Sustainable Logistics

Responses to a Global Challenge

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Judging by the number of publications, conventions, company releases and political statements focusing on this topic, it becomes clear that questions and issues relating to sustainability have been and still are receiving a great deal of attention from managers, politicians and scientists alike. And yet it is precisely the people who are expected to find solutions and develop specific measures for adaptation who are surprisingly unsure about how to handle this topic. This insecurity – which both leads to a delay in political reactions and fosters a superficial, marketing-driven culture of “greenwashing” at the company level – is also linked to the fact that the term sustainability continues to remain vague even today. That is precisely why we will introduce our deliberations by developing a clear definition of “sustainability” and outlining the fundamental implications of this term in detail.

This book distinguishes itself from the numerous other research papers on this topic mainly in two regards: the broad range of topics that are discussed, and the depth of the analysis regarding potential courses of action. This means that we will begin by thoroughly exploring the future framework conditions in which the logistical system and process architectures must be adapted and redesigned. These measures include different types of political interventions with which governments increasingly try to reinstall the market mechanism by internalizing what are known as external costs. Logisticians must understand this context (such as the objective and mechanism of emission permits) so as to be prepared. Yet they also need this more comprehensive knowledge in order to be able to make a qualified contribution to the interdisciplinary dialog and to promote their cause in the public debate. At the same time, this book deliberately also addresses political decision-makers as a separate target group, because in the past their insufficient knowledge of the nature and impact of logistics has often led them to misjudge the effects of their own measures.

Unfortunately, science has not yet been able to bring forth any groundbreaking studies on sustainability. This is partly due to self-restraint in the respective research approaches. Scientists who limit their work to identifying empirical regularities (e.g. by conducting surveys among managers) or analyzing case studies are clinging to what is currently observable, thereby neglecting to critically analyze the question of whether current “best practices” meet all the new requirements of sustainability, or whether, in this new context, they should in fact be deemed insufficient or even blamed for generating counterproductive side-effects. Just like scientists in the field of operations research who fail to capture the complexity of the sustainability problem from the very outset with their strict orientation towards mathematical optimization models and their implicit
prioritization of quantifiability over relevance, they have to leave the field of much-needed innovation to practitioners. In this book we deliberately distanced ourselves from such limiting perceptions of "scientificity" and have taken the liberty of thinking in a less restrictive manner, both in terms of content and concepts.

Measured against the target aimed for by politicians and set by climate researchers –namely the goal of reducing greenhouse gas emissions to create an economy which can get by with an elevation in global warming of just two degrees Celsius and in which industrialized nations are only allowed to produce twenty per cent of the greenhouse gas emission levels of 1990 by the year 2050 – the bar has been set so high that it cannot be surpassed with the logistics models available to us today and that were developed under different circumstances. The main approach of this study therefore consists in systematically and unreservedly examining all existing logistics models with regard to the extent to which they either foster or hinder the attainment of the respective objectives. This process also includes analyzing individual restructuring measures and new developments on a case-by-case basis to see if they could bring us closer to our goals or are perhaps even indispensable.

The focus here lies on transport processes, which, in the context of globalization, already rank among the largest sources of pollution and which will become increasingly important in relative terms, because this logistics-driven sector is highly dependent on oil and is particularly difficult to decarbonize. For us it is never just a matter of drawing attention exclusively to environmental protection; at the same time, we always want to concentrate on the task of securing mobility on our increasingly overburdened transport routes by using our traffic infrastructure and modes more wisely. Even though sustainable mobility is fundamental for logistics to function, logistics has been assigned a double social responsibility with which it was never confronted in the past. Companies can only become sustainable if, on a global scale, they contribute to decoupling the growth in freight traffic from economic growth. That is the major challenge which we would like to help overcome with this book.

We can conduct a particularly in-depth analysis by also searching for and identifying the forces that drive the high levels of transport intensity in our economy in areas for which logisticians are not responsible (even though they frequently have to answer for the consequences). Apart from marketing, this also includes superordinated corporate business models that were developed in a day and age when transport and infrastructure capacities were not yet scarce and when sustainability was not yet factored into decision-making and design processes. All in all, it is foreseeable that in this altered and extended planning context, companies will once again give logistics a higher priority within their own businesses.

If something needs to get better, it must be changed. The experience we gained from collaborating on projects with our clients has helped us retain a grip on reality in our search for new paths to follow. However, feasibility is a soft restriction to the extent that much of what we today consider to be unalterable framework conditions of our actions could principally be viewed as a shapeable
variable that could therefore be “shifted.” Lifting such perceived “practical constraints” opens up new approaches for finding solutions. However, entering new thought territory is not necessarily without risk. That is why we welcome suggestions as well as constructive criticism. If this book provides our readers with a stimulus to think outside the box, then we have achieved our objective.

This book is based on the German edition published under the same title, which is why some of the problems and case studies discussed here refer to situations that are currently taking place in Germany and Central Europe. Even though this might mean that some of the conclusions reached here (e.g. regarding the role of the railroad as a mode of transport) cannot be applied one to one in other regions on this planet, these examples still help understand which obstacles have yet to be cleared on our road to sustainability. While sustainability is a global problem, some of the specific questions must be asked within local contexts, which may vary from region to region in terms of scope and urgency. This insight, too, is crucial for working together to find solutions. Since greenhouse gas emissions know no geographical boundaries, the new challenge analyzed in this book is of a global nature.

According to an ancient Native American proverb, we have not inherited the Earth from our fathers – we have borrowed it from our children. That is why, just this once, we have decided to dedicate this book not to our wives, but to our children and grandchildren – even those who have yet to be born.

Krefeld and Munich, July 2012

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Management Summary

There is no longer any reasonable doubt that it is necessary for our economy to be ecologically restructured. This topic has been increasingly focused upon during the last few years. While the discussion about environmental protection used to be mainly of a local nature, characterized by concerns about dying forests, polluted bodies of water and badly handled waste disposal, the focal point of most debates nowadays is the danger of man-made global warming caused by greenhouse gas emissions. The center of attention has thus shifted from the source of all cycles of matter, i.e. the issue of the regenerability of scarce resources, to their decline, i.e. the absorptive capacity of the earth. Both cases deal with finite capacities characterized by the interdependent nature of their exploitation: if we handle natural resources more carefully, we also make less use of final disposal zones such as waste dumps or the earth’s atmosphere after the frequently multi-tiered processes of material transformation. During the update of these debates, the term “sustainability” (to be specified later) also entered center stage.

The follow-up costs of uncontrolled global warming, which will be discussed in more detail later, also explain why the main focus has been permanently shifted to the greenhouse effect caused by the combustion of fossil fuels. The overwhelming majority of climatologists are convinced that “anthropogenic” global warming cannot be stopped if we keep following the path we have chosen until now. The physical base effect, however, appears to be relatively simple: due to the accumulation of greenhouse gases in the atmosphere, less thermal radiation from the surface of the earth can reflect back into space. The scientific consensus pertaining to that issue, last expressed in the 2007 report of the Intergovernmental Panel on Climate Change (IPCC), is emphatically supported by the most important national Academies of Sciences (including those of all G8 countries.)

We cannot and will not partake in debates about probable scenarios. However, it is sufficient for the work at hand that it was possible to convince political leaders around the world of their correctness, and that those politicians act accordingly. The tolerable maximum of a global warming by 2 °C (as compared to pre-industrial times) has not yet been laid down in international law; however, it has been accepted by nearly all the countries in the world following the conferences of Rio, Kyoto, Copenhagan, Cancún and Durban. Apart from other essential changes that we are facing, with the expected increase in the oil price and the growing congestion of our traffic routes being regarded as especially grave, political intervention in market development and price-shaping processes pertaining to high-emission human actions are going to significantly change the framework conditions of our decisions. We will be under massive pressure to adjust.
A major part of the debate about substituting fossil fuels with renewables strongly focuses on the power industry. To the extent that traffic as a polluter becomes the center of attention, public interest mostly shifts towards the development of energy-efficient, low-emission power units for passenger cars and small delivery vehicles as well as alternative fuels. As a consequence of globalization, however, worldwide freight traffic and consequently the logistics systems determining its scope have become a prominent issue. The published figures regarding the share that freight traffic holds in worldwide greenhouse gas emissions vary according to the sources, but all of them illustrate how important this sector has become.

According to the International Energy Agency (IEA), the transport sector accounts for 30% of the carbon emissions in OECD countries, with 23% allotted to the road transport segment (OECD 2008, p. 6 et seq.; the OECD countries account for 15% of the global population but generate roughly two thirds of the gross world product). A study carried out by the International Energy Agency (IEA 2010, p. 11) states the following: “The transport sector is a huge consumer of energy (accounting for 19% of global final energy consumption in 2007) and will account for 97% of the increase in world primary oil use between 2007 and 2030. The consequent energy security and greenhouse gas emission implications of oil-dominated road transportation mean that reducing the fuel used in this sector is one of the highest priorities for all countries.”

Logistics is trailing far behind, however, in the task of analyzing possible savings potentials. The attention paid to this particular problem area is still grossly out of proportion compared to the important role it plays in the great project of “sustainability.” With this book, we aim to help bridge that gap. In doing so, we look at the freight traffic sector not only from an environmental angle but also take into consideration the looming shortcomings in infrastructure in this new context of sustainability. This is about “sustainably” maintaining mobility on our increasingly overburdened traffic routes.

Due to the resulting race to catch up, the costs of the necessary adjustments across all sectors will rise higher and higher the longer we wait. It would therefore be wise to do what is necessary soon. Logistics is going to have to make a major contribution here, because it is managing the global flow of goods, which can be energy-consuming and cause high levels of emissions depending on the respective carriers. This makes logistics an important player in the field. It creates and shapes the prerequisites for our economy characterized by an extensive division of labor and spread of business locations, making logistics the heart and nerve center of globalization. Living up to this responsibility under new framework conditions requires unconditionally putting all its previous basic principles and system designs to the test. This step is not only necessary to meet public expectations and/or political conditions but also out of self-interest. Whenever there is a significant change in the conditions surrounding certain decisions, the decisions themselves also have to change.

Apart from a detailed description of the problem, the text presented here includes the analysis of several, to some extent very different options for action with solution potentials of varying concreteness. Making no claim to be
exhaustive, we aim to create an impression of the range of conceivable methods of resolution and at the same time highlight the prerequisites and limits of feasibility in individual cases. That requires going to great lengths in the analysis of individual topics, which may at times make reading somewhat demanding for a hurried reader. Readers who seek a starting point and an overview can benefit from the fact that they will need little secondary literature beyond this book.

We have prepended a management summary to the text for readers who wish to gain an initial impression of the results of our work. Of course, this summary does not replace the text. We do not seek to patronize our readers, but instead provide them with some food for thought. By means of the prepended theses we are hoping to spark their curiosity.

30 Theses on the Development of Sustainable Logistics Systems

1. You cannot design what you cannot define. That is the first problem. The term “sustainability” is as plausible as it is diffuse. That is why we have to begin our statements with our own, unambiguous definition, and go into detail about its implications due to the central importance of this term. All linguistic subtleties aside, sustainability as a system status worth striving for cannot be measured exactly (let alone finally), neither in micro- nor macroeconomic terms. It must therefore be understood as a regulative guiding principle. In a logistics-related context, it includes preserving an intact environment as well as maintaining the mobility that is necessary for our economy based on the division of labor. In both reference systems for sustainability we are reaching our limits with our current economic strategy; limits which are, however, of varying preciseness. Regarding the issue of mobility, most analyses are independent of the climatologists’ prophecies of doom.

2. Since any delay will only lead to calls for a (by then barely feasible) higher reduction of harmful emissions per unit of time, almost all leading climatologists demand immediate action and a change of course when it comes to global warming. The global economic crisis triggered in 2008 had the effect of an involuntary (but not sustainable!) environmental protection project, and has given us some room to breathe. Furthermore, together with the high debt rates of large banks and national budgets that later emerged, the crisis has at least achieved a temporary shift in political priorities and a narrowing of financial leeway. Yet since the environment waits for no man and is unwilling to negotiate, we must be careful to prevent a loss of attention turning into a loss of time, which increases our risk of failure and adds unnecessary costs to any delayed activity.

3. Logistics can, and must, make an essential contribution to developing sustainable economic strategies. In light of the proportions of the problem we are facing (for which some say logistics is partly to blame), the demand for sustainability also requires us to thoroughly rethink our design of networking and process architectures and therefore to expressly question our own actions. Paradoxically, in the medium and long term we will not be able to afford an
especially lean logistics system that is deprived of any buffers and all temporal leeway. Currently, though, logistics is not yet part of the solution but rather part of the problem. However, we must handle the restructuring process with care, since logistics is the heart and nerve center of our economy.

4. Sustainability is also (but not only) a question of resource efficiency. Technological advances of all kinds will foster the pursuit of sustainability. However, for a number of reasons to be discussed in detail later on, it is highly questionable whether these advances by themselves can guarantee sustainability. Since the ingenuity of man cannot be predicted, it is hardly possible to anticipate the respective consequences. However, since – due to the high energy density required in this sector – 97% of global freight traffic density still depends on oil, it would be grossly negligent to simply assume that they will be sufficient and arrive in time to relieve our logistics systems of the pressure to adjust. Cargo aircraft, container ships and heavy trucks will not be able to run on solar cells in the near future; wind and solar energy are only generating electricity, and for reasons to be explained later, biodiesel is at best an additive but not a fully suitable substitute for fuel. Moreover, even highly efficient new drive technologies would require a lot of time to be installed on a large global scale. After all, any efficiency gains in a growing economy and with a growing world population are permanently reduced by making products and their use more affordable, which generates an increase in demand similar to a “boomerang effect.” That is why we are going to need both: innovative technologies and innovative logistics processes and network architectures. (It may be a comfort to climate change skeptics that efficiency gains provoked by ecological motives will create benefits for our society even if global warming does not unfold as expected; for instance, by creating new jobs in a new industry, by decelerating the rise of oil prices, and by decreasing our dependency on foreign oil-producing countries.)

5. Even though people constantly demand quick action, especially in politics, one thing is for sure: logistics will only adapt its systems in a broad, sustainable manner when there is a need to react to a significant change in core framework conditions, meaning there will be a delay. But it is possible to describe the possible options for that even now, just like those framework conditions, which we clearly point out at the beginning of this book. While this enables us to carry out thorough preparatory work, it does not justify passively sitting around and waiting.

6. Climatologists’ warnings and admonitions are based on complex simulation models. While around the globe climate researchers’ assessments of the impending climate change mostly coincide, their results and conclusions are not entirely without controversy outside of their own scientific community. However, there are no alternatives for such models, seeing as we cannot experiment with the earth itself. Nonetheless, that does not oblige us to join in the dispute about the truth of these models. It will be sufficient for the analysis at hand to observe that politicians mainly heed those warnings and the increasing pressure from the public (also influenced by non-governmental organizations), and that they will intervene in the economy accordingly (e.g.
by issuing tradable emission permits and successively depleting them). All that gives rise to an entirely new planning context.

7. At target level, political decisions are often made without knowledge of the available instruments and means. The target agreement made in 2009 at the summit of the eight most important industrialized countries (G8) in L’Aquila (which was still not passed as a binding global standard in Copenhagen, Cancún, Durban and Rio de Janeiro, though) to reduce carbon emissions in times of a growing economy and world population to 20% of the emission level of 1990 within developed countries by 2050 is highly demanding, not least because – according to the EU Commission – global CO₂ emissions have already risen by more than 40% since the year of reference (cf. the German magazine *Der Spiegel*, No. 42, 2001, p. 29 et seq.). Nonetheless, the world’s leading climatologists are of the opinion that this target agreement represents the absolute minimum of what must be achieved in order to limit global warming to two degrees. (By now the WWF, among others, even names a target figure of 95%.) To the extent that in the area of freight traffic, which relies almost entirely on fossil fuels, these objectives cannot be achieved by technological innovations alone, the adjustments made to the logistics systems need to be of massive proportions. (“Oil accounts for 97% of transportation energy use” (IEA 2002); there seems to be little room for renewables.) Even then, at the end of the day the traffic and logistics sectors will probably only be able to reach the mentioned objectives after exhausting all internal adjustment potential described here, and only on the basis of limiting the worldwide division of labor and spread of business locations. Since it would bring about a loss in welfare, that strategy appears realistic only to a limited extent. Time and time again, sustainability proves to be a balancing act between conflicting interests.

8. Radical intervention becomes increasingly necessary, seeing as a large percentage of the emission reduction potential of more efficient technologies such as low-emission engines would already be “eaten up” by rather moderate growth rates of traffic and the economy. Taking the growth rates predicted for newly industrialized countries such as India or China into account, we might see that happen very early on. As early as 1972, the Club of Rome described what could await us if we do not successfully restructure our economy in order to contain these developments: the limits to growth. We would have to accept the fact that a “limited” planet does not allow for unlimited growth. Although we could extend the reach of scarce resources such as oil by continuously increasing usage efficiency, we will come to a point at which we have to learn how to live in harmony with nature instead of exploiting it and learn how to exist against the background of an economy that no longer registers any growth. The time frame currently available for reshaping our economy and making it both low-carbon and more environmentally friendly still offers us a choice (which means that, as yet, there is no reason to show resignation). As climate scientists predict, once this window of opportunity has closed, necessity will dominate our actions. More specifically, that means: in order to meet our goal of restricting global warming to 2° Celsius (above
pre-industrial levels), we would need to switch from a strategy targeted at prevention to the much riskier and presumably more expensive approach of containing the effects.

9. In the medium term, rising transportation costs are going to be among the key factors spurring a sustainability-oriented restructuring of process and network architectures. In turn, this development is driven by three principal causes:
   a) rising energy and transport costs;
   b) a loss in time, productivity and reliability produced by overstrained traffic routes; and
   c) political measures targeted at internalizing external costs (ecotaxes, toll fees, emission certificates or the like).
   These factors have a cumulative effect. Emission trading is a prime example of the pressure building up as a result of the political measures taken. Opportunistic corporations that show no more than half-hearted commitment to climate protection will have to struggle with the extra costs to be paid for emission permits and thus suffer from a competitive disadvantage in comparison those to companies who thoroughly scale back their emissions.

10. Being confronted with a climate shock that can no longer be neglected, the general public has now also become aware of the problem of the man-made greenhouse effect. The growing environmental concerns among the population as well as the reaction of the media, of non-governmental organizations (NGOs) and of bloggers put the topic at the center of public attention and increasingly press politicians to take action. Education on the total amount of emissions caused by specific products or product categories (carbon footprint) will play a significant role here. While the concept of “climate-friendly consumption” calls upon the consumer to become active, a lot of work will still have to be done in advance (data collection across the various value-added steps and product lifecycles, standardization to allow for comparability) to put this idea into practice. Currently, in spite of the high levels of public awareness regarding environmental issues, the rates of environmentally friendly behavior among the general public still tend to be rather low – not only, but also due to the lack of information available on product carbon footprints.

11. The sustainability criterion also results in another conflict of objectives for the logistics industry that has not yet been a subject of further research. A good example to illustrate this conflict is the question of whether it is justifiable to put up with emission levels rising by more than 1000% just to reap the benefits of a 50% labor cost reduction (as it is the case with textiles imported by airfreight from Asia, for example). While the internalization of external costs, which we will outline in greater detail later in this book, will not completely eliminate these kinds of conflicts, carbon footprints will at least make such processes more transparent for the customers.

12. All current predictions regarding the increase in traffic to be expected in the medium term considerably exceed existing traffic infrastructure capacities. However, the capacities at our disposal strongly depend on how wisely we use them. That is our chance.
13. The performance of systems is generally determined by their bottlenecks. The same applies to the traffic system: the projected infrastructure overload will first become evident in the case of heavily trafficked routes (e.g. seaport hinterlands). However, we can already observe that such traffic overload often spreads far beyond its point of origin. Approaches targeted at a redistribution of the growing amounts of traffic movements across various routes and across various times of the day using traffic telematics systems or road pricing models – thus reducing traffic peaks and moving some of the peak-time traffic to off-peak times – will only postpone the point when we finally reach our capacity limits, but not manage to avoid a capacity overload altogether. Part of the reason for that is that as opposed to private car traffic, freight traffic is subject to cycle times determined by industrial processes and thus offers only a limited window for postponing traffic movements (or would bring about high opportunity costs) – at least against the backdrop of current process models. Ceteris paribus, an increase in the number of traffic jams cannot be avoided.

14. There are several reasons why charging tolls for passenger cars will be inevitable. Firstly, in order to reach the ambitious carbon reduction goals set by politicians, the huge amounts of emissions caused by private traffic cannot be neglected. (Passenger cars account for 71% of all vehicles operated on German highways.) Passenger car drivers also create external costs, including substantial follow-up costs incurred by traffic jams. Secondly, compared to freight traffic, the demand for traffic infrastructure created by passenger traffic shows a far higher flexibility and price elasticity (i.e. there is more leeway with regard to mobility). Thirdly, from an economic point of view, it would not make sense to try and impose restrictions regarding the use of scarce capacities that would only apply to those road users who – by comparison – make the largest contribution to our GNP. Not only would this approach fail to appropriately allocate a public good that has not always been a scarce resource and thus result in a decline of public welfare. Sparing passenger traffic would also constitute a violation of one of the key rules of environmentally motivated state intervention: the “polluter pays” principle.

15. An aspect that current projection models fail to account for is that traffic-related bottlenecks in freight traffic show a tendency of self-aggravation (to compensate for time and productivity losses, an increased number of vehicles is required to handle the same transport volumes, which would again send transport costs soaring). As a result, once a mobility crisis comes close to a full-scale traffic infarction, an exponential increase can be observed.

16. According to findings presented by the European Commission on 17 June 2009 and a position paper of the European Conference of Ministers of Transport (CEMT) presented in Sofia, Bulgaria, in 2007 (cf. www.internationaltransportforum.org; last accessed on 18 March 2010), the economic costs of traffic jams across Europe amount to about 1% of the GDP and thus wipe out parts of our economic growth. Newly industrialized countries will presumably face growth losses of an even larger scale. One of the main tasks in logistics will thus be to manage to decouple the increase in
traffic from economic growth. (In the last few years, the ever-expanding trend of division of labor and the spread of business activities across various locations has regularly given rise to an above-average increase in freight traffic.)

17. For decades, German and European politicians have been calling for a transfer from road transports to railroad transports – this will have to become reality. But it is not going to provide a long-term solution to the problem, because
   a) for the time being, the railroad company service profiles do not match the tightly scheduled logistics systems in place in industry and retail (restructuring these systems might help, but it would cost money and, in light of current cross-company coordination of schedules and cycles, would require – at least in some parts – cross-company agreements), and
   b) the railroad companies’ capacities are absolutely insufficient for putting this approach into practice, and public funding for an expansion of these capacities is short.

For the foreseeable future, given that freight traffic is closely integrated into industrial processes, pricing strategies in the form of ecotaxes or tolls will not be a feasible way to force a large part of freight traffic “off the road.” Up to a certain limit (which might constitute a problem with regard to political feasibility), high toll charges would make freight traffic, which, at least in the short run, lacks price elasticity, more expensive, but would not significantly reduce freight traffic volumes. The same is true for emission certificate-based charges imposed on airfreight and sea-freight transports. Certainly, railroad transport is going to benefit in the long run from both increasing unpredictability and a relative increase in road transport prices. Once the projected rise in demand for traffic infrastructure has become a reality, railroad transport will become a fully accepted mode of choice. At the end of the day, we will have to use all available capacities offered by alternative modes of transport in order to keep up the flow of traffic on our roads as long as possible. This will render the enduring modal split discussions, which have coined the political debate in the field of common transport policy in Germany for more than 20 years, pointless.

18. It is impossible to expand the existing traffic infrastructure to a degree that would match the growing demand, as such a project would lack both funding and political acceptance. Furthermore, due to lengthy red tape-stricken approval procedures (land-use plans, project plan approval procedures) and increasing waves of public protests, such expansion measures could not be realized in time. And privately funded traffic routes will not manage to close that gap either. So if we cannot influence supply, we have to try and manage demand, i.e. find smarter ways of using the capacities available.

19. The steep rise in transport costs projected will fundamentally change our attitude towards transportation as such. While we now still perceive transport capacities to be an infinite, commodity-like resource, we will have to realize in the long-term that they are a scarce and precious good and that our overall supply chain design will have to be adapted to the capacities available.
20. One of the effects of rising transport costs on logistics systems is a change in trade-offs. This change will especially be felt with regard to the balance between transport and inventory carrying costs as well as between transport costs and labor cost differences compared to countries that we currently consider to be low-cost nations. Depending on the respective industry, their business model or their product portfolio, different companies will feel this pressure to change more or less strongly. It is possible to put together a list of those criteria that will be decisive for how intense the impact might be. This will help to distinguish between “early adopters” and “late followers.”

21. Under certain conditions – in case of products with a low value density or a high number of variants, for example – we are going to see long-distance transports to certain sales regions replaced by local, storage-based sales activities (renaissance of warehousing, decentralization trends). Decentralized distribution systems provide more room for maneuver and thus help to achieve high and even levels of vehicle utilization in long-haul primary transport activities, as they allow for a free (i.e. no longer order-based) scheduling of transport frequency.

22. Process models based on a combination of pull-principle activities and radical time compression, i.e. models following the guiding principles of the “One-Piece-Flow Models,” will be specifically put to the test. In order to pursue the sustainability goal, both the just-in-time concept and the issue of batch size optimization have to be reconsidered. Replenishment strategies, order policies and transport planning (loading space utilization) must be more closely coordinated. In this respect, we are facing a paradox: we need to reintroduce (utilization-enhancing) jams into the flows of goods in order to improve the flow of traffic.

23. The radical compression of time in processes – originally targeted at eliminating waste of any kind – has already given rise to waste at another point: not only have these processes become increasingly vulnerable to disruptions, but they have also contributed to a boom of the mainly airfreight-based express freight market. This has not only led to a deconsolidation of transport movements, but has also increased the use of small-scale express delivery vans and of high-emission airfreight transports – neither of which are in any way sustainable. Efforts to eliminate this separation and acceleration of transport operations have to focus on the causes of the problem, i.e. on the artificially created shortage of the time, the elimination of all kinds of reserves that would allow for adaptation as well as the self-made disintegration of demand predictability.

24. One way to help us obtain the scope of action required to reshape logistics in a sustainable way will be a reduction of overly comprehensive service commitments. These service requirements considerably narrow down our present scope of action when it comes to reshaping logistical systems in accordance with our sustainability goals. In turn, extra time buffers added to delivery times allow for load leveling in transport operations (decoupling load from the unpredictable fluctuations in the numbers of orders coming in per day) and allow us to switch to more environmentally friendly modes of
transport as well as to reduce the number of polluting (as a result of deconsolidation) express freight shipments. In order to put this into practice, companies will have to convince their customers to accept this new situation. This might constitute a significant barrier and delay the change required. However, customers who refuse to accept these deceleration efforts run the risk of becoming victims of a different kind of deceleration caused by an increasing number of traffic jams, which can be seen as indicators of a traffic infrastructure overload.

25. If we do not succeed in decoupling the increase in traffic from economic growth, the increasingly overstrained traffic infrastructure will set the limits for our economic growth. And if a traffic infarction leads to road and rail being “out of service,” not only traffic will come to a standstill. One might get the impression that, so far, nobody has actually thought through what such a scenario, i.e. a steep increase in opportunity costs resulting from a failure to expand existing infrastructures, could eventually entail – neither the traffic experts in politics nor economic or logistics stakeholders.

26. In the long run, rising transport costs combined with decreasing labor cost differences and a more ecofriendly consumer behavior will promote a trend back towards running business on a more regional scale. In certain situations, this option will be a feasible path to follow. Labor cost levels in production are one of the key parameters here. Other factors that might spur a re-regionalization include an increase in production flexibility, which would make it possible to replace the currently small number of universal, specialized factories by a larger number of local, universal factories (that is to say: production moves closer to where the customers are located, along the lines of “build where you sell”). In the long term, globalization in its role as a process of change will experience a deceleration or a partial inversion, but not a standstill. And consumer education will play a significant role in that process. (At some point, it is no longer going to be “hip” to drink water from Italy in Berlin.)

27. However, the prerequisites for reversing the artificial time shortages introduced by business-on-demand models need to be created elsewhere. Longer lead times mean that we must regain our ability to generate stable demand forecasts, and reducing the variety of products and product variants will further promote that trend in the long run. In this case, due to the reduction of complexity, efforts to protect the environment and efforts targeted at cost minimization would go hand in hand. Prolonging product life cycles would have a similar effect. However, apart from fashion products, there are certain limits to this approach, seeing that innovations are the key drivers for economic growth. And without economic growth, we will not be able to afford effective environmental protection measures.

28. The rationale that excessive, uncontrolled product proliferation and variety – via a chain of cause and effect involving several steps in between – constitutes a barrier for a more economical use of transport capacities so far has not been part of the decision-making criteria considered by managers, because most organizational structures are designed in such a way as to spread out causes
and effects over several different areas of responsibility. Logistics thus had to comply with requirements set by roles and functions outside the logistics units (in particular from marketing) and was forced to develop process architectures and network configurations accordingly. The sustainability of these structures is now being called into question. The most important conclusion to be drawn from this insight is: without improving the status of logistics within the organizational structure, many companies will not be able to make full use of the most significant levers for promoting sustainability. In many cases, sustainable logistics will require a reassessment of marketing strategies and business models devised and implemented from above.

29. The proposition of a fundamental harmony existing between economic efficiency and ecological effectiveness does not hold up to generalization. Cost-incurring state intervention is necessary to use the market as an instrument contributing to environmental protection. The market on its own would not be sufficiently capable of doing that, seeing that the environment does not have a single owner who would be able to represent it in pricing processes. As a result, the costs incurred by carbon dioxide accumulating in our atmosphere are currently assessed as amounting to zero. On the other hand, according to the analyses presented in the world-renowned Stern Report, any extra expenditure required for restricting global warming to 2° Celsius can be justified using the argument that the costs resulting from doing nothing would be at least five times higher.

30. Consequentially, one of the main tasks of politics will be to coordinate the measures taken around the world in order to prevent that conservationists are punished while polluters who thwart and undermine the sustainability goals are rewarded by obtaining a “free rider” position in the market. If these efforts are successful, achieving “sustainability” does not require a new ethic going beyond the self-healing powers of the economy as such, and sustainability will be uncoupled from the altruism of individual economic decision-makers. But in order to achieve conservation by change, we need to bring in all the intelligence logistics has to offer and break free from our traditional ways of thinking, as well as dismiss some of our success models from the past. As Albert Einstein once said, “We can’t solve problems by using the same kind of thinking we used when we created them.”
Chapter 1
Basics

Summary. The first chapter clarifies the initial situation by stating the importance of logistics for the topic at hand and by providing supporting figures, and defines the aim of this book. Then the terminological and conceptual basics are explained in detail. In doing so, the focus initially lies on specifying the term “sustainability,” which has become much overused in everyday language and therefore requires clarification. In connection with this explication, we elaborate on the initial basic concepts such as the external costs model and the issues it raises, knowledge of which is a prerequisite for the analysis to follow. We delimit the three reference systems for sustainability that form the basis of this book, including the mobility sector, and we illustrate the interdependencies that exist among them. Another section deals with the three essential determinants, which, when changed, will force logistics to thoroughly adapt its system in the future. For the sake of the analysis, a planning horizon of fifteen years is assumed.

On the whole, we intentionally broaden the analysis horizon in the first chapter before we focus on technical issues in logistics. As logistics specialists we aim to close the gap in our specialist area when it comes to the general discussion about sustainability issues. To do so, however, we need to understand the broader context of that debate to be on a par with everyone else involved.

1.1 Initial Situation and Objective

There is hardly a word that has boomed as much over the past few years as the term sustainability. On 28 April 2011, Google returned about 47,700,000 hits for the English term “sustainability.” However, the scope of its popularity is remarkably out of proportion with its conceptual clarity. We can no longer afford that discrepancy in view of the tasks we are facing, as it clearly has some grave practical consequences. For example, if the term is unclear, people can blow smoke with impunity and engage in some superficial greenwashing without the fear of being detected. Above all, however, if the term sustainability is insufficiently defined, it will not restrict the leeway for human action to the extent it actually should, considering the status quo.

It is quite obvious that there is still a vast gap between what companies realize is a new need for action and what they are already doing today. “Most companies
consider the environment when making strategic decisions but significantly fewer have implemented ‘Green Supply Chains’, citing the lack of information as the main reason” (BearingPoint Survey Report 2008). Many current measures appear to be marketing-driven above anything else, and their dimensions – compared to the dimensions of the aforementioned gap – resemble tentative first attempts to explore a new path in mainly uncharted territory. And quite often the marketing messages about social responsibility do not accurately reflect what companies are actually doing. Again, we would like to quote from the 2008 BearingPoint study (op. cit.): “When companies take action, they are typically taking the easy route of reputation and brand protection on green messaging.”

At the moment, only a few pioneers can boast a combination of a detailed strategy, a solid organizational foundation, dedicated projects, clear goals, rules of measurement, and dedicated resources. (However, it must be said that the number of those pioneers has increased since the first edition of this book was published.) This lack of proactive action, supported by conceptual uncertainties, can probably not only be blamed on a lack of ethics and responsibility but, above all, on the widespread, deeply rooted tendency of leaders to strive for quick success and therefore to be reluctant about changing priorities between economic and ecological objectives and thereby incurring costs. Obviously, it is precisely the sectors that count transportation among their core business activities that are still hesitant in this respect. According to a study by the Fraunhofer Workgroup for Supply Chain Services (SCS) published in May 2011, only 20% of the logistics companies in question were able to report about relevant measures for the promotion of sustainability (cf. the German magazine DVZ, No. 62, 2011, special supplement, p. 7).

Similar behavioral patterns can be observed in consumers who, in surveys, have pretended for years to be much more environmentally aware than they turn out to be in their actual purchasing behavior. In both cases, it may be a lack of knowledge about the long-term consequences of our actions and the options we have for promoting sustainability that plays a role; a lack of knowledge that only makes it harder for the real Homo oeconomicus to make rational decisions. The alternatives are not always as obvious as the decision to either support free-range chickens or to buy cheaper eggs from a battery farm. In the context at hand, it is not only about estimating the consequences of our actions, but always also the consequences of doing nothing. The pressure to act which we will be under in the future primarily arises out of the difference between those two factors.

Methodological Classification and Definition of the Object of Study

If in our pursuit of eliminating these knowledge gaps we turn to science for help, we will soon enough learn that research is at a very early stage as well. “There has been little research on the impacts of supply chain practices on green logistics performance,” is the summary by Harris et al. (2010, p. 116), and Halldórsson et al. (2009, p. 89) describe the current state of their carefully researched literature as “rather sobering.” You can read a lot about life cycle assessment and environmental management certifiable pursuant to ISO norms, but what is
lacking – beyond such rather formal instruments – is answers to the question as to which substantial contribution can be made by logistics in its own sector in order to realize the eco-political target of an 80% reduction of greenhouse gas emissions by 2050, which will be discussed in more detail later.

Methodically, there are several ways to acquire and/or generate such knowledge. Surveys are a popular way, e.g. in the form of Delphi studies, as developed by the Rand Corporation at the end of the 1950s. The results of such survey studies are usually interesting and well worth reading, but they never tell us about reality; instead, they only tell us what experts think or assume about how the situation will develop. (It is equally difficult to generalize case studies, which often merely yield singular and anecdotal evidence.) Therefore it is precarious to derive a trend on a factual level from the mean value of the opinions gathered in such studies. Apart from the possibility that these experts may be wrong, that they occasionally adjust their answers to what they feel is mainstream or socially desirable, and that they sometimes just do not have the time or means for more in-depth causal analyses and model evaluations, surveys carried out among managers are mere snapshots that inevitably tend to trail behind developments rather than anticipate them. They help us assess the current state of affairs at a given time, but are less helpful in answering the question as to what specific course of action we can take in the immediate future. This question lies at the heart of this book. In order to answer it, we need to take an independent look from a different angle at the content of the current logistics systems and practices as well as to what extent they can be changed.

It is remarkable that many relevant studies about promoting sustainable freight traffic barely even touch upon the topic of restructuring logistics network and process models. Obviously, the authors of these studies fail to take into consideration that these systems, which are implemented and run by the shippers, have a much stronger impact on the utilization of transport capacities than the order allocation and route planning decisions of the owners of these capacities. A typical example is the most recent WWF study, “Blueprint Germany – A Strategy for A Climate Safe 2050” (WWF 2009). The “Freight Traffic” section (apart from the ever-abiding theme of modal shifts – so far, all attempts at tackling this issue have been chronically unsuccessful) is almost exclusively about measures to reduce energy consumption as well as shifting to alternative, ideally renewable, energy. (If you read the text carefully, you will find that it is mostly demands rather than measures.) Traffic performance is expected to substantially reduce its growth as compared to relevant estimations, but no one even tries to suggest how that might be done. Therefore, the logistics models that cause the economy to be so traffic-intensive do not even enter the analysts’ radar – which, by implication, means that people are, or even have to be, conducting “business as usual.” Quite obviously there is a knowledge deficit in logistics among both environment and traffic experts. It is one of the aims of this book to fill that gap.

“Numerous studies have illustrated how practices such as the centralization of inventory, just-in-time-replenishment and wider sourcing of supplies can carry a significant environmental penalty” (McKinnon 2010, p.15). Examining and
adjusting logistics process and system architectures requires more effort than evaluating questionnaires, yet at the end of the day it will probably also yields more results. We would like to invite our readers to walk down that road together with us, and we see the results of our work as a contribution that may serve to spark a debate. Anyone who participates in that discussion breaks new intellectual ground, just like the authors. Decarbonizing our economy and reducing its transportation intensity is a task that will take more than one generation to complete.

A widespread methodical approach for taking into consideration the uncertainty of future developments would be the scenario technique, an approach which we made a conscious decision not to use. We know that we thus deprive ourselves of the chance to include unexpected developments and events in the analysis, such as another economic crisis or a growing danger to global trade posed by a rise in terrorism. On the other hand, however, we make sure to have the possibility to concentrate intensely on three main development lines which we are convinced will distinctly mark the future of logistics. We will deal with these drivers of the logistics system adjustments that become more and more necessary in a separate chapter (1.3) at the beginning of the book.

Undeniably, there is a range of measures which support both environmental protection and profitability. A trivial example would be training classes for truck drivers on how to save fuel. However, in contrast to what people like to say in celebratory speeches, such examples cannot be generalized and streamlined into a universally applicable harmony thesis. A catalyst makes a vehicle more expensive, just like a city toll or a green tax make its operation more expensive. The rude awakening will come only when – behind a pretty façade such as a “Corporate Social Responsibility Program” – measures are being considered that benefit the general public but have a negative impact on shareholder value. That has so far not been part of our economic system’s constitution, and realistically it should be seen as the exception rather than the rule in highly competitive markets. The only way to escape this conflict is for politics to provide framework conditions that make environmental protection a question of compliance for all companies alike. Another incentive might be that environmentally friendly behavior displayed by forward-looking companies will be rewarded with premium prices or at least a larger market share.

In the past, clean air was never regarded or treated as a scarce resource. As indivisible “public property” that cannot be allotted to any individuals, it used to be open for unrivaled use by everyone. One additional emitter did not restrict the other emitters’ options for use, and no one could be excluded. By now, the earth’s potential for self-cleaning is unable to cope, and this behavior is no longer sustainable. Therefore we are convinced – and will give more specific reasons later in this book – that we can only guarantee a sustainable future if the state (e.g. by issuing emission permits) acts as a sort of substitute owner of the environment, puts a price on scarce capacities for greenhouse gases to accumulate in the earth’s atmosphere while at the same time imposing a quota on their usage if need be; and if
1.1 Initial Situation and Objective

a) the state (e.g. by issuing emission permits) acts as a sort of substitute owner of the environment, puts a price on scarce capacities for greenhouse gases to accumulate in the earth’s atmosphere while at the same time imposing a quota on their usage if need be; and if

b) companies make a successful effort to adapt their logistics models to the dramatically changing framework conditions that were detailed at the beginning of this book, thus providing for more sustainability out of economic self-interest. This book is about precisely those adjustments.

In many recent publications about “Green Supply Chains,” the authors head straight for a debate about objectives and measures for the realization of “green logistics” without considering the broader context (as an example, see the “Action Manifesto” by Emmett and Sood, 2010). But we are convinced that in the broader context of the debate about sustainability that is held by economists, politicians, climatologists, and environmental protection organizations around the world, logistics specialists will only be able to participate, and their proposed resolutions be heeded, if they understand that very context. Moreover, this knowledge (e.g. familiarity with the logic and the consequences of emission certificate trading) also has an impact on their own work. In this book, we therefore consciously embed special logistical analyses in the broader context of the discussion about the possibilities and limits for restructuring our economy and making it a sustainable, mainly decarbonized economy. Advances in small details require a view of the entire picture.

Even though it is clear that any measure that helps to reduce emissions (from the aforementioned training of truck drivers to running warehouses on solar power) is helpful and necessary, it is becoming ever more clear to us that the pressing problems that lie ahead will require us to make much more drastic adjustments. Target values for emission reduction were formulated by politicians in international agreements and published with a clear commitment, but were not yet adopted internationally in Copenhagen, Cancún and Durban. These targets will only be met, however, if we take the dimensions of the changes to a new level, if we strive for that goal with all our intelligence and creativity, if we stop concentrating so much on short-term successes, if we develop an accordingly strong disposition to make and accept changes, and if – as most climatologists would add – we do not waste any more time.

Focusing environmental issues on the aspect of climate change brought about by greenhouse gas emissions brings with it the danger of detracting attention from other eco-political topics and objectives such as the preservation of biodiversity, the pollution of potable water, or the acidification of our oceans. Within the context at hand, however, namely a book about sustainable logistics, such goal displacement is comparatively harmless. Instead we will tackle another topic, which is closely interlinked with highly pressing sustainability issues: maintaining mobility on our traffic routes.

Due to the broad range of at times very different approaches to promote an economy which anticipates the conceivable long-term consequences of its decisions and does not become a victim of the side effects of its own actions, we
will focus on the “central lines” of network and process design in the main part of this study. In favor of that focus, we will do without a more detailed analysis of smaller fields which deserve separate, special and in-depth examination, such as optimizing stowage space on loading platforms, reducing the volume of waste materials during production, or replacing plastic bags by environmentally friendly packaging materials at the point of sale.

Likewise, analyses of reducing pollutants in logistics properties will also not be included, in order to leave more room for the focus mentioned above. There are, however, remarkable improvements possible in that area, as attested by the Immogate center near Munich Airport, which was awarded the gold medal by the Deutsche Gesellschaft für Nachhaltiges Bauen [German Society for Sustainable Construction]. (During a life cycle of 20 years, the 26,000 m² (280,000 sq ft) hall produces 12,000 metric tons less CO₂ than a conventional warehouse and lowers the annual operational and energy costs by 25%.) Cutbacks of this kind usually apply to the construction of a property rather than its operation, and to that extent they are system- and process-neutral. Even with an impressive carbon footprint (depending on location and object), their share in the total of greenhouse gas emissions that can be influenced by logistics is relatively small. Moreover, the apparently still unfavorable balance between additional investments and saved extra costs will, according to the head of the market department at the Fraunhofer SCS group, lead to an economically unattractive payback period of 10 to 15 years (German magazine DVZ, No. 81, 07 July 2011, p. 13), which will slow down the spreading of the corresponding technology. The draft of a European standard for the calculation of greenhouse gas emissions (DIN EN 16258) still does not take warehousing and cargo handling into consideration, either.

Although 19% of worldwide electricity consumption is used for lighting, replacing conventional light bulbs with energy-saving bulbs is not the subject of our research, either. While we do dedicate a transportation-oriented chapter to technological advances and innovations in the area of energy efficiency and pollutant reduction, that chapter merely serves to complete the picture and suggests only exemplary solutions. The results and consequences of the inventive genius of man can only be predicted to a certain extent. A detailed examination of the conceivable or expectable technological advances, such as elaborating on the potential of improved propellers for deep-sea vessels, would go beyond the scope of a book that is primarily oriented towards economic design options (and would also exceed the authors’ expertise). Of course, this does not imply any value judgment. We need the synergy of logistical and technical innovations. For this reason alone we must have an idea of the conceivable consequences of human creativity in this sector: certain premises we use as an argumentative basis (here, especially the premise of a strong increase in fuel prices in the long term) are based on the scarcity of natural resources, which can be balanced by technological leaps of efficiency and/or the substitution of primary fossil fuels.

We would like to point out, however, that in our view, quantum leaps in energy efficiency will be hard to achieve with the carriers of today (a solar-powered cargo aircraft is indeed hard to imagine), whereas the contributions that logistics can make to preserving the environment and maintaining free-flowing traffic might
1.1 Initial Situation and Objective

well be clearly above the level of any increase in technical efficiency. It is simply more productive to make better use of a transport’s capacity, to shorten the route or avoid it altogether than to keep running it with lower-emission vehicles in unchanged logistics systems and on overburdened traffic routes. It is also possible that there will not be enough time to make the necessary inventions and render them suitable for the market in time. After all, according to the International Transport Forum (2008, p. iii), 98% of worldwide freight traffic depends on oil (the Carbon Disclosure Report 2010 states that this equals 60% of the total oil consumption in the OECD countries). In principle, it is possible to start much earlier with the logistics system adjustments developed here.

Our work does not supply a panacea or recommendations for easy action; it is instead meant to provide more of an initial, well-structured thinking platform on the basis of a conclusive “if-then” logic for future system developments as well as encourage corresponding considerations and discussions that may lead us further. At the same time, we want it to provide a grid of criteria which enables individual companies to examine their current state and determine how far they still are from concepts that deserve to be called “sustainable,” and which barriers they still have to remove in order to become part of a new economic-ecological balance.

Anyone who expects this text to provide general trends or even simple formulas of a “quantum leap” kind will therefore be disappointed. Just like the initial situation, sustainable models in the future will be contingent insofar as their relative advantage depends on a number of situation-specific framework conditions, which can differ vastly across various companies and industries. “Measure A looks promising if Condition X is met; if Condition Y is met, it is certainly advisable to resort to Plan B.” Hence it is not possible to provide any decision guidance through simple (future) “best practice” models that are universally applicable regardless of the context. That guidance can only be supplied by designing innovative configuration patterns for processes and networks while at the same time associating those patterns with beneficial or obstructive framework conditions. That will also be helpful to distinguish between the companies which will probably be among the first to adopt certain system adjustments and the “late followers” which follow later or go down an entirely different road. (It is one of the flaws of most trend studies that they do not pay enough attention to such differentiations.)

Likewise, the models and measures described and discussed in the following base their approach on a common denominator, which we are describing in the summary as a new paradigm of sustainability. This paradigm illustrates in twelve points which characteristics of the current manner of conceptualizing and operating logistics will be put to the test and to what extent that profile is expected to change.

**Target Groups of This Book**

This book is primarily directed at decision-makers in the fields of logistics and supply chain management. To the extent that we critically examine superior business models as to their sustainability, we would like to address the *top management level of companies* as well (which, by the way, should also support