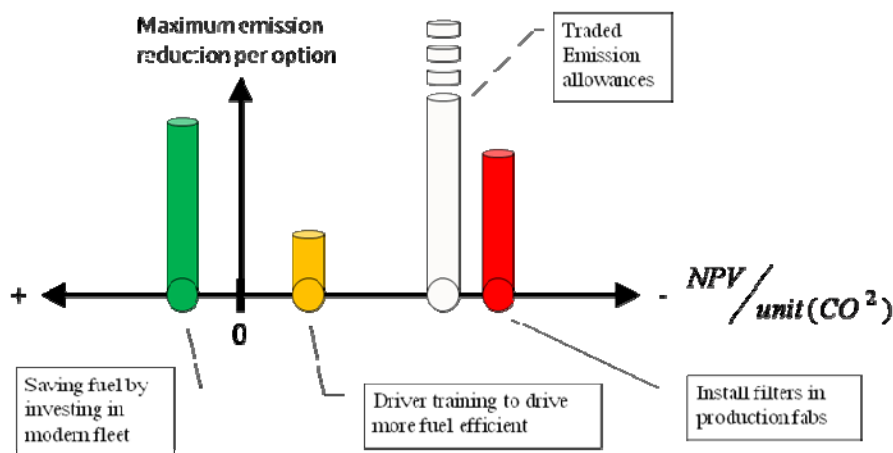


Figure 10: Example for emission reduction activities - extended by the maximum emission reduction per activity

This list can always be cut off at an NPV equivalent to that of purchasing emission allowances. This cut-off point can be interpreted as the 'emission reduction efficiency' of this company: The point at which external (market based) emission reduction makes more sense than internal methods.¹⁶

The sum of NPVs is then the subjective cost of the desired emission reduction for the specific company. When dividing these total costs by the amount of emission reduction, we have the average cost of emission reduction – for the specified amount of reduction.

¹⁵ There might be the case where an option can result in different emission reductions at different net present values. This can be approximated by splitting one option into a number of separate options. Another, more accurate way is to set up a corresponding formula and use optimization techniques to complete the process.

¹⁶ A vision for the future: companies that have different subjective costs of emissions could implement techniques like 'cash-for-emission swaps' in order to create value for both parties. It will be interesting to see when and how (financial) institutions will introduce such techniques.

Conclusion on Carbon Emissions

We can conclude that the integration of emissions and especially their financial implications is not straightforward, since there is no clear way in valuing these (at least in Asia) currently mainly externalized costs.

Introducing the concept of ‘subjective costs of emissions’ could provide a viable third way: between pure regulation and pure market mechanism – but also a chance to adjust for industry- and consumer-specific characteristics and exposures.

Finally, the theoretical framework to integrate these costs – and in parallel the benefits of emission reduction projects and investments – depends also on how to value missed emission targets: the fines by violating regulations are given, and prices for traded emission allowances can be estimated (and hedged in advance); but the impact of a missed public self-commitment on the cash flow is definitely harder to estimate, but crucial to determine the NPV of emission related investments.

Hard to Integrate: The Valuation of Social Sustainability

When having a look not only at our basic model, but also at the majority of literature, the social dimension is often missing completely. This is surely due to the huge difficulties in measuring it in monetary terms. Nevertheless, social sustainability is no completely new topic to the management theory and practice:

Key Finding 17

Especially when it comes to employee attraction and retention, showing corporate social and environmental responsibility, and mirroring it in the company’s values is crucial at all levels.

This finding shows us that the social dimension is not only about rather abstract CSR (corporate social responsibility) activities where a separate budget is spent on charity, but that social sustainability plays a more and more important role for today’s employees. Companies cannot afford to ignore these issues as this is what shapes the preferences of (prospective) employees. Besides current and prospective employees, social sustainability also affects other stakeholders like the communities companies operate in, as well as governmental bodies, consumers and shareholders. A lot of business activities of a company have an impact on these stakeholders, and therefore comes with at least theoretical

costs and benefits. As with the physical and financial supply chain, there are usually trade-offs: to please one group of stakeholders can have a negative impact on others, and the ability to make an optimal decision depends on how accurate these impacts can be measured and compared along all dimensions.

The basic issue is that the environmental impacts (e.g. CO2 emissions) can at least be measured in a relatively accurate way, whereas the measurability of social implications itself is a hard nut to crack. There exist only a few simple measures such as the **number of accidents** or average days on **medical leave** that help to measure the impact of a supply chain's activities on the social dimension. A logistics service provider has developed a methodology to measure its contribution and impact on Singapore in financial, environmental and social terms: social measures are defined, including the number of employees and indirectly **newly created jobs** in Singapore, the **money spent for advanced training** and the days employees spend on **volunteering in social activities** like getting involved in **local community work** or pure **charity** projects.

Key Finding 18

There are no quantitative, monetary measures for the benefits of social responsibility. There are some quantitative (non-monetary) measures – like when it comes to safety – that could be translated into financial numbers.¹⁷

This is a first and precious step to try to define measures for the social dimension. A subsequent step has to then be to translate social measures into financial measures in order to include these costs and benefits into the overall decision-making processes.

Key Finding 19

When selecting NGOs to work with, the reputation risk that occurs is usually mitigated by proper due-diligence. But again, there are no quantitative models or measurements.

¹⁷ It might be that the application of financial measures could impact the perception of these activities of not being as altruistic as they should be in the public opinion.

Key Finding 20

OBM might face different problems when doing CSR activities in different countries in Asia Pacific: These activities are relatively easily linked to political issues and corruption, therefore lowering its effectiveness and even creating further risks. NGOs can still put a lot of pressure on MNCs due to environmentally or social questionable practices, whose absence isn't always hard to guarantee for the OBMs. But these companies have often anticipated this and try to be rather active than reactive.

The bottom line for CSR activities is at the moment to control risks. By collaborating with NGOs, companies try to ensure that potential issues can be mitigated early enough. In addition, companies can profit from the outsider perspective that an NGO can bring. All this helps to reduce risks and therefore improves not the social sustainability of the whole supply chain. Risks that are imposed by collaborating with an NGO include that the NGO itself may act in an unfavorable way, and in so doing also affect the reputation of the company. This risk is usually mitigated, as suggested by the above finding.

Finally, social sustainability remains a difficult issue. It has gone out of focus as a lot of public awareness has been drawn towards environmental issues – especially considering global warming and the related CO2 emissions. Nevertheless, social sustainability is still affecting business performance, even if it is hard to measure, and this is exactly why it is important to try to improve its measurability.

Share Price Performance as the Ultimate KPI

There are several studies that show the relationship between being the implementation of sustainable business practices¹⁸ and excess returns such as (Economist Intelligence Unit, 2008).

There are studies that show that the hedging (e.g. of fuel and oil prices, foreign exchange rates, etc.) reduces short- and medium-term fluctuations and thereby creates value as it stabilizes cash-flows and makes it more predictable – something that is valued by shareholders. Introducing Sustainability in a convincing way has basically the same effect:

The advantage of more favorable terms of financing by banks – resulting from a reduced risk exposure due to sustainable business practices – is only one way of how sustainable business practices enhance the overall financial

¹⁸ In these studies, being sustainable is mostly defined as being listed in a sustainability-index like the Dow Jones Sustainability Index (DJSI).

performance of companies and therefore their supply chains. This is illustrated by the following key findings:

Key Finding 21

There is a risk mitigation aspect of trade and supply chain finance: Banks want to ensure the (financial) sustainability of the business that they finance in a longer term. This implies that more financially and in general 'sound' businesses will have an advantage in finding banks to finance then and/or get better conditions due to their lower risk.

Key Finding 22

Companies that implement environmentally and socially sustainable business practices can benefit from better conditions when it comes to trade and supply chain finance, as they are perceived as yielding reduced risks in several areas.

Key Finding 23

Banks typically facilitate working capital management that becomes especially important in a liquidity crisis to ensure the integrity of the supply chain. Depending on credit ratings and the economic circumstances, these services come with costs when the bank takes over the credit default risks of the debtor, or when payments are discounted.

All above mentioned findings provide another way to increase the measurability of sustainable business practices in financial terms: The higher the degree at which a bank perceived a company, as well as the associated supply chain, as being sustainable, the better the conditions for financing. These better conditions are typically easier access, lower interest rates and longer periods – originating from a lower risk exposure of the company, and the whole supply chain. Especially when considering the currently rather unfavorable conditions for financing that resulted from the ongoing liquidity crisis, access to favorable trade finance is vital.

Key Finding 24

Shareholders expect and appreciate sustainable supply chains, but only as long as the hard facts show that at least the corporation does not lose money on it.

Trends in Supply Chain Management

Besides talking about how to integrate aspects of sustainability into today's supply chains, a lot of findings on future trends could be gathered during the expert interviews. These trends describe how variables and relations in the environment of supply chains are expected to change over time. As these variables impact not only traditional elements of supply chain management (like costs, capacities, etc.), but also environmental and social aspects.

By definition, the overall resilience and agility of a supply chain determines its sustainability: the ability to deal with future developments in a favorable way; to say it in a more technical term: the ability to yield a positive NPV in the face of a continuously developing environment.

The following sections highlight the some trends as identified by our interviewees.

Boon and Bane of Information Technology

Information technology (IT) continues to be a buzzword when it comes to state-of-the-art supply chain management. Despite the predictions that IT will become indispensable in today's supply chains - even accelerated by the current economic downturn where IT should enable gigantic cost savings – this technological revolution is slower and at a much lower magnitude than expected.

As the following finding indicates, integration can have substantial benefits:

Key Finding 25

Investments in IT can not only help to synchronize the physical supply chain, but also to take financial aspects into account. IT can be beneficial for both the physical as well as the financial supply chain by enhancing the alignment of the supply chain with demand (and predicting factors), virtually in real-time. (In addition, this synchronization can help to reduce the severity of the risk of cascading effects or the default of accrued receivables) The finding also emphasises that this improvement comes at very specific costs in the form of having to invest in the needed IT infrastructure, whereas the improvements are harder to measure. The resulting ROI calculations are therefore not so easy, and therefore management might tend to delay such projects.

This finding also shows the typical picture that often appears when talking about sustainable business practices. The necessary (financial) investments are relatively easy to assess, whereas the continuous benefits are hard to measure.

From the perspective of sustainable supply chain management, these issues have to be taken into account when trying to improve the IT integration across the whole supply chain. Improved efficiency (e.g. reduction of the bullwhip effect) and an enhanced risk management regarding cascading effects (e.g. cascading default risks) have to be contrasted with the risks of leapfrogging traditional intermediaries/brokers between the Western and Eastern (business) cultures.

Regulatory Changes and Governmental Initiatives

Key Finding 26

MNCs especially seem to perceive most regulations in ASEAN and Greater China as rather hindering and sometimes counter-productive, sometimes even imposing some risks or pressure on the supply chains.

Key Finding 27

Some regulations seem to promote protectionism and can therefore hinder an optimal value creation process across several countries and therefore lower the effectiveness of the supply chain design in ASEAN and China.

Key Finding 28

The regulatory situation is very complex and rather confusing in ASEAN and China, making it difficult for MNCs that operate in and between them.

These three findings indicate rather that the whole region of ASEAN and Greater China still offers a lot of potential to improve and unify regulations. There is clearly a risk of unheralded and irreproducible regulations, but also enormous opportunities if the unification of ASEAN can follow the example of the European Union, also integrating Greater China.

Key Finding 29

Hong Kong or Japan might take the lead in environmental regulations, while such regulations are not expected in some ASEAN countries like Thailand, Indonesia, Malaysia, Philippines and Vietnam – but even Singapore's role is not at all clear. China seems to be moving towards more environmentally friendly regulations.

The expectation by interviewed experts is that most countries of ASEAN won't introduce significantly more environmental friendly legislations in the future. This is mainly due to their economic gap.

Key Finding 30

Most ASEAN countries have a different social structure, as well as a certain dependency on tourism, which favours environmentally aware regulations. When applying the reversed causality to China, one could conclude that China would rather neglect the importance of a more environmentally friendly legislation as it is not as depending on it.

This finding offers an interesting perspective on the differences between Mainland China and most of the ASEAN countries: Due to the importance of tourism for their GDP – as well as the longer existence of a relatively large middle class – in a lot of ASEAN countries, the environment enjoys a relatively high level of legislative and practical protection now. In China, economic growth was for a long time facilitated by externalizing costs at the expenses of the environment and parts of the society. The current economic downturn put a lot of pressures on the Chinese government to promote growth that is needed to stabilize the society. This forces Chinese decision makers to compromise somewhere between the environment on one side, and social and economic issues on the other side.

Key Finding 31

Some countries/locations might have a slight advantage of location if the environmental (and social) impact might benefit from an adequate, environmental and social friendly surrounding, but trends in Asia Pacific seem to remain more or less constant: China is still 'en vogue', whereas countries like Vietnam remain promising but still limited in their overall attractiveness.

Key Finding 32

There is a certain willingness from MNCs to move facilities to ASEAN due to the planned and ongoing improvements of infrastructure and regulations there, but this depends on how these countries are able to match the requirements in terms of price, quality, lead time and other, financial aspects.

The experts mentioned, it is hard for most companies to measure the economic benefits of environmental friendly practices in supply chain management, but providing an environmental and social friendly surrounding is already a soft factor in today's decision making processes and will gain importance. On the other side – and despite the current economic situation – the trend to source to China is still unbroken, whereas promising newcomers

like Vietnam suffered more from the economic turmoil and are still 'limited in their attractiveness'. Potential upcoming countries (e.g. in ASEAN) have to prove themselves as being capable to offer better or at least similar conditions like today's supply chains are used from Greater China, Singapore and in certain sectors also Thailand and Malaysia. This leads us directly to the next section that focuses more on the trends in the logistics infrastructure in ASEAN and Greater China.

Evolving Logistics Infrastructure

Key Finding 33

Despite the high degree of standardization and economy of scale in ocean shipping, there can be significant differences in local costs at ports that are involved when shipping by sea. These differences are usually depending on the country and the level of competition.

As ocean shipping is still the predominant way to connect the countries of Greater China and ASEAN, the development of corresponding facilities as well as their differences in costs (e.g. Terminal-Handling-Costs) can make a difference and attract or repel supply chains. Differences are especially visible within Mainland China, where costs in the southern parts (Hong Kong, Shenzhen and Xiamen) are often driven by competition and rather fixed by tariffs in Shanghai and Beijing. This will impact the stream of goods and amplify via economy of scale and availability of hinterland transportation and proximity of supplier clusters of different industries.

Key Finding 34

'China heavily invested in port and shipping technology (E.g. new port of Shanghai with an 'artificial city' at the landside for half a million people with warehouses and production facilities, as well as universities, schools, shopping centres, etc. This construction had probably a very bad impact on environment and animals, but it's a big step towards long-term sustainability)'

Key Finding 35

'China invests heavily in infrastructure to increase the ability to bring industrial (and farmers' goods) from the West to the East, and to bring goods from the East to the West (supplies like TVs, toothbrushes, etc). The current logistics system (lorry-based) there produces lots of carbon emissions and is not very efficient and sustainable. Almost an 89% environmental efficiency factor with a rail-based logistics system.'

Key Finding 36

There is a general lack of proper infrastructure to boost the logistics performance in ASEAN, as well as some of the reasons for it.

All these findings indicate that there are heavy investments in the logistics infrastructure in Mainland China, whereas ASEAN still struggles with an older and less efficient logistics infrastructure – except the well-developed feeder network that provides excellent connections between the ports of Singapore and other ports in ASEAN, Asia Pacific and worldwide.

Key Finding 37

Trucking and ocean freight complement each other in ASEAN and Greater China as there is a lack of railway connectivity.

Railway connectivity could not only help to improve transportations times within ASEAN, but also to connect ASEAN more closely with Greater China. The already mentioned fact that transportation within ASEAN relies heavily on ocean shipping leaves a lot of opportunities untouched which could arise from a railway network that could connect Singapore, Malaysia, Thailand and Vietnam, and even further North, from Vietnam directly into the more Western provinces of China. But still, such projects are very ambitious as the process of economic integration within ASEAN is rather slow.

Key Finding 38

When suppliers move within China, the logistics infrastructure is crucial: Opportunities in the west depend to a large extent on the developments of the logistics infrastructure, whereas even a near shore relocation can have significant impacts on the logistics situation.

A reason for the above mentioned investments into the logistics infrastructure in Mainland China is the aim to connect the rather less developed Western provinces with the more developed provinces in the East and South. This is not only to access less expensive labor force, but also to enable to bring products to the West; this should help to promote growth in these provinces. Another result could be the relocation of supplier from Eastern and Southern provinces to the Western provinces of China. This will be discussed in the next section.

Relocation of Suppliers in the Electronics Industry

In the electronics and high-tech industry, the favorable conditions that are offered by production clusters were and are one of the main reasons for the success of many countries in Asia to become indispensable for today's global

supply chains. These production clusters can be found around Hong Kong, Shanghai, Beijing, as well as in ASEAN countries like Singapore, Malaysia and Thailand.¹⁹ To anticipate trends that impact how these clusters work and how they eventually relocate is therefore vital for achieving sustainable supply chain layouts. As a result, the expert interviews aimed to explicitly capture expectations and opinions regarding potential supplier relocations:

Key Finding 39

General criteria for supplier selection remain the traditional factors like (total landed) costs, lead time and quality. Nevertheless, the availability of skilled (engineering) labour and geopolitical issues seem to be taken into account, too.

When talking about supplier relocations, several decision makers shared the same opinion as presented in finding 39: General criteria of supplier selection will still hold, so nobody expects a gold rush mentality that causes irrational decisions.

Key Finding 40

Usually, there is an impact of changing FTAs and custom duties: First, associated costs can have a significant impact, by making it impossible – or enabling it – to integrate certain countries in certain supply chains. Second, as the high-tech industry is heavily clustered in Asia Pacific, these changes would influence every player more or less the same, therefore affecting the industry as a whole, rather than the comparative advantages of single player – due to the geographical similarity of their supply chains. Third, there is the risk that such changes have a very indirect impact via the hard to estimate impacts on upstream n-tier suppliers, as their locations can vary and be therefore differently affected.

As finding 40 explains, one of the easiest ways to influence the geographical preferences in sourcing decisions is regulations on trade. These changes can happen unexpected and literally overnight. Nevertheless, these are not the only aspects of shifting supplier bases.

Key Finding 41

The relocation of supplier bases takes place in patterns and affects rather whole cluster, whereas the viability of such relocations might be differ between different industries or even companies within the same industries.²⁰

¹⁹ See (Yeung, 2008), (Lüthje, 2004), (Van Liemt, 2007) and (Foster, et al., 2006).

²⁰ It will be interesting to see the outcomes of the different approaches of individual attempts to exploit arbitrage opportunities versus the economies of scale and robustness when operating embedded in a local industry cluster.

Key Finding 42

Especially bigger MNC expect more from their suppliers and are heavily involved ensuring compliance in an active way. In general, quality is no big issue anymore as it was in the past – at least in the high-tech and electronics industry.

Key Finding 43

Certifications are on the bottom line of supplier evaluation and selection. But there is also the perception that being certified is not the end of all, and can even become contra-productive as it can easily cause some administrative work.

Key Finding 44

There are some limitations in the collaboration between OBMs and their suppliers:

- Sometimes regulations can become an issue
- The end-to-end visibility is still not given when going beyond the 1st and maybe 2nd tier suppliers
- The financial supply chain seems not to be an integral part of supply chain collaboration in today's supply chains.

These three findings show another interesting trend when it comes to supplier selection and evaluation: Quality is usually not as much of an issue as it was in earlier times when sourcing from ASEAN and Greater China; and Certifications are not the ultimate answer to ensure quality and compliance. Due to the increased 'clock-speed' in these supply chains, especially OBMs are playing a more active role and get closer to their 1st and even 2nd-tier supplier in order to ensure the needed quality and compliance. But despite all efforts, there are still limitations to this integration as indicated in finding 44.

It will be interesting to see if further integration will be achieved – offering more efficiencies; or if the current de-coupling at the level of the 1st or 2nd-tier supplier will persist – offering eventually more robustness when thinking about the clustering of suppliers and its implications as discussed in (Lüthje, 2004) and (Yeung, 2008)

Globalization versus Regionalization of Sourcing

Due to soaring fuel prices (especially in 2007 and 2008) and the risks of cascading effects (e.g. credit defaults) that have increased during the last years in a lot of global supply chains, a lot of people claimed that the current crisis heralds the end of globalization as we know it. The new buzzword was suddenly

'Regionalization', a concept that should not only avoid complex global dependencies, but also help to save fuel prices and lower environmental (CO2) emissions.

Several of our interviewees also commented on these theories:

Case Study by a producer of household appliances: 45

Imagine you're a US company and want to source some strategic components more locally from Mexico, because all your component suppliers are usually in China. If someone says that we should start to source motors for washing machines from Mexico, this would mean:

1. Let's assume you are able to find a company that produces the needed kinds of motors
2. If they can make a prototype you take it to R&D
3. Then you buy 200 motors to manufacture 200 prototypes of the washing machine for testing
4. Then the supplier has to adapt the motor to match all quality criteria to pass all tests (This can imply several rounds of testing)
5. Finally, R&D might be satisfied, then you'd ask them to produce 2 million motors. This implies eventually long-term contracts, financing of their tooling and so on, and take several months of negotiations. (And then you still have to ship them to their destinations)

Then – and only then – you can start to actually source from them. From the first decision to source these motors from Mexico to the first washing machines with such a motor in the shelves it can easily take two years. Meanwhile, oil prices can go up and down several times.

Key Finding 46

There is a certain flexibility to relocate final assembly, but the bottom line will remain to source components from countries like China, because no one can ignore the competitiveness and economy of scale that these countries offer. The case illustrates this finding, that despite the fast moving industry, certain evolved structures in today's supply chains are hard to ignore or overcome. Like illustrated, the simple decision to source components from a closer location (to the US market) than e.g. China implies a lot of time, costs and efforts that can hardly be compensated by the benefits of achieving near-sourcing.

This case study shows in a very impressive and comprehensible way that even if a company tries to modify its supply chain towards a higher degree of regionalization, it won't be as easy and won't even be an economic viable decision. Finding 46 clearly supports this.

Key Finding 47

'Trends/Developments in oil prices will determine to which extend supply chains will change towards one of these mutual exclusive directions:

- Direction 1: Producing everything highly efficient in bulk, producing near the customers, holding lots of inventory, and distributing rather slowly.
- Direction 2: Going on like in the past, as consumers want everything faster. ('Nobody wants to wait six weeks for his new laptop')

In addition, changing product prices will have some impact, too.'

These findings show two different tendencies in global supply chain management that only seem to be contrary in the first sight: The evolved supply chain structures won't change this fast, but just continue to evolve – shaped by rather long-term developments like trends in oil prices.

Key Finding 48

Supply chains have achieved lead times that often enabled 'build-to-order'. Nevertheless, in times of high demands, capacities are ramped up and sales figures are given higher priority than classical supply chain factors like lead time, interest rates and backing instruments. This is when inefficiencies appear and get manifested in daily operations, lowering the synchronization and flexibility of the supply chain. Obviously, when demand is dropping, a lot of risks appear but having an in general less synchronized supply chain: Overcapacities, high inventory levels, liquidity issues, etc. The question for the future is: how much supply chain managers have learnt from past experiences, and what IT can contribute to mitigate these risks when demand is increasing again.

This finding provides a rather pessimistic outlook on rather operational supply chain management that shows us that also – or especially – environmental and social factors will probably become less important for companies when the economic situation is picking up pace again.

Key Finding 49

Reverse logistics is not a feasible (and financially sustainable) concept when considering the current layouts of the global distribution networks: These distribution networks are designed to deliver products fast, but not to enable an efficient collection and take-back process, resulting in high costs for recycling.

This finding shows the currently low importance of reverse logistics due to the lack in the 'evolution' of such extensions of traditional supply chains. Therefore, only regulatory pressure seems to be able to have a significant impact on recycling – at least in ASEAN and Greater China.

Key Finding 50

CSR activities are rather done locally and de-coupled from operations. There is some cross-country alignment, but mainly to achieve economy of scale.

There is the general tendency to treat CSR activities not only as a cost centre without any relevant outcome to normal business. As this finding exemplifies, companies more and more try to introduce business practices into their CSR activities, even to integrate them somehow into their business model – at least to align them with their core competences. These trends will surely intensity.

Conclusion

Our aim was to identify the most important elements and drivers regarding sustainability in supply chains.

Key was the integration of all three dimensions of sustainability: economical, environmental and social. Currently, the main issues when it comes to dealing with sustainability is the lack of (monetary) measurability and valuation, as well as the uncertainties about medium- and long-term trends that influence what is perceived as being sustainable.

The presented approach by obtaining different perspectives helped to make the ambiguous topic of sustainability more tangible and to structure traditional elements of supply chain management with new elements that are frequently addressed in today's literature. The subsequent SWOT analysis indicated a strong need to actually integrate these new elements.

As the situation analysis indicated the high complexity and ambiguity when it comes to sustainability in supply chain management, the methodology of expert interviews was used to access expert knowledge in order to identify what really matters for different stakeholders of current supply chains, how to integrate these elements, as well as what trends they expect for the near and far future. The findings from these interviews were structured and turned into the starting point to select and discuss the integration of financial, environmental and social sustainability-related aspects

Finally, the discussion of the experts' expectations about future developments helped to identify long-term trends and critical alternative paths that will impact the long-term sustainability of supply chains.

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