

# Transportation & Logistics 2030

Volume 1: How will supply chains evolve in an energy-constrained, low-carbon world?



# Acknowledgements

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We would like to thank the panellists who took part in the Delphi survey that underpins this report. For confidentiality reasons their names will not be mentioned.

Special thanks go to Tom Gorman, CEO of CHEP EMEA and Harry Hohmeister, CEO of Swiss International Air Lines, who took the time to share their thoughts and insights with us.

Finally, we would like to express our appreciation for the expertise provided by the below listed individuals: Jenny Bailey, Andreas Baur, Nicholas Bell, Thomas Brüderlin, Giorgio Elefante, Richard Gane, Martha Elena Gonzalez, Susanne Klages, Christian Knechtel, Socrates Leptos-Bourgi, Alexander Müller, Dr. Moritz Nill, Roman Popovic, Robert Prengel, Gerd Tritschler, Joris van Meijel and Rene Willems.

# Welcome

Capacity management, cost control, cash management: these are the words heard in every boardroom, and represent some of the challenges that transportation and logistics (T&L) operators are facing as they navigate through the current economic environment. Taking quick and determined action is crucial for every company to address the threats of the crisis; for some companies responding appropriately will be a question of survival.

At the same time, business leaders should not ignore the long-term trends in their markets and must ensure a sustainable positioning of their organisations. What will be the fuels for future means of transport? How can the T&L industry contribute to mitigating its environmental impact? How can the bottlenecks in transport infrastructure be overcome? Will the supply chains of the future still be global in nature? Or will we be experiencing a shift back to regional supply networks? Are the emerging markets of today the emerging markets of tomorrow? Is the maxim of sustainability and ethics a sustainable one or a temporary fashion?

Transportation & Logistics 2030 (T&L 2030) is a series of publications that address these questions. Our objective is to develop insightful future scenarios about the development of the industry up to the year 2030.

In the first issue we put a particular focus on the scarcity of energy resources and how it affects the industry. The price of oil has long been a key factor for T&L. But with the extreme price fluctuations seen during the past 2 years and the increasing importance and awareness of the carbon footprint of transportation, the industry is more than ever challenged to develop forward-looking solutions. A shift in consumer behaviour may be an additional parameter influencing transport modes and supply chains of the future.

This study draws upon a rigorous mix of desk research and the results of a Delphi survey among 48 selected subject matter experts from 20 countries around the world. We are proud to present this report which was composed by members of the Transportation & Logistics industry practice at PricewaterhouseCoopers, in close cooperation with experts from the Supply Chain Management Institute at the European Business School.

By publishing the T&L 2030 series, we do not intend to predict the future. T&L 2030 is meant to be food for thought, our 'stimulus package' for in-depth discussions among industry leaders, strategists and other subject matter experts – and we are happy to be part of that debate.

We hope you will find T&L 2030 inspiring and welcome your feedback.



Klaus-Dieter Ruske

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# Foreword

Everyone travels to work. The shelves of the supermarkets are well-stocked. Internet orders are delivered. However, what happens when the petrol prices increase to three Euros per litre? – Vacant work places, empty supermarket shelves, and out-of-business Internet retailers.

Exactly how volatile energy prices affect transport and supply chains is something that everyone wants to know: supply chain managers, procurement professionals, logistics managers, politicians, manufacturers, logistics service providers, strategy departments, business development managers, decision makers in all industries and hierarchies, and last but not least, consumers and automobile drivers. This study gives answers – differentiated answers.

What can managers and society expect in the future with high probability? What surprises are lurking behind the next bend? And, possibly the most important: Despite or in the middle of all the uncertainty and threat – what opportunities does the future have to offer to those who know how to use this knowledge?

It is self-evident: Taking action is better than waiting around for something to happen. However, only those who are aware of the prospects for the future can proactively plan. The capability to respond to changes in the future depends on knowing what is expected to happen in the future.

Some of the relevant findings from this study include: He who focuses on carbon footprinting is stepping on the right foot. Logistics service providers who become “local heroes” will be successful regardless of the petrol price. Or also: Companies which control the flow of goods using real time, reduce interruptions and thereby energy consumption, which in turn increases customer attractiveness and strengthens market position. These are just three of the 18 projections from the study which could be instrumental for interested readers in successfully handling their specific corporate future.

Shakespeare called the future “the undiscovered country”, but it doesn’t have to remain so. Readers, who help themselves to the presented study findings, may depart on a sometimes surprising but worthwhile trip in discovering the undiscovered.

I wish all interested travellers on this expedition into the future fruitful and inspiring reading for their own future expertise.



Dr. Heiko von der Gracht

Director of Center for Futures Studies and Knowledge Management  
Supply Chain Management Institute  
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# Executive Summary



How will supply chains evolve in an energy-constrained, low-carbon world? For one thing, they will go much further in the direction of ensuring that the cost of emissions is paid by those who reap the benefits, spurred not only by regulation, but also by changes in consumer behaviour. Supply chains will benefit from improvements in technology which enable significant real-time control, allowing greater flexibility. And although in some sectors regional supply chains are likely to grow in importance, overall the supply chain of 2030 will remain primarily a complex global system – but one where transport costs and emissions are increasingly key constraining factors. These are some of the key take-aways of the first release of our T&L 2030 series. This study conducted by PricewaterhouseCoopers and the Supply Chain Management Institute is based on a multifaceted analysis of the ramifications of energy scarcity for the Transportation & Logistics industry. The methodology draws upon a rigorous mix of desk research and the results of a RealTime Delphi survey among 48 selected experts from 20 countries around the world. Interviews with two top industry CEOs provide an additional practical perspective.

### Fuelling the T&L sector

Oil price volatility is a significant risk for the sector, but soaring oil prices are unlikely to be the primary driver for fundamental change. Alternative energy may take up some of the slack engendered by diminishing oil reserves; while the experts on our panel do not believe a major energy turnaround will be achieved by 2030, they do expect to see notable growth in renewables. New regulation and ambitious targets being set in a growing number of countries around the globe may provide the underpinning necessary to drive significant technological change in this area, although there is substantial controversy around what direction developments will take and how rapidly advances can be achieved.

Oil prices will increase and so will the use of alternative fuels, however neither are likely to revolutionise T&L – but the need to track, document, and allocate costs for emissions just may.

One area where there is consensus among panellists, however, is around carbon emissions. We see reducing emissions as posing a greater challenge to T&L companies over the next twenty years than obtaining a sufficient supply

of energy. Our panel anticipates that by 2030 systems will be in place to ensure that the cost of carbon is allocated to the causer; further, most of the experts we surveyed see this development as a positive one for the sector. Whether or not they see it as a business opportunity, logistics providers will most likely need to track, document and disclose their caused CO<sub>2</sub> emissions in the future. Tracking carbon emissions may only be the first step, though. In the more distant future, logistics service providers will need to document all types of emissions, such as noise and nitrogen oxide, in order to measure the full environmental impact of their activities over the long-term.

The need for a sustainable supply chain, which tracks and documents emissions, has numerous ramifications. On the company level, introducing mobility accounts may provide one way to reduce the carbon footprint of employees. Companies may also be able to monitor total emissions, and eventually manage these in such a way to reduce the carbon footprint of the organisation – and by extension its customers. One of the first steps will be providing information on the carbon emissions generated during the logistics process; this may prove critical to customers if "carbon tickers" documenting the sustainability of individual products proliferate, particularly for consumer goods. Companies with significant, documentable expertise will likely be rewarded by the financial markets, as they will achieve higher "sustainability ratings" once external measures become popular. They may also be able to offer customers "green credits" for more sustainable transportation options, or share their own expertise as eco-consultants.

### How consumers may reshuffle the cards for T&L operators

While current and future regulations will certainly have an important impact on the industry, some of the push towards ensuring sustainable supply chains is likely to come directly from the end-user. Consumers are the primary users of many means of transport, and their purchasing decisions have a strong influence on manufacturing supply chains. Individual mobility differs significantly between developed and developing countries. While in developed countries we observe a rethinking of individual mobility patterns with respect to the associated carbon footprint, it seems likely that in developing and emerging countries people will become more mobile, rather than less so, over the next decades.

Our panellists assume that more eco-aware consumers will show a greater preference for locally produced products. They will also continue to demand greater control over

the logistics process, and will more actively intervene in the delivery process of the goods they do order. This will increase the complexity of logistics processes, making necessary a highly sophisticated technical infrastructure, which may require investments in hard- and software as well as skilled workforce. This may sometimes hinder efficiency, so logistics providers will need to make the carbon footprint of various choices transparent to their customers so that they can make a contribution to the sustainability of their consumption patterns in this area as well.

Patterns of individual mobility vary in different regions; however concerns about cost and carbon footprints will spur individuals to reduce holiday and business travel and consume more locally produced goods.

Greater numbers of consumers are likely to live in environments which more fully integrate work, leisure and everyday activities, reducing some of their need for transport on a day-to-day basis. Business and leisure travel may also decline, as communication technologies improve and the population ages. A look forward suggests that some companies may wish to take a close look at their business models and consider how they position the company for the long-term. In some industries and regions, "local patriots" may be able to capitalise on increasing regionalisation of supply chains. Increasing urbanisation may give rise to home delivery specialists able to negotiate the congested last mile in urban environments. Logistics service providers may also want to consider whether to position themselves as low-cost logistics providers, where customers can select just the services they need, or as high-technology providers offering highly sophisticated real-time control of the flow of goods.

### Transport modes – more automated, but marginal modal shift

How products get from the assembly line to the consumer is also likely to change. The heated debate around the balance between different transport modes looks unlikely to cool. Logistics service providers will have to cope with a different transport architecture, as transportation networks will need to change in response to these ultra-large transport modes. More bundling efforts will be required, and the modal split may also be altered.

Further advances will become necessary as infrastructure bottlenecks, such as congestion in mega-cities, impede growth. Government-mandated local monopolies look unlikely, so companies may need to look for other solutions. Collaboration is also critical to maintaining flexibility; T&L operators may profit from developing research projects along the supply chain, or sharing resources with competitors. The latter option, known as "co-opetition", could have cost-saving potentials – options could include sharing warehousing, transport networks, or last mile delivery solutions in crowded urban centres. Greater use of autonomous and self-controlled systems may provide some other options.

### Supply chains achieve greater efficiency

Technological advances will also underpin some developments in the supply chain. In particular, supply chains will continue to become more efficient through the development of continuous real-time control of the flow of goods. Real-time control systems enable logistics service providers and their customers to monitor and control many business processes through Internet interfaces. Some of our experts also see opportunities for client intervention in the logistics process stemming from the so-called "Ubiquitous computing" being an important part of real-time control and of the entire logistics future.

Supply chain design, including the location of production sites, will need to take energy and emission costs related to logistics processes into account. There will be no reverse of globalisation, but many supply networks will be established at a regional level.

Unfortunately it won't result in supply chains that are resistant to external shocks. Implementing an existing plan is generally far more effective than scrambling to react to a crisis, so devising scenarios around various contingencies makes good sense.

Transportation costs will be a predominant criterion in determining where to set up production sites, and the minimisation of energy consumption will be a paramount criterion in overall supply chain design, rather than cost efficiency and speed. These trends will not result in purely

local supply chains, but one point seems clear – most companies will look to reduce energy consumption and the cost thereof. Logistics service providers will need to balance energy efficiency together with speed to support supply chains which take into account both factors, as well as other cost concerns such as access to raw materials and labour.

Logistics service providers should observe how the sourcing strategies of manufacturing companies evolve over the years. Whatever strategies manufacturers use to manage their sourcing costs, it is clear that improving efficiency and reducing the cost of global sourcing by reconsidering the location of production sites – whether from emerging markets like China, Vietnam or Central and Eastern Europe or developed markets – will be a key challenge to achieving global competitiveness in the future.

### Broadening the perspective

Interviews from two of the sector's top CEOs suggest some of the ways today's executives are already thinking about increasing sustainability to prepare for the future. Both interviews highlight the importance of the role of collaboration, be it with governments, or with customers, to achieve environmental goals. Harry Hohmeister, CEO of SWISS explains how his company is doing their part to reduce carbon emissions, for example by updating their fleet of aircraft. He calls for governments to do their part as well in ensuring that the aviation industry is able to fly as efficiently as possible. CHEP EMEA's Tom Gorman discusses how his company collaborates with customers, for example by offering Total Pallet Management on premises to reduce

transportation costs and the carbon footprint, helping them achieve greater sustainability.

The report also includes a section "extreme scenarios" where we encourage a broader perspective by showcasing how two of these areas (the oil price and consumer buying behaviour) may interact in four possible visions of the future.

And what is in it for transportation & logistics operators?

- Some 20 promising future opportunities for transportation and logistics operators have been identified and showcased in our "opportunity radar" based on the findings of the Delphi survey.

### Future prospects

Logistics companies should bear in mind for the years to come that logistics networks will change, sometimes dramatically, as their environments change. Climate change and CO<sub>2</sub> emissions will continue to gain urgency and consumers are likely to make more sustainable purchase decisions. New ways of doing business such as co-opetition and bundling cooperations will help increase efficiency, and completely new areas of operation such as fabbing supply chains may emerge. These developments offer new opportunities for logistics companies that are informed about upcoming events and flexible enough to adapt their businesses accordingly. Scenario planning and management strategies may provide an edge in keeping one step ahead of the pack as the world in general, and the T&L industry along with it, meet the challenges of the future.

# Findings of Delphi survey

Will energy scarcity  
reshape the T&L industry?



## Section 1

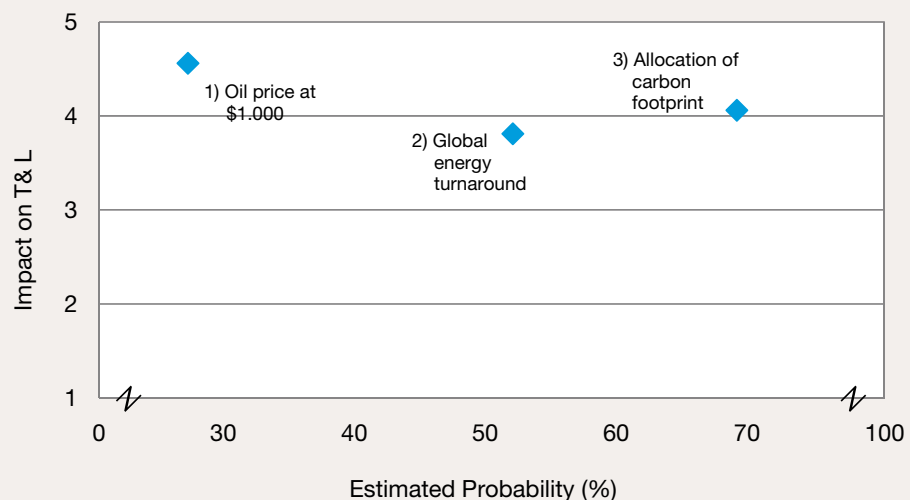
# Trends in energy and emissions

Energy supply and demand represent one of the most significant issues for T&L companies and will continue to play a defining role in the future of the industry. Oil price volatility is a significant risk to the sector, although our research suggests that oil prices are highly unlikely to rise in the order of magnitude necessary to trigger truly revolutionary change over the next 20 years. Alternative energy may take up some of the slack engendered by diminishing oil reserves; while the experts on our panel do not believe a major energy turnaround will be achieved by 2030, they do expect to see substantial growth in renewable energy sources. New regulations and ambitious targets being set in a growing number of countries around the globe may provide the

underpinning necessity to drive significant technological change in this area, although there is substantial controversy around what direction developments will take and how rapidly advances can be achieved.

One area where there is consensus, however, is around carbon emissions. We see reducing emissions as posing a greater challenge to T&L companies over the next 20 years than obtaining a sufficient supply of energy. Our panel anticipates that by 2030 systems will be in place to ensure that the cost of carbon is allocated to the causer; further, most of the experts we surveyed see this development as a positive one for the sector.

**Figure 1**  
Delphi results of trends in energy and emissions



### Theses

- 1) 2030: The oil price has risen to \$1,000 per barrel because oil production peaked years ago.  
**Delphi Results** Probability: 27 % • Impact: 4.6 • Desirability: 1.7
- 2) 2030: The global energy turnaround has now advanced to the point so that in some countries alternative energy accounts for up to 80% of the overall energy mix.  
**Delphi Results** Probability: 52 % • Impact: 3.8 • Desirability: 4.0
- 3) 2030: By using standardised measurement and evaluation systems (i.e. emissions trading, toll systems), the carbon footprint of logistics processes in supply chains must be allocated to the causer and factored into the price of the product.  
**Delphi Results** Probability: 69 % • Impact: 4.1 • Desirability: 3.9

Please find detailed information and explanation about the Delphi methodology as well as the parameters probability, impact and desirability on p. 55ff.

## Oil prices will not rise in the order of magnitude necessary to threaten conventional transport.

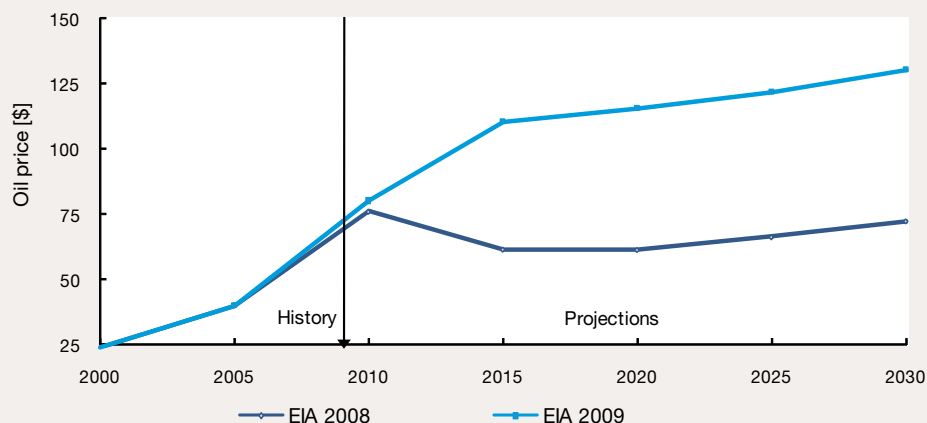
Developments in oil price and supply continue to have far-reaching implications for T&L companies. Despite the push towards reducing fossil fuel consumption demand for oil will remain strong in 2030, and will probably rise overall. Growth in the emerging economies will underpin increased demand. Over four-fifths of the increase in demand is likely to come from China, India and the Middle East, while demand in OECD countries should decline.<sup>1</sup> Oil will continue to play a key role in the overall energy mix. Its current share of 34 percent will fall only slightly to 30 percent by 2030.<sup>2</sup>

Significant price fluctuations in recent years, culminating in the dramatic 45 percent price increase from January to July 2008, coupled with much greater short-term price volatility, have made clear just how sensitive prices are to short-term market imbalances.<sup>3</sup> They have also highlighted the ultimately finite nature of oil (and natural gas) resources. While new oil reserves exist, extraction techniques will need to improve and will likely be significantly more costly; further it is questionable whether the remaining known oil reserves can be exploited quickly enough to meet the level of increased demand. Some industry sources believe that the problem of supply is not the lack of global resources, but rather a lack of investments where needed; they argue that enough oil is available if investments

are made.<sup>4</sup> Industry authorities vary widely in the extent to which they expect oil prices to rise and their prognoses as to when supplies will no longer be adequate, however even the most pessimistic estimate only places the oil price at around \$200/barrel in 2030.<sup>5</sup> Figure 2 shows two projections made by the US Energy Information Administration (EIA), published in EIA's Annual Energy Outlooks of 2008 and 2009. These projections are relatively low, however the significant adjustment made in 2009 – as compared to the projections of 2008 – suggest that short-term external factors are likely to have a sustainable effect on the oil price.

In our Delphi survey, we chose to frame the issues around oil prices with a deliberately provocative statement – “the oil price will reach \$1000 per barrel in 2030”. Our expert panel strongly disagrees that oil prices will rise in this order of magnitude, in line with prognoses. However, the wide range of supporting comments provided show a high level of uncertainty about oil resources, usage and price developments. A number of experts believe that significant investments into alternative energy resources should lead to diminished importance of oil in the overall energy mix and a reduction in the demand for fossil fuels. Some experts also believe that competition from new energy sources will lead OPEC to increase production, effectively keeping oil prices down. Overall, there is no general consensus about when or to what extent oil prices may rise.

Figure 2  
Oil price  
projections



Source: US Energy Information Administration, EIA (2008) International Energy Outlook, EIA (2009) Annual Energy Outlook

Where our expert panel agrees, however, is that a massive hike in the oil price would have serious ramifications for the industry – this thesis receives the highest rating from the panel on its potential impact on the T&L sector. Should the oil price soar to a four digit figure, regionalisation of supply chains and relocation of production sites would be the consequence. If oil prices stay in the three digit figure range, global sourcing and transportation are still expected to provide reasonable cost advantages.

Regardless, the oil price will fundamentally alter the pattern of trade and flow of goods in many sectors and economies. Oil price volatility would also clearly impact future global economic growth, or could even lead to a decline in world GDP. The T&L sector is cyclical in nature, so slower global growth or a global contraction would have a significant impact on the industry. Decisions to outsource manufacturing in “low-cost countries” and distribution patterns may need to be re-evaluated, should oil prices increase substantively.

External factors such as unanticipated natural disasters or political upheaval could have a strong and sudden impact on oil price volatility, and T&L companies will need to have appropriate risk management systems in place to manage the uncertainty. Some options include hedging for oil price fluctuations, organising operations in a less energy-dependent way and pricing that passes oil price fluctuations on to customers.

### Alternative energy usage will increase, but a global energy turnaround will not be achieved by 2030.

Given the primacy of fossil fuels in the current energy mix, experts from the International Energy Agency (IEA) anticipate that they will continue to cover more than 85 percent of energy needs until 2030.<sup>6</sup> The current contribution of renewable energy sources is relatively low at approximately 7 percent of the global energy mix. In 2008 the IEA forecasted that this share would increase only minimally, up to around 8 percent,

by 2030, based on a reference scenario which assumes no major shifts in current government policy and growth patterns.<sup>7</sup> Such predictions assume that comprehensive and far-reaching replacement of fossil fuels by alternative energy is unrealistic without a major technological breakthrough.

Some non-governmental organisations (NGOs) see an energy revolution as more achievable using existing technologies. In 2009 Greenpeace and the European Renewable Energy Commission published the second edition of their “Energy [r]evolution” series detailing a vision for decreasing carbon emissions. They argue that it is possible to increase renewables to 30 percent of the global energy mix by 2030, in explicit contrast to the IEA’s prognosis.<sup>8</sup> Their calculations are based in large part on promoting “efficiency” in order to reduce overall demand as well as stimulating investment in renewable technologies.

While arguments over the speed of change continue, there appears to be little doubt that the importance of alternative energies will increase in coming years. Green or clean energy is heralded by many as a possible engine for economic growth that could help lift the world out of a global recession. Incentives for companies to switch to alternative energy are already strong; using renewable energy sources can help companies seeking to reduce overall emissions levels and lessen their dependence on oil, thus reducing the risk engendered by high price volatility. Ambitious projects are beginning to emerge, such as the DESERTEC Industrial Initiative (DII), announced in July 2009, which plans to develop a framework for carbon-free power generation in the deserts of North Africa.<sup>9</sup>

Political initiatives are playing a major part in supporting efforts to increase alternative energies in the global energy mix. Countries without significant oil reserves strive for greater energy independence, particularly in light of the geo-political risks inherent in doing business with many of the countries with significant oil reserves.

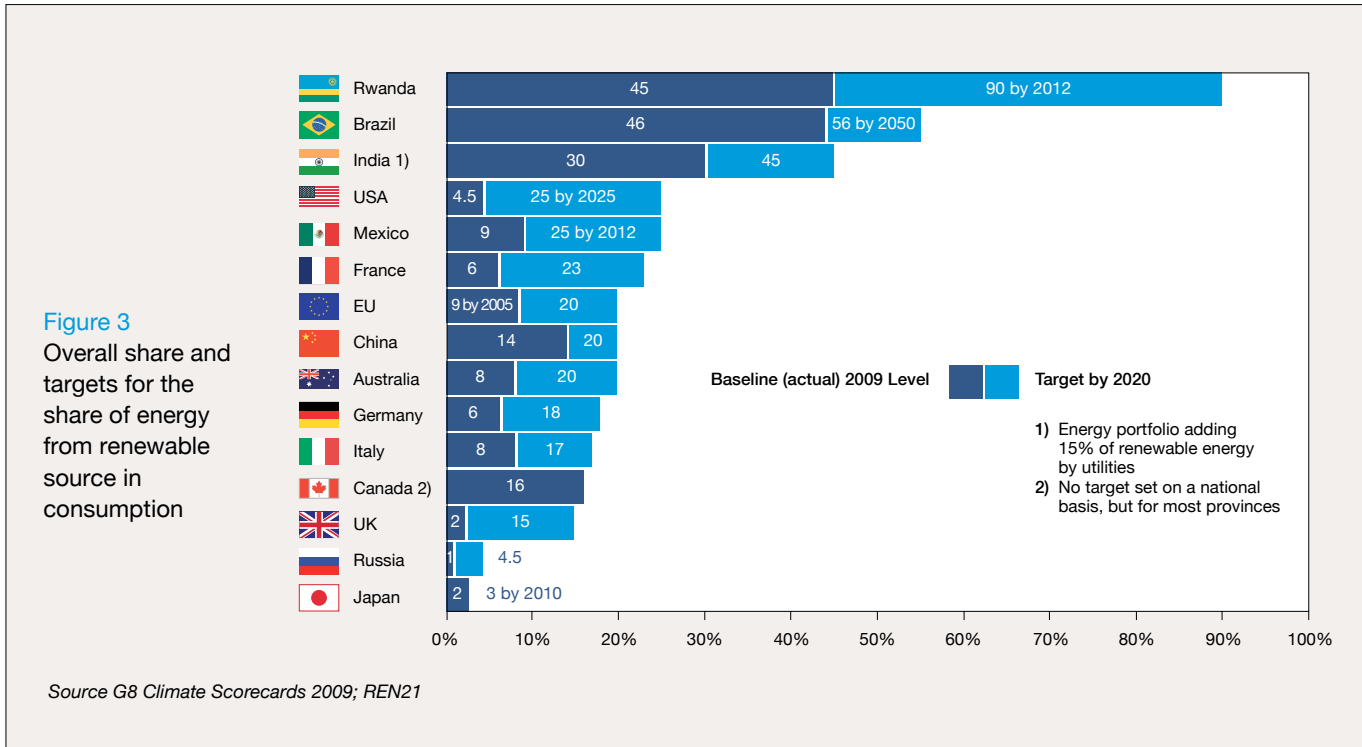
Sustainability is also high on the political agenda in many regions. In March 2007 the EU set a target of 20 percent green energy usage by 2020; specific country targets were agreed in December 2008.<sup>10</sup> In the US, the election of President Barack Obama also marked a political turnaround that is likely to lead to new federal policies around resources, energy and climate change; some US states have already imposed their own limits. Emerging countries are also stepping up to meet this challenge, e.g. the Chinese government is targeting 20 percent of its energy capacity from renewable energy by 2020.<sup>11</sup> Figure 3 provides a comparison of current and targeted renewable percentages for selected countries in both the developed and developing world.

Economic and fiscal incentives remain necessary to encourage an increase of the share of renewable sources in the energy mix, given higher costs. Many CEOs are also looking for clear, defined targets from governments. In PwC's 2009 Annual Global Utilities, more than half of the respondents feel that their renewable energy investment programmes are being negatively affected by the lack of clarity from governments on renewable energy targets and amount of financial support for renewable energy.

We asked our Delphi panel to envision the likelihood of a true global energy turnaround, where alternative energy has predominated to such an extent that it makes up 80 percent

of the overall energy mix in some countries. This vision raised extensive controversy amongst the Delphi experts. Although they agree that such a development would be extremely desirable, there is little consensus about how likely sources are to be developed. Some of our experts commented that higher cost will deter some shifts to alternative energy sources; until these are truly cost-competitive – as is the case with sugar-based ethanol in Brazil (see Country in focus: Brazil on page 15) – fossil fuel sources are likely to prevail. Still, the potential exhaustion of conventional fossil fuel sources and the extreme oil price volatility seen in 2008 are already accelerating the search for alternative sources and innovative solutions in some countries.

We anticipate that the specific energy mix will vary widely between countries. Questions around the future development of the price of fossil fuel remain a key factor contributing to uncertainty. The relative price of oil, for example, could significantly impact future investments in alternative energy. The cost effectiveness of wind and hydro power and level of economic development may play a part in determining the extent to which renewable energy sources gain in importance. Political, social and demographic factors will also have an impact. Taking those parameters into account, the majority of countries will still be dependent on fossil fuels in 2030, especially in emerging countries facing strong industrialisation and concomitant increases in energy usage.



## Country in focus: Brazil

Brazil is one of the world's leaders in the use of renewable energy. In 2007, 46.4 percent of all energy consumed in Brazil came from renewable sources.<sup>12</sup> An impressive 85.6 percent of Brazil's electricity was generated via hydropower, although some detractors have criticised the social and environmental impact of Brazil's aggressive construction of large dams.<sup>13</sup> Wind power is on the rise, and the country is the world's number 2 producer of ethanol, with more than 15 percent of the country's transportation fuel needs covered by ethanol production. Biodiesel production also increases. While much of this is from sugar cane – the UNECE-FAO has described Brazil as the only location in the world where first generation ethanol is being produced cost-competitively<sup>14</sup> – second generation bio fuels derived from cellulose are also in use and likely to increase in importance.

Brazil's positive contribution to fighting climate change is offset by the more widely publicised deforestation in the Amazon rainforest, some of which has been attributed to flooding caused by the same large-scale dams which provide renewable power. Still, the Brazilian government has introduced regulation to control deforestation, and is actively promoting renewable energy. Ironically, climate change itself may pose something of a threat to Brazil's renewable energy profile. A study by the Institute of Engineering Graduate Studies and Research (COPPE) at the Federal University of Rio de Janeiro (UFRJ) suggests that increased temperatures due to climate change will increase electricity usage by 8 percent by 2030, while power from hydro-electric plants will suffer from less and more erratic rainfall.<sup>15</sup> Though, Prof. Roberto Schaeffer, one of the directors of the study, believes that the potential to generate energy from wind power may actually increase.<sup>16</sup> Since no official statements about the future objectives for renewable energies in Brazil can be found. Greenpeace has developed future scenarios about Brazilian's use of renewable energies. According to the organisation, Brazil may be able to generate approximately 56 percent of energy from renewables in 2050.<sup>17</sup>

Reducing transport emissions will be a greater challenge for transport companies than the supply of energy.

Since the 1990's, sustainability and climate change issues have moved into the spotlight as key political, corporate and social concerns. In the early years of the 21<sup>st</sup> century, extensive media coverage and films like "An inconvenient truth" from Al Gore or "Home" from Yann Arthus Bertrand brought home the consequences of climate change to the general public. Scientific evidence around climate change is mounting, as documented in the Intergovernmental Panel on Climate Change (IPCC) summary report in 2007. Over the long-term, a shift to energy sources with a low or zero carbon footprint will be imperative. The IEA and other authorities have emphasised the need for strong and urgent action in order to reduce CO<sub>2</sub> emissions and other green house gases. They see a framework for long-term action towards clear, quantified global targets for the stabilisation of green house gas in the atmosphere as critical to reaching this goal.<sup>18</sup> Agreements such as the Kyoto Protocol established the first consistent guidelines aimed at reducing CO<sub>2</sub> emissions globally. As the 2012 end date for the Kyoto Protocol approaches, countries around the world are looking towards Copenhagen, where the next United Nations Framework Convention on Climate Change (UNFCCC) Climate Conference will be held in December 2009. Ensuring participation and commitment from developing powerhouses like China and India, and from the world's largest emitter, the US, will be critical for any agreement reached in Copenhagen.

Transportation accounts for more than 13 percent of CO<sub>2</sub> emissions worldwide, with road freight transport representing the largest – and growing – portion.<sup>19</sup> Achieving a substantive global reduction of emissions will therefore necessitate a significant decrease in transport emissions. In developing markets, transport-related emissions are growing significantly. India and China lead the list in terms of the average annual growth rate of emissions, followed by the rest of Asia. While the fuel efficiency of transport vehicles is improving, gains are more than offset by increases in vehicle numbers and utilisation.<sup>20</sup>

Pressure on the sector is not only coming from governments, though. Customers are increasingly demanding that their T&L providers demonstrate environmental and social responsibility (see Spot on Emissions on page 17f). Some companies are already responding. Some airlines now offer consumers the option to pay an additional charge to offset the carbon emissions represented by their flight. Some

logistics companies are offering a variety of “green logistics products”, whereby a customer may choose an option that ensures that the CO<sub>2</sub> emitted during the transport process is compensated through internal or external climate protection projects.

These offers, however, are rare and do not currently reflect the mainstream. A 2009 PwC survey around “green logistics” undertaken at logistics companies in Germany showed that 70 percent did not offer green logistics products. Most also do not plan to integrate such offers into their product portfolio, seeing little incentive. Further, the majority do not track their CO<sub>2</sub> emissions, because customers are not yet requesting such documentation. These results suggest that tracking and controlling of CO<sub>2</sub> emissions at logistics companies is still a niche today, although there are some very high profile exceptions to the rule. The majority of companies do not yet see the importance of this upcoming trend and have not integrated the opportunities – and risks – it presents into their corporate strategies.

**Whether or not they see it as a business opportunity, logistics providers will most likely need to track, document and disclose their caused CO<sub>2</sub> emissions in the future.**

### Costs related to the carbon footprint of logistics processes will be allocated to the causer.

The costs of mitigating climate change are estimated at around \$600bn - 1.500bn annually and whilst governments will need to contribute, some 80-90 percent will need to be financed from the private sector.<sup>21</sup> Footing the bill will be challenging for governments and companies struggling to survive a global recession, but the consequences of failing to act look to be much grimmer.

As noted, the T&L industry will undoubtedly have to play its part in reducing GHG emissions. The first step will be agreeing on limits. Standards for measuring emissions and systems for allocating the impact will then follow (emissions trading, toll systems). The goal of such systems is to ensure that the carbon footprint of logistics processes in supply chains will be taken over by its responsible causer.

In the transport realm some measures are already in place. The aviation industry faces inclusion in the European Union Greenhouse Gas Emission Trading System (EU ETS) beginning in 2012. A few major cities have introduced congestion charges (i.e. London, Singapore), and tolls for the use of highways in most countries of Europe, Japan and Chile

are already in place. The Netherlands are going a step further and are currently planning to implement an all-embracing measurement system, in which each CO<sub>2</sub> emission caused by road traffic will be tracked and allocated to the causer.<sup>22</sup> Businesses and private persons will have to pay a charge for each kilometre driven, regardless on which road. The Dutch project is in its early stages and no final contracts have been signed. However, it signals the extent to which individual governments may take measures to address the need to reduce CO<sub>2</sub> emissions. Further, such political initiatives may follow and could help foster strong frameworks to protect the environment in the long-term future. Some countries may lag behind, if they lack the political will to drive far-reaching change, or the financial and administrative capacity to instigate and manage such systems.

This trend provides a major incentive for optimising the supply chain and for exercising a strong influence on technology and planning, in order to increase competitiveness of environmentally-friendly transport technologies. Logistics managers generally expect stricter environmental laws and regulations to come with a high price tag.

Our Delphi panel experts see tracking and allocating external costs to the primary causer as the necessary result of the environmental damages and associated costs caused by transportation. The panel not only shows a strong consensus that this type of allocation of the carbon footprint is highly probable (68 percent), the majority also, somewhat surprisingly, rates it as a highly desirable outcome. Further, the panel also concurs that this shift will have a significant impact on the T&L industry.

Accurately measuring the carbon footprint in order to reflect all carbon costs also creates significant administrative challenges and costs. Some of our experts believe that logistics companies may experience difficulties passing the associated cost increases on to customers. One notes that in order for such a system to be fair, it should ultimately pass costs on to consumers, who will increasingly be expected to pay for the carbon footprint they are causing.

The diversity of transportation modes and the variety of environmental impacts creates additional complexity in the legislative framework needed. As one of our panellists argues, useful standards used for the systems will need to take all factors into account for all modes of transport, i.e. sulphur levels of bunker oil for shipping, and not only carbon emissions. Further, industry-wide standards such as the “carbon calculator” under development by the Association of European Vehicle Logistics (ECV) will be imperative to

ensure consistent measurement and prevent unnecessary duplication of effort.<sup>23</sup>

**Tracking carbon emissions may only be the first step, though. In the more distant future, logistics service providers will need to document all types of emissions, such as noise and nitrogen oxide, and the use of resources in order to measure the full environmental impact of their activities over the long-term.**

## Spot on emissions

Growing commitment to reducing GHGs, but debates over how continue ...

Over the past couple of decades, the recognition that climate change is at least partly due to greenhouse gas (GHG) emissions caused by mankind has led to ever-intensifying efforts to limit the amount of GHGs, notably of carbon dioxide, released into the atmosphere.

With the transport sector accounting for 13 percent of GHG emissions worldwide (IPCC 2007) and roughly double that (and growing) in some regions, the focus of policy-makers is now shifting onto it. There are three basic ways of reducing GHG emissions: improving efficiency of energy conversion; using less GHG-intensive energy sources within a particular mode of transport; and switching from one mode of transport to another.

There is little global consensus on where, by what means, or even by whom emissions are to be curbed. Nor is there any consensus on which methods for reducing emissions are most appropriate. This is as true of transport and logistics as it is of the energy and utilities sector. As a result, a number of regional and country-specific measures are currently being tried and tested, ranging from "hard" regulation (e.g. eco-taxes or emission standards) via market-based mechanisms (cap and trade schemes) to entirely voluntary schemes (product carbon labelling).

### Patchwork of direct obligations

In Europe, aviation is in the process of being incorporated into the local emission trading system

(ETS) with maritime transport likely to follow. The EU ETS places the burden on those emitting carbon dioxide. There is also progressively more regulation aimed at improving energy (and by extension, carbon) efficiency in the road sector: carmakers in the EU will need to meet mileage requirements for their average fleet by 2013, and they may eventually face maximum limits for fuel consumption.

Meanwhile, Australia, New Zealand and the US are all taking steps to set up their own emissions trading schemes, which will be directed further upstream and force fuelling companies to buy allowances. It is expected that costs will be passed through at least in part, thereby affecting many more sectors - including transport - indirectly.

Upstream mechanisms differ in their impact from ones such as the EU ETS: where an upstream ETS merely favours sectors that are less reliant on fossil fuels, an ETS singling out a particular sector shifts the balance between the sectors more markedly. Nevertheless, even in an upstream ETS some sectors (such as aviation) are less able to reduce dependency on fossil fuels, so that the overall effect may still be similar. In both cases the geographical limits are likely to result in distortions at the edges - for instance changes in route patterns or the movement of hubs to places just outside the borders of a measure.

### Extensive indirect pressure

But it is not only legislators that have started to put pressure on the transport and logistics sector. Customers are increasingly taking an interest in the supply chain of the products they buy, demanding that companies disclose information not only on the (ethical) provenance of their goods but also on the amount of carbon dioxide that was emitted in producing and distributing them.

This is not usually an easy question to answer, owing to complex supply chains and the number of parties involved along them. Nevertheless, a number of companies have started to respond to such customer demand by endeavouring to calculate individual product carbon footprints and offering "green" - i.e. carbon offset - products and services.

Financial investors are likely to pressure such disclosure, because it could give them additional insight into energy efficiency and the possible degree of future regulatory exposure.

### The big challenge: how to allocate GHG emissions downstream?

To some extent development is hampered by difficulties with measuring and allocating GHG emissions. As long as there is no robust mechanism available for allocating emissions to a particular step or product along the logistic chain, comparability between different companies and indeed sectors suffers.

Both international bodies (such as ISO or the GHG Protocol Initiative) and trade bodies (e.g. IATA, ICAO) are working on standardising methods for measuring GHG emissions. To allow comparability between different companies and sectors, such methods should be as accurate, transparent and complete as possible.

However, even in the absence of an internationally recognised, all-encompassing standard, GHG emissions are developing into a cost factor, albeit one that takes some effort to quantify.

### What now for transportation?

The general thrust of current international developments shows that GHG regulations are very likely here to stay. For one thing, national governments have shown their willingness to cut back on GHG emissions even without international agreement - making it all the more likely such an international agreement can be reached. Given the growth of emissions from the transport and logistics sector, it is likely to remain in the focus for some time yet.

As outlined above, the measures that are currently in place or being set up are complex and not necessarily coherent across the globe. Nevertheless, what they all have in common is that they will force companies to conduct a competitive GHG emissions analysis along the logistics processes. This includes monitoring of emission intensities of upstream and downstream activities as well as assessing specific carbon costs.

The sooner the transportation sector learns to assess and benchmark its GHG exposure, the better it will be equipped to aid decision-making by both policymakers and customers.

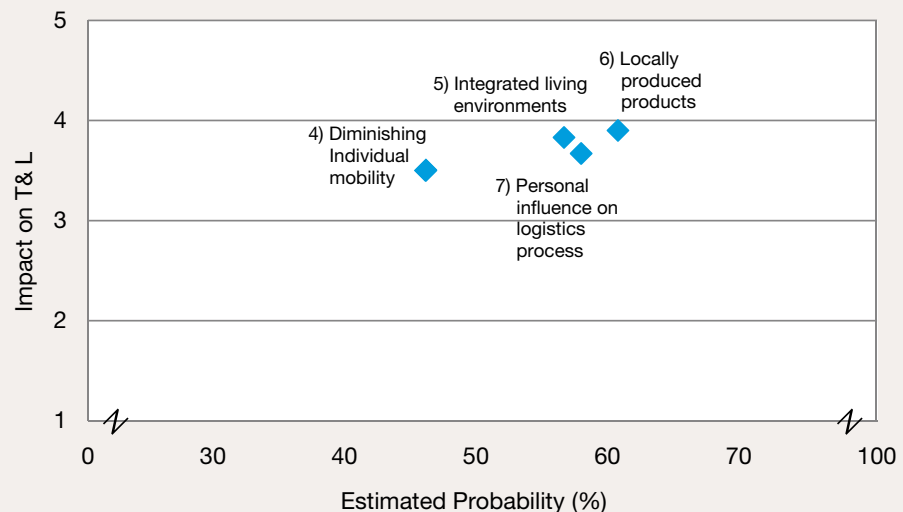
## Section 2

# Changes in consumer behaviour

Consumers are the primary users of many means of transport, and their purchasing decisions have a strong influence on manufacturing supply chains. Our panel anticipates that consumer behaviour is likely to change in various ways. While consumer patterns vary in different regions, more eco-aware consumers will probably show a greater preference for locally produced products. They will also continue to demand greater control over the logistics

process, and will more actively intervene in the delivery process of the goods they do order. Realisation of consumer preferences may sometimes hinder the efficiency of logistics processes, though. Logistics providers will need to make the carbon footprint of various choices transparent to their customers, so that consumers are able to apply sustainability criteria in choosing shipping and delivery options.

**Figure 4**  
Delphi results  
of changes  
in consumer  
behaviour



### Theses

- 4) 2030: Due to the scarcity of energy resources, the mobility of individuals has strongly decreased.  
**Delphi Results** Probability: 46 % • Impact: 3.5 • Desirability: 2.2
- 5) 2030: Work environments, everyday activities, and leisure options are better integrated, which has led to considerable reductions in transport.  
**Delphi Results** Probability: 58 % • Impact: 2.7 • Desirability: 3.6
- 6) 2030: Consumer behaviour has changed such that locally produced products are strongly preferred.  
**Delphi Results** Probability: 60 % • Impact: 3.9 • Desirability: 3.5
- 7) 2030: Personal influence on the logistics process has become more important for customers than the speed of delivery. Customers actively intervene in controlling the delivery process of goods.  
**Delphi Results** Probability: 56 % • Impact: 3.8 • Desirability: 3.2

Please find detailed information and explanation about the Delphi methodology as well as the parameters probability, impact and desirability on p. 55ff.

Our experts believe that greater numbers of consumers are likely to live in environments which more fully integrate work, leisure and everyday activities, reducing some of their need for transport on a day-to-day basis. At the same time, our experts don't anticipate that individual mobility overall will diminish strongly. Some view mobility as a fundamental need of mankind, which is unlikely to alter substantially. Panellists did, however, note a number of possible impacts on business and leisure travel. They anticipate that a portion of individual mobility will shift to transportation which uses alternative energy, and feel that regional travel may increasingly be favoured over long-distance holidays.

### Mobility resulting from business or leisure travel will be restricted in order to reduce costs and carbon footprint.

The worldwide financial crisis and global recession of 2008/2009 has had a significant negative impact on business travel, and the scarcity of energy resources has also contributed to declining numbers of business travellers. While some business class travellers shifted to travelling economy, many stayed grounded due to increased air fares, fuel costs for individual transport and prevalent corporate travel restrictions or outright bans.

Leisure travel and tourism have also been negatively impacted, with overall revenue passenger kilometre (RPK) down across the globe. The demand for leisure travel depends strongly on a nation's economic conditions. When economies stagnate or decline, so does the level of disposable income upon which tourism expenditures depend.<sup>24</sup> In 2008 media coverage of "staycations" (stay-at-home-vacation) proliferated in the US and UK.<sup>25</sup> In 2009 the trend appeared to be continuing. The quarterly published Manhattan Lodging Index by PwC showed for the first quarter of 2009 an average decline of 16.3 percent in the occupancy level; similarly the International Air Transport Association (IATA) forecasts a decline in 8 percent for RPK (revenue passenger kilometres).<sup>26</sup>

The level of growth of the global gross domestic product (GDP) will certainly have a major impact on travel over the long-term; while some sources predict a recovery in 2010, longer-term growth levels remain uncertain. Even if a strong recovery of the GDP promotes renewed growth in travel, increased awareness of the carbon footprint may have an impact on both business and leisure travel.

Further, most parts of the world will witness demographic aging during the 21<sup>st</sup> century. Studies assessing travel

patterns and travel needs of elderly people demonstrate that mobility diminishes with increasing age. Older people travel less and the number of journeys as well as travel distance decline as a result of changing needs, lowered income and disability. In other parts of the world, mainly emerging and developing countries with high fertility rates, the picture is reversed. There people will start travelling due to experienced economical growth or opening of their country to the rest of the world.

Our Delphi panel considers a decrease in long distance travelling for business or leisure purposes as probable. The panel anticipates that longer journeys will be the most strongly impacted; they believe that local trips and "staycations" will become increasingly popular.

The panel also views further development of various means of communications as well as greater numbers of telecommuters working from their 'home offices' as contributing to a decreasing importance of individual mobility. In the world of business, video conferencing is increasingly seen as a viable alternative to face-to-face meetings, a trend that is likely to intensify as technology improves and becomes less costly. In the personal realm, "virtual tourism" may provide an alternative to travelling. For example, the website 1001wonder.org intends to document 1001 cultural and natural sites around the world in three-dimensional photography and to enable users to interact with those images. Users are thus able to experience many important tourist locations from the comfort of their own home.

Panellists see a shift towards decreasing mobility as undesirable, since individual mobility positively influences personal development as well as social integration. Another drawback noted by our panel is that access to technologies replacing individual mobility may also be limited for people in less developed countries.

### Individual transport needs may decline as living environments, including both home and work, return to being more integrated.

City management will face new challenges in future decades. The increasing importance of individualism and consumerism as dominant modes of behaviour supports a continuation of the current global trend towards urbanisation. According to the United Nations Habitat report, over 60 percent of the world's population will live in cities by 2030.<sup>27</sup> The structure of urban environments may continue to evolve, however, with some communities developing around circuits of relatively autonomous neighbourhoods, rather than radiating out from

one central core downtown area. These less centralised urban areas may require re-thinking transportation networks.

As cities grow, so do their transportation needs. Increased transport capacity is often a source of pollution and noise that affects quality of life in the city. Increased energy costs, caused by rising prices of oil, strongly affect the provision of transport in cities. Road congestion in metropolitan areas increases CO<sub>2</sub> emissions – and decreases quality of life for commuters stranded on over-crowded streets and highways. Improving the situation requires optimising the use of various modes of transport, as well as ensuring “co-modality” between different modes of mass and individual transport.<sup>28</sup>

Looking at the transport modes is only the first step, though. In the EU’s Leipzig Charter for Sustainable European Cities, ensuring that working, living, leisure options and everyday activity are proximate to each other was viewed as a particularly effective strategy.<sup>29</sup> These new urban development concepts see the potential of re-integrated life settings to reduce traffic volume. The reintegration of living environments in city districts will dissolve the sharp segregation of living and working areas, promoting social aspects like strong local communities and family life.

On the whole our Delphi experts view the reduction of individual mobility in everyday life as fairly likely. This shift in living environments will impact the local and regional transportation of people, rather than the transportation of goods. Panellists also anticipate that consumers will become increasingly aware of their environmental impact (e.g. their “personal carbon footprint”) and will make decisions accordingly. They cite some positive possible impacts to more integrated living environments, such as less time spent during travelling due to investments and improvements in highly efficient public transportation systems and the minimisation of congestion. Advances in technology such as mobile computing are also seen as supporting this trend.

The extent to which these approaches will proliferate globally, and the time-scale necessary, remain to be seen. Some observers have noted that individual cities often develop character and authenticity over time, rather than through urban planning efforts.<sup>30</sup> Existing settlement patterns are also difficult to modify once erected. The high capital cost of new development and the presence of existing infrastructure are likely to slow a shift to more integration between working and living environments. Our panellists point out that the reintegration of living and working environments is primarily an urban phenomenon; those living in rural environments are less likely to benefit from those shifts.

Several of our Delphi panellists feel a reintegration of living environments is unlikely to happen by 2030, as in many countries people are still becoming increasingly mobile today, rather than less so. In developing countries with historically low rates of car ownership, newly emerging middle class consumers may be eager to achieve the status and freedom that owning a car confers; many will continue to join the ranks of car-owners in years to come. Pent-up demand and the lure of the private automobile are thus likely to prevail over thinking about environmental concerns for many seeking greater individual mobility. Another aspect is city housing which is already cost prohibitive for many, so price would be a limiting factor in a wider application of this change. Further, cultural backgrounds strongly influence desired work and home surroundings, so integrating living and working environments may not be equally feasible in all cultures.

### Locally produced products will be preferred by consumers.

The produce department of a conventional grocery store in Europe or the US now offers a complete assortment of tropical or exotic fruit from bananas to mangos to cape gooseberries, while Chinese grocers have added European milk and yoghurts to their selection. Global sourcing has become commonplace, and fruit grown in regions with longer growing seasons may be available year-round, while local produce is sometimes only available seasonably. Consequently, many consumers are barely able to distinguish between “international” and “local” products.

Nevertheless, heightened awareness of sustainability issues have begun to be reflected in purchasing patterns, where some consumers prefer environmentally friendly products, whose supply chain is transparent and can be retraced to the original manufacturer.<sup>31</sup> One example: purchasing food directly from the farmer has regained popularity in recent years. In the US, the number of farmers’ markets has nearly tripled from 1994 to 2008.<sup>32</sup> Reduced transportation of produce means less emissions; these markets also support small-scale farming which often uses fewer pesticides. Shoppers at farmers’ markets are most often driven by a perception of superior quality; however, cost is the other key driver of purchase decisions. If transportation costs rise, locally produced goods may initially achieve some cost advantages over foreign goods. This may decrease with time as reduced competition leads to price increases.

So will supermarket shelves around the world still stock mangos and bananas in 20 years? Will the trend towards local consumption spread to other types of consumer

goods? This seems conceivable for some goods, such as clothing, furniture or toys. At present the group of consumers preferring locally produced products represents a minority in developed societies.

Action by government may support local consumption in the future. The EU has already announced an objective to “promote sustainable consumption and production patterns (SCP)”.<sup>33</sup> Still, the world economy is currently deeply intertwined, and a shift to a trade model based solely on locally produced products would also negatively impact the world’s smallest, poorest and most geographically disadvantaged countries, such as those in Africa and Central Asia.<sup>34</sup> These countries lack the production scale and infrastructure to build local manufacturing industries and attract cheaper transportation services. If developed nations concentrate solely on economic factors in the supply chain, they may neglect social sustainability factors.

Our Delphi panellists raise some additional concerns. They point out that no community will be able to satisfy all of its needs. As they also note, consumer behaviour determines the design of supply chains. Moreover, consumer behaviour will always be influenced by price and quality regardless of the manufacturer. The switch to regional supply chains may be unrealistic considering the current consumerist trend, since developing countries are increasing demanding imported products and are unlikely to return to local sourcing by 2030. Limited consumption to locally available products would represent a dramatic refocusing of consumerist lifestyles.

Despite these constraints, the Delphi panel overall rates this type of shift in consumption behaviours as both a likely and a desirable development that would potentially reduce environmental harm by reducing the need for long-distance transportation. One panellist even describes this type of greater awareness as an “imperative human need” in order to survive in an energy deficient environment.

**If the panellists’ vision becomes reality, different sourcing and production networks will need to be implemented. Infrastructure will also likely become far less centralised. Logistics service providers would return to a regional and domestic focus and limit their activities to local and nearby centres.**

**Consumers exert a greater level of personal influence on the logistics process and actively intervene in last-mile delivery.**

Some manufacturers in the retail and consumer goods industry have already responded to the growing shift towards greater individualism by offering mass customisation, a strategy which allows consumers to tailor many aspects of their product to meet their specific needs. Computer manufacturer Dell is the best-known example of this trend. Dell allows consumers to order directly from the manufacturer and customise which components and software should be included in their desktop or notebook computer. In the T&L sector, a trend towards mass customisation can also be observed.

The logistics supply chain has already achieved high adherence to delivery dates, short delivery times and high flexibility. In some instances consumers are already able to influence the delivery time of goods on order and are getting more involved in the whole delivery process, with most major carriers providing an online package tracking service. In the future customers may not only be able to request a particular time window for delivery, they will also actively intervene in controlling the delivery process of goods by changing or redirecting the route of transport of their deliveries real-time.

Most of our Delphi experts believe that greater personal influence on logistics processes is a likely development. They also see this trend as having a fairly high level of impact on the T&L industry. Allowing consumers some control over the logistics process requires a delicate balancing act in order to avoid endangering the efficiency of the system as a whole. Providers will need to be pro-active in ensuring that consumers are aware of the influence of their choices on the environmental impact of the shipping process and encouraging decisions which also take the overall efficiency of the supply chain into account.

**Allowing consumers to intervene in controlling the delivery process of goods increases the complexity of logistics processes. A highly sophisticated technical infrastructure will be necessary, which may require investments in hard- and software as well as a skilled workforce.**

Offering end-users real-time control over the logistics process without increasing price levels will represent a significant challenge. Difficulties inherent in the process will increase with distance. One expert notes that it is probably unrealistic to exercise personal influence on inter-continental logistics processes. Some experts also note that logistics service providers will need to consider the very high level of investment needed and the relatively small return gained through such implementation.

Overall, there is no clear trend favouring speed or personal influence as a decisive factor in supply chain design. The role of these factors will likely vary substantially for different transport modes.

## Thinking out of the box - Fabbing

The fabber (short form for "digital fabricator") is a "factory in a box" which produces things automatically from digital data. Fabbers generate three-dimensional, solid objects that can be used as models, prototypes or delivered products. The production method, also known as additive manufacturing or rapid prototyping, accurately creates objects by spraying layer upon layer directly from a three-dimensional computer-aided design (CAD) model. In 2009, the Society of Manufacturing Engineers deemed personal fabrication one of a list of six "Innovations that could change the way you manufacture."<sup>35</sup>

Different three dimensional printers currently on the market use a number of raw materials which range from foundry sand and polyamide plastics to ceramics, cement, starch or paper.<sup>36</sup> Sectors which use a large number of component parts, such as the automotive and aerospace industries, may have the

most potential applications for fabbing technologies. One expert estimates that the market for additive manufacturing had already reached nearly \$1.2 billion in 2008.<sup>37</sup> Some of the primary users of current systems may be manufacturers using fabbers as a supplement to other production techniques.

Today's 3D printers are out of the price range of most end-users, but the Fab@Home project is already actively working on a flexible, inexpensive fabber that will use multiple raw materials and "democratise innovation."<sup>38</sup> By 2030, the fabber may be as standard a peripheral device of home computers as scanners and printers today, allowing consumers to produce simple items and spare parts at home.

Even if fabbing does not displace traditional manufacturing to a significant extent, it may become an important niche market. New "fabbing supply chains" may develop around raw materials and reverse logistics. Smaller quantities of raw materials would be transported to larger numbers of decentralised production sites (possibly even households). Transportation of parts and finished goods would decrease, while the reverse logistics for fabbed products would open up a new area of logistics activity. For some this may appear like dreams of the future, but logistics companies of today should take note.

## Section 3

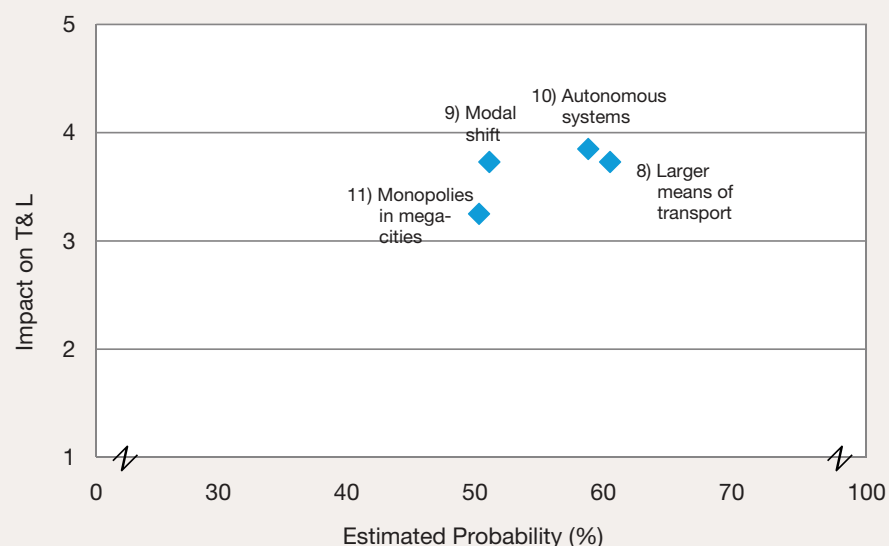
# Drivers in transport modes

Transport modes have seen a number of advances, from the introduction of larger aircraft and vessels, to the broadening of the use of automated guided vehicles systems (AGV) from intralogistics to wider application beyond the factory gate, e.g. in airports or undergrounds. Transport modes often operate in competition with one another, and how to achieve the "right" balance between various modes has become the subject of heated debates in some countries, infrastructure bottlenecks are emerging which impede growth, such as extreme congestion in mega-cities.

Without doubt, transport modes will continue to change in the future to address these issues. But will the changes represent an evolution or a revolution? Will regulation attempt to improve the situation in mega-cities or alter the modal split?

Our panellists view two developments as fairly likely in the area of freight transport. They believe that larger means of transport will become more prevalent as a way of compensating for rising transportation costs. They also see revolutionary potential, as autonomous and self-controlled systems may change the face of freight transport in a more

**Figure 5**  
Delphi results  
of drivers in  
transport modes



### Theses

- 8) 2030: Larger means of transport (gigaliner trucks, ultra-large container ships) have become prevalent in order to compensate for rising transportation costs.  
**Delphi Results** Probability: 60 % • Impact: 3.7 • Desirability: 3.1
- 9) 2030: The debate over modal shift is obsolete. The share of road transportation in the modal split has further increased.  
**Delphi Results** Probability: 50 % • Impact: 3.7 • Desirability: 2.4
- 10) 2030: Autonomous and self-controlled systems (agent systems, automatic guided vehicles) have revolutionised freight transport.  
**Delphi Results** Probability: 58 % • Impact: 3.9 • Desirability: 3.7
- 11) 2030: In order to cope with infrastructural bottlenecks, service providers control monopolies for deliveries and waste of disposal of entire districts within large megacities.  
**Delphi Results** Probability: 50 % • Impact: 3.3 • Desirability: 2.7

Please find detailed information and explanation about the Delphi methodology as well as the parameters probability, impact and desirability on p. 55ff.

fundamental way. Local monopolies as a way to manage infrastructural bottlenecks in mega and large cities are seen as uncertain and highly undesirable. A further modal shift towards road transportation is also seen as an undesirable outcome. Here, again, the panellists rate probability as fairly uncertain, although the potential impact of such a shift would be substantial.

### Larger means of transport may increase in prevalence, necessitating significant infrastructure investment.

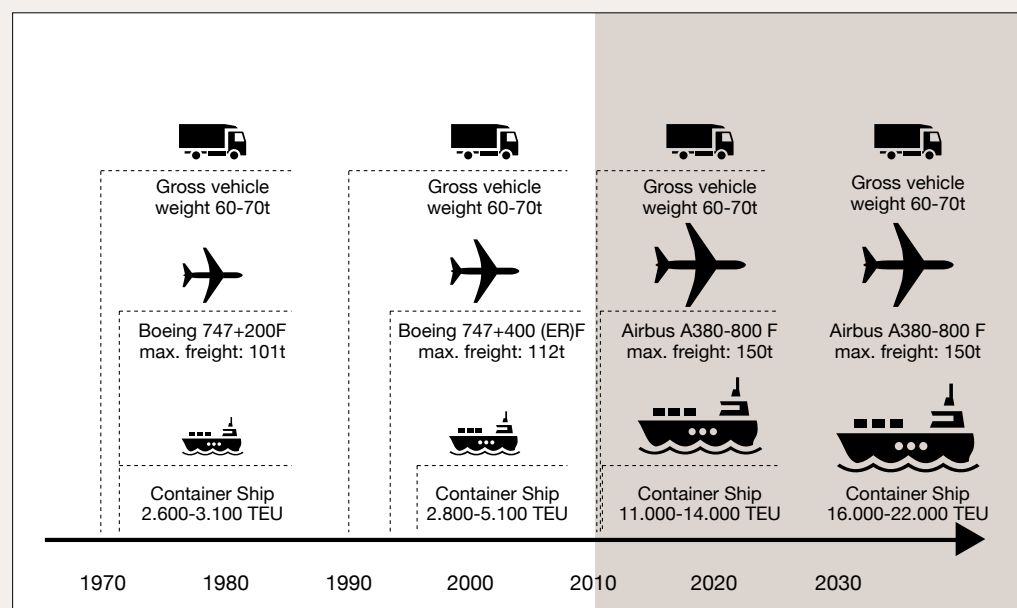
The increase in size of transport means has helped cope with the growing demand for transport capacity in recent decades, but has also caused some to question when the natural size limits will be reached.

In road transportation, the advent of mega trucks, categorised as LHV (longer and heavier vehicles), has generated substantial controversy. Regulations around these vehicles vary; in the US and Europe (except Sweden and Finland) trucks travelling on motorways are generally limited to 40 tons, meaning that mega trucks (60t) are essentially not permitted. In Canada and Australia, though, LHVs are allowed up to approx. 70 net tons. Mega trucks would theoretically consume less fuel per palette of goods transported than do

standard 40t trucks, and could potentially offer energy and cost-saving benefits.<sup>39</sup> Detractors argue that any benefit in fuel consumption will only be realised if the trucks are fully utilised; an unlikely situation given the current 64 percent utilisation rate of standard trucks.<sup>40</sup> They also see mega trucks as exerting a negative influence on efforts to promote use of more environmentally-friendly transport modes and as a threat to infrastructure capacities.<sup>41</sup> Mega trucks could even intensify the modal shift from rail and inland water to road, thus negatively influencing the overall environmental impact of transport. Arguments have also been raised around the safety of such vehicles, since accidents involving them may become more serious.

The theory that "bigger is better" has entered into other modes of transport as well. In the ship building segment, ultra large container vessels (ULCV) have begun to make in-roads into the container market. In 2009, the first 13,800 TEU vessel was launched; according to the Wall Street Journal, up to 200 such vessels may hit the waves by 2013.<sup>42</sup> Shipbuilders already have plans ready for 16,000 TEU and 22,000 TEU mega-carriers; its designers argue the latter could save transportation costs per transported TEU by up to 40 percent.<sup>43</sup> Bigger vessels are more vulnerable to a downturn in global trade since they have much higher cash break even points. Investment in such vessels will, therefore, depend on

**Figure 6**  
Historical  
development of  
different transport  
modes



whether they are economically viable. As with mega-trucks, a high utilisation rate will be necessary to gain the estimated benefits. On its maiden voyage, the first 13,800 TEU tankers sailed with a full cargo – but only after offering discounted rates. The ability of ULCVs to approach certain key ports and the supporting terminals is also key to their achieving greater acceptance. Safety is another key concern and classification societies will need to set new rules for such vessels.

Very large aircraft (VLA), defined as planes with seating for more than 400 passengers, have also entered the aviation scene. A number of factors have contributed to the development of such aircraft, including concentrated and constantly increasing demand for air travel, high load factors, growing congestion, rising fuel prices and greater environmental sensitivities. Airbus' 21st century flagship A380 is the largest example, although Boeing's 747-8 also falls into this category. Airbus and Boeing differ in their expectations for the total market for such aircraft; Airbus' most recent forecast predicts 1283 VLA by 2026, whereas Boeing expects just 740 VLAs in the next 20 years, a notable drop from 960+ in its previous forecast.<sup>44 45</sup> The future viability of such aircrafts will depend on airport development and capacity utilisation, both which are currently limiting factors on aircraft size. Given the recent quantum leap (A380) and the need to refinance any R&D investment, combined with the current decline in aircraft demand, it appears unlikely that aircraft manufacturers will invest in the development of any still larger aircraft for launch before 2030.

Overall, our Delphi experts view a greater prevalence of larger means of transport as a valid lever to compensate for rising transportation costs and realising greater economies of scale, although they note that larger means of transport are also subject to certain limitations, i.e. infrastructure, natural or markets constraints. As one expert notes, in emerging countries like India, infrastructural inadequacies will militate against this trend, since their road infrastructure and ports already struggle with the current sizes of transport modes. Other experts mention physical restrictions such as the Strait of Malacca, the Panama and Suez canal which represent natural limits to the size of container ships. Our panel also mentions some constraints regarding the markets and segments which may be impacted, i.e. these are suitable only for long haul routes but not last-mile distribution. Some markets may require greater frequency rather than larger capacity, meaning that such transport modes will not be suitable. One example cited: the A380 was built to satisfy specific high density markets, however some airlines have changed strategy and are now planning to use more frequent service with smaller aircraft to serve some of these destinations.

Many of our experts see the implementation of larger means of transport as having a major impact on transportation and logistics. Seen through their eyes, transport costs will lower, and new capital will be deployed in transport infrastructure. The architecture of transportation networks will also change in response to these ultra-large transport modes; more bundling efforts will be required, and the modal split may also be altered.

## Thinking out of the box – Nanotechnology

Nanotechnology is one of the key technologies of the 21st century which benefits from knowledge acquired in numerous natural sciences and technical disciplines. It has the potential to impact a wide range of business processes in almost every industrial sector and could soon play an integral role in the packaging industry, textile sector, electronic and optical industry, or in health care. Nanotechnology may help deliver innovation in a wide range of products, from new types of pharmaceuticals to water-proof textiles or wrinkle-reducing cosmetics.

Manufacturing at this ultra-small scale allows for the creation of products with unique and novel characteristics which cannot be realised with conventional technologies. These new materials could have a significant impact on future supply chains. Nanotechnology will make stronger packing materials possible, and also potentially provide superior insulation and protection from chemical or UV effects. This may help improve the cost profile of transporting some types of goods, as the amount of damage incurred during the shipping process can be substantially reduced.

Furthermore, nanotechnology enables the creation of ultra-light materials for any imaginable application area. This may lead to decreased weight for a wide variety of products and correspondingly lower energy costs during the transport process. Nanotechnology may also help engines consume significantly less fuel. Further, some researchers believe that nanotechnology will play a major contribution to the development of fuel cell technologies.

Advances in nanotechnology are also expected to reduce the number of required material for information

and communication technologies (ICT). Components of ICT and other products may become more powerful and smaller. Consequently, a significant reduction in the size of existing products would mean a drop in transportation requirements and warehousing needs.

Nanotechnology may also play a role in achieving real-time control of the supply chain. Nanoelectromechanical Systems (NEMS) may be the next generation of sensors on products and goods. These sophisticated tracking devices are capable of recording temperature and condition throughout the entire logistics chain and calling for action if any disruptions occur.

### Issues regarding operational flexibility and investment complicate a switch to more energy-efficient transport modes.

The on-going debate over the best balance between various modes of transportation has emerged with new intensity in recent years, as energy resources have become scarcer and the need to realise energy efficiency more urgent. Consumer demands for "greener transportation" are also playing a role in the discussions.

Rail and inland water transportation are generally viewed as more sustainable than road transport. While both means of transport outperform road transportation with regards to energy efficiency, the indisputable advantage of road transport is its unbeaten flexibility. While road transport has grown significantly over the past several decades, infrastructure and capacity bottlenecks set limitations on future growth in some areas.

Some governments are already taking action to promote rail transport. Different rail stakeholders have signed a common strategy for the European rail network in order to create "a single European railway system by 2020".<sup>46</sup> While the agreement addresses some historical hurdles to inter-company collaboration, achieving its goals will require significant investment in infrastructure and whether governments will have the capacity and willingness to fund improvements remains to be seen. In the US, \$9.3 billion of the \$787 billion stimulus package has been earmarked for improvements in the country's rail system, however much of this investment pool will be directed towards passenger rail.<sup>47</sup>

Inland water transportation is regarded as reliable, secure, relatively environmentally-friendly and underused. It is ideal for the carriage of heavy low-cost commodities over long distances. Following the enlargements of the European Union, this mode could do much to relieve traffic on east-west routes. Nonetheless, investment policies have given priority to road transportation in Eastern Europe and governments have supported and funded their expansion.

There is little agreement amongst industry sources, or our expert panel, as to whether a widespread modal shift to road transportation can be expected. In Germany, forecasts predict only a slight change in the current modal split by 2030, with road transportation expected to average 82 percent.<sup>48</sup> Overall, our Delphi experts evaluate an increase in the share of road transportation as undesirable.

Any discussion of the modal split of transport needs to take into account regional disparities as a consequence of topographical differences and historic development of transport and infrastructure. The extent to which a modal shift can take place depends on the availability of infrastructure required for the specific transport mode. For example, the EU and US have developed much more extensive railway networks over time than exist in China. However China has a more extensive network of navigable rivers, canals, and other inland bodies of water.<sup>49</sup> The feasibility of a shift between modes will need to take into account the existing infrastructure and level of investment necessary to accomplish far-reaching change.

Insufficient investment in energy-efficient transport modes and the operational flexibility of road transport will hinder a significant shift in the modal split and road transportation is likely to hold the major share in the pie.

### Autonomous transportation systems will support speed, accuracy and better use of infrastructure.

Autonomous, driverless transportation systems have the potential to equip future transport modes with the ability to safely navigate in different environments and transport people and goods without the use of a human driver. Extensive research in this area is already underway, and pilot projects are in place. Automatically guided vehicles and driverless park shuttle systems at airports use existing technologies in order to enable driverless transportation. Such systems may use a navigation system combining the use of lasers, odometry via magnets, and ultrasonic sensors to navigate driverless vehicles, for example around a loop connecting long-term parking to the main airport.<sup>50</sup>

Comprehensive application of such systems could be hindered by high investment costs, but extensive research is already ongoing. For example, the "Citymobil" project provides a vision of an integrated automated transport system for an urban environment.<sup>51</sup> Autonomous systems need not be used in isolation. Dual-mode transit such as the use of monorails equipped with docking stations for cars and automated magnet-equipped highway systems are also being researched.

The "CargoCaps" project provides an innovative concept for an automated transportation system designed specifically to carry freight. Each cap is designed to transport two Euro-pallets in underground pipelines.<sup>52</sup> The caps would provide the potential for 24-hour, automated delivery of freight and could help minimise road congestion in crowded urban areas.

Our Delphi panel regards a proliferation of autonomous transport systems as fairly likely. Given the progress already being made, anticipated improvements in IT, and significant further investment, these types of systems may become the "state-of-the-art" for many forms of transport by 2030. Some experts are extremely positive about the potential – one expert points out that since not all possibilities and implications of this technology have been explored, an entrepreneurial rush to use these approaches might lead to a revolution like the Internet did.

However, before the vision can become reality, a number of hurdles need to be overcome. For example, under current laws, the liability for driverless vehicles is unclear, and official safety standards have yet to be released.<sup>53</sup> Some of our experts see this aspect as a major issue, noting that risk of having driverless vehicles is too high, and that service and specifics of the industry will always require a human intervention.

Additionally, autonomous transport requires modern transport infrastructure and closed-loop supply chains, which limit its applicability. The efficiency and reliability of such systems has also yet to be confirmed. A number of experts express concerns around the costs of such systems. As one panellist notes, the cost of developing systems and implementation should be lower than costs of fees, commissions, losses, damages, theft, security, customs, and it must prove to be more efficient and reliable.

In essence, many experts see such a trend as desirable, given that it potentially improves speed and accuracy, while

also making better use of infrastructure and potentially reducing congestion.

### Monopolies for urban deliveries do not look to be a likely or desired means for administrations to reduce logistics bottlenecks.

As already noted, there is a clear global trend towards urbanisation. The number of so-called megacities, whose total population exceeds 10 million people, will increase to 27 cities by 2025, with almost 10 percent of the world's population living in such urban environments.<sup>54</sup> This trend is especially apparent in Asian and South American countries, where two-thirds of all worldwide megacities are currently located. Projections indicate that more than 500 million Asians will move to cities in the next 25 years, which represents a flow of about 2 million people per month.<sup>55</sup>

In the developing world, megacities often grow faster than their infrastructure and without a clearly defined zoning direction. This uncontrolled urban sprawl fosters higher traffic volumes, and thereby increasing pollution and emissions as well as the development of social disparities. The massive scale of megacities means that logistics processes need to be carefully organised and coordinated in order to cope with infrastructural bottlenecks in a cost-efficient and sustainable manner. Unfortunately, public authorities that often have to provide oversight for intra-urban freight transport are frequently not designed to control and optimise transportation structures, particularly for the huge scale that these cities have attained.<sup>56</sup> Central development, planning and implementation of megacities' logistics are often impossible, since budgets are inadequate.

If the number of active logistics service providers in megacities is not governmentally limited, logistics service providers face severe limitations in their efforts to supply megacities efficiently. While each supplier may be able to optimise his own distribution structures to a certain extent, the overall solution for the megacity as a whole is likely to remain suboptimal.

The difficulties inherent in providing logistics services to megacities represent a greater incentive to develop new transport concepts or modes, particularly if they are able to integrate different means of transport and solve the problem of the "last mile." The use of autonomous transport means such as those discussed in the previous section may be one promising direction for cargo transport in megacities.

Another possible solution to cope with the logistics challenges in megacities could be for public authorities to grant monopolies to urban logistics providers, delivering in pre-defined districts within large and megacities. Monopolies would organise and clearly define supply areas in megacities, similar to the provision of waste disposal, which already relies on service provider monopolies. Obtaining a monopoly would additionally provide an incentive to invest in transport equipment and even infrastructure.

Our Delphi experts assess the advent of such monopolies as uncertain. Most do not see monopolies as a desirable solution for organising city logistics. In a market economy, free competition is given preference to monopolies. Some of

the panellists mention the prevalent concern that monopolies are vulnerable to corruption and inefficiency, and that they eliminate the freedom of choice and could lead to higher prices for consumers. They also drew comparisons with current monopolies, such as energy companies, which they do not see as providing any true advantages, while still requiring high levels of oversight from governments and administrations. One expert points out that this oversight could only be effectively achieved in situations where the government is already involved in the management of the relevant provider. The implementation of this city logistics system would therefore not free governments from the burden of overseeing intra-urban freight transport.

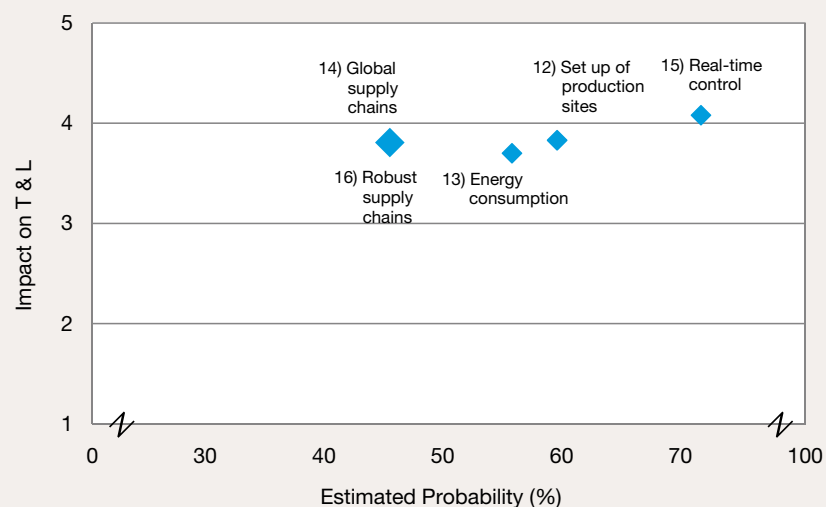
## Section 4

# Design of future supply chains

The logistics industry provides the backbone of global supply chains. In recent years, more widely dispersed and global supply chains have evolved in many industries, often due to substantial cost advantages obtained via "low-cost country sourcing". The complexity of these networks raises serious risk issues, both in terms of the possible impact of external shocks such as natural disasters, and the difficulty of maintaining adequate oversight around movements of goods and components around the world.

Our Delphi experts believe that supply chains will continue to become more efficient through the development of continuous real-time control of the flow of goods; this thesis receives the highest overall probability rating of any in our survey. The trend towards real-time control is expected to have a strong, positive impact on the industry, with high ratings on both probability and desirability scales. Unfortunately it won't result in supply chains that are resistant to external shocks. Most of our experts rate such

**Figure 7**  
Delphi results of  
design of future  
supply chains



### Theses

- 12) 2030: The reduction of transportation costs has become the predominant criterion in determining where to set up production sites.  
**Delphi Results** Probability: 59 % • Impact: 3.8 • Desirability: 3.3
- 13) 2030: The minimisation of energy consumption is the paramount criterion in supply chain design, rather than cost efficiency and speed.  
**Delphi Results** Probability: 55 % • Impact: 3.7 • Desirability: 3.7
- 14) 2030: Global trade and transport only exist for valuable, time-critical or specialised goods. Local procurement, manufacturing and distribution dominate the commodity market.  
**Delphi Results** Probability: 45 % • Impact: 3.9 • Desirability: 3.0
- 15) 2030: Continuous real-time control of the flow of goods eliminates disturbances in the supply chain and thereby significantly increases resource efficiency.  
**Delphi Results** Probability: 71 % • Impact: 4.0 • Desirability: 4.3
- 16) 2030: The logistics world has developed solutions to design flexible and robust supply chains that are resistant to external shocks.  
**Delphi Results** Probability: 45 % • Impact: 3.8 • Desirability: 4.5

Please find detailed information and explanation about the Delphi methodology as well as the parameters probability, impact and desirability on p. 55ff.

an eventuality as fairly uncertain. Two other trends also look to be fairly likely: transportation costs will be a predominant criterion in determining where to set up production sites, and the minimisation of energy consumption will be a paramount criterion in overall supply chain design, rather than cost efficiency and speed.

These trends will not result in purely local supply chains, though. Our panel results suggest that a shift to using global procurement only for valuable, time-critical or specialised goods is fairly unlikely; such a development is also not seen as particularly desirable.

**Decisions where to set up production sites will increasingly be influenced by transport costs. This will, however, not lead to a trend of 'de-globalisation'.**

Many companies are not sourcing as profitably in emerging countries as might be hoped; some actually experience losses during the purchasing process.<sup>57</sup> In many cases, increased logistics costs offset any price advantages on the goods obtained. Despite improved infrastructure and increasing competition, logistics costs in China and other emerging markets are likely to continue to increase.

Some companies are already very aware of the challenges. PricewaterhouseCoopers' study of the retail and consumer (R&C) industry, *Global sourcing: Shifting strategies*, showed that many R&C companies see transport and logistics issues as a significant challenge to cost-effectiveness. Overall 75 percent of all respondents saw increasing fuel costs as a major barrier to achieving incremental cost savings from their global sourcing programme in the next five years. Around two-thirds also believe that transportation mode congestion will have a negative impact on the bottom line.

Efficient supply chain design will not necessarily mean a solely local or regional supply chain, though. Another strategy could be increasing the number of regional distribution centres, to reduce the overall distances goods need to travel to reach end-users and thus cope with higher transportation costs.<sup>58</sup> Whether or not regional supply chains are going to prevail will depend on a number of factors that may vary by market segment. The need to ensure that suppliers achieve quality standards and to monitor their reliability and stability may prompt some manufacturers to 'go local' (see Spotlight on Automotive on page 34f. *Detangling the complex web*). On the other hand, as long as the cost advantages effectuated by offshoring production to low-cost countries dominate, global supply chains will continue to be in place. Wage

disparities between regions will probably diminish over the coming decades, so regional supply chains are likely to gain importance.

**Logistics service providers should observe how the sourcing strategies of manufacturing companies evolve over the years. Whatever strategies manufacturers use to manage their sourcing costs, it is clear that improving efficiency and reducing the cost of global sourcing by reconsidering the location of production sites – whether from emerging or developed markets – will be a key challenge to achieving global competitiveness in the future.**

We asked our experts to evaluate whether global trade and transport are likely to exist only for valuable, time-critical, or specialised goods, while commodity markets will be dominated by local procurement, manufacturing and distribution. The answer: probably not. Only 45 percent consider this as a likely event, and most also do not rate it as particularly desirable.

We also asked if the reduction of transport costs would be the primary criterion for locating production sites in 2030. The answer here differed. Our experts see this as fairly likely, although they are also not convinced that such an emphasis would have a positive effect on the industry. Our experts do note that if such a shift occurred, it would likely have the largest impact on rail and road. Decisions around the location of supply chain nodes could have significant impacts on the transportation and logistics industry more generally.

**The minimisation of energy consumption will become a paramount criterion in supply chain design, together with total costs and the speed of delivery.**

Historically, minimising energy consumption has not universally been seen as a paramount criterion in supply chain design. The oil price shocks seen in early 2008 brought the issue into the foreground for many industries, however, questions remain around how best to design a truly energy-efficient supply chain.

One option: to slow down. The shipping industry is taking a close look at "slow steaming", and in some cases speed limits have been imposed in the world's shipping lanes.<sup>59</sup> A study by Maersk showed that substantially reducing engine load was a viable option to reduce costs. Container ships travelling at half speed could significantly reduce fuel costs and CO<sub>2</sub> emissions. Maersk subsequently began utilising slow steaming; the company reports being able to select any given speed down to 10 percent engine load, enabling

a more flexible voyage and schedule planning, as well as vessel savings amounting to 10-30 percent fuel and CO<sub>2</sub>.<sup>60</sup> Slow steaming does have some limitations, though. Longer transit times may not be acceptable for perishable or time-sensitive cargo. Further, main engine maintenance and the risk of main engine casualty may increase.<sup>61</sup>

Some airlines are also slowing down to save on fuel costs. Often flying slightly slower can decrease fuel burn, while adding only incrementally to the duration of a flight. The savings per flight are relatively modest, but they can add up to significant savings when implemented consistently.<sup>62</sup> Many companies in the parcel delivery segment also offer options based on the speed of delivery. Customers willing to prioritise price over speed may select ground delivery over air, for example, although here cost is generally the driver, rather than improved fuel efficiency or emission reduction.

Our Delphi experts rate a prioritisation of energy consumption as a paramount criterion in supply chain design as somewhat uncertain, although this is one measure where the panel average does not represent a consensus. Opinions vary widely. Some experts feel that a concern for energy consumption is unlikely to override concerns around overall cost efficiency and speed, even if fossil fuel prices rise sharply or regulations make energy consumption more costly. Others see an effort to minimise energy consumption as part of a shift towards greater sustainability. As one expert optimistically put it, efficiency, effectiveness and sustainability can be improved simultaneously in cases of collaboration along the supply chain.

Consumer demand may play a part here as well, as consumers look for goods which have not "wasted" energy. One expert argues that "logistics is about how the whole set of criteria interacts", a view echoed by several other panellists.

**One point seems clear – most companies will look to reduce energy consumption and the cost thereof. Logistics service providers will need to balance energy efficiency together with speed to support supply chains which take into account both factors, as well as other cost concerns such as access to raw materials and labour.**

**Continuous real-time control of the flows of goods eliminates disturbances in the supply chain.**

Improved technology has already led to substantial improvements in real-time monitoring of the flow of goods. Tracking and tracing systems allow an exact view of location of different products, be they at the supplier, distributor,

salesman, or already delivered to the end-customer. Supply chain technology applications that enable shipment and equipment tracking increase supply chain visibility, facilitate inter-organisational information sharing and also enhance security. For example, global positioning systems (GPS) enable detection of unplanned stops in transit, which can help pinpoint en route tampering with shipments and vehicle departures from pre-designated routes (e.g. "geo-fencing").<sup>63</sup> Such systems can also help avoid delays in the production process or delayed deliveries by providing information on the status of components.

During the delivery process, sophisticated sensors can provide detailed information on a wide range of parameters such as temperature, humidity and brightness. Some "smart" containers can also detect whether a shock has been received. RFID provides a new technology to receive, store and forward corresponding information. Hence, decision makers receive a broad picture about the condition and location of individual goods as well as components across the entire supply chain.

Real-time control systems are also playing an increasingly important role in ensuring higher levels of security. Shippers and logistics vendors are working together with governmental authorities to develop and apply better technologies for inspecting shipments. Radiation and chemical detection sensors and improved x-ray technologies can increase both the speed and accuracy of inspections.<sup>64</sup>

**Logistics service providers with sophisticated tracking and tracing systems may also be able to employ these to speed the process of adhering to government-mandated security measures. Customs authorities in the European Union are moving towards systems controls instead of physical controls of cargo, if the logistics service provider is an Authorized Economic Operator (AEO). This shift creates significant advantages both in terms of time and cost, as bottlenecks can be avoided.**

Our Delphi experts view achieving real-time control of the logistics process as a viable goal. The panel discussions for this projection lead to the highest probability rating of 71 percent. Real-time control is also seen as having a significant positive impact on the sector, with experts giving it high marks both for impact and desirability. Technology will permit strong oversight, thereby facilitating early communication and resolution of any disruptions that may occur. Inaccurate deliveries are one common disturbance in the supply chain and can cause significant additional costs; these may be reduced through new tracking mechanisms. Other

disturbances to the supply chain such as incorrect storage or expired products can also be managed more effectively, as real-time control systems allow logistics managers to take appropriate counter measures more quickly. Further, by gaining a more comprehensive understanding of how and why disturbances arise, companies may be able to fine-tune the supply chain to avoid future incidents.

Understanding the flow of goods within a supply chain depends upon accurate knowledge of various time points along the chain. In many cases, data information is not reproduced correctly, since the data's integrity depends on various suppliers which do not always comply with the same quality criteria.<sup>65</sup> Our Delphi experts assert that real-time control will enhance the ability to use data and convert it to useful information, thus helping to improve information exchange between supply chain partners.

**Real-time control systems enable logistics service providers and their customers to monitor and control many business processes through Internet interfaces. So-called "Ubiquitous computing" will be an important part of real-time control and of the entire logistics future.**

The term "Internet of things" is increasingly being used to describe the vision of a decentralised, autonomous organisation of intelligent logistics objects in service-oriented environments. Logistics data would be stored on RFID tags attached to the goods to be conveyed, which means all required information for logistics decision-making is 'on the ground'. Currently, software and machinery manage the processes to transport and store things – in the future, the objects themselves are likely to provide direction to these systems. Tagged suitcases will direct their own path through the transportation net of an airport. Such systems will also help to optimise the flow of consumer goods from the warehouse to the point of sale by providing real-time, transparent access to customer demand.

Strong information technology systems are therefore increasingly a core competence to ensure competitiveness. Our experts are convinced that by pairing advanced information technologies with intelligent transport systems, companies can improve transport efficiency, resulting in significant savings and higher margins enabling faster processes, higher flexibility, better service levels, and better communication. Real-time control systems will also allow logistics providers to offer higher levels of customer service.

**Supply chains will not be totally immune to external shocks, so a high level of flexibility and adaptability will be key.**

External shocks such as wars, terrorist attacks, natural disasters, or pandemic outbreaks can have enormous impacts on supply chains.

In the shipping sector, piracy represents a significant external shock to the global supply chain which puts economic pressure on shipping companies and their consigners. According to the results of a recent PwC survey, every fifth German shipping company has already been the victim of piracy.<sup>66</sup> Well-publicised hijackings suggest the problem is not confined to German shipping companies.<sup>67</sup> Increased insurance rates and longer routes are the result. In recent years the impact of natural disasters on the supply chain has also been made vividly clear. When Hurricane Katrina hit New Orleans in 2005, it had a massive impact on supply chains. Five major ports in the Mississippi River Basin with an annual volume of more than 450 million tons of cargo had to halt operations.<sup>68</sup> Roads and rail infrastructure were also damaged, and barge freight disruptions meant that many incoming deliveries needed to be rerouted. When Hurricanes Ike and Gustav hit the Gulf in 2008, the US lost as much as 20 percent of its oil and gas supply for two weeks, with significant impacts not only at the pump, but also in supply chains of diverse industries, such as chemical companies dependent on Gulf oil for petrochemical production.

Pandemics also have the potential to pose significant challenges to supply chain. When the SARS epidemic shut down many parts of Asia in 2003, the electronics industry around the globe felt the impact. An outbreak of Swine Flu (H1N1) in Mexico spread to a number of other countries in May 2009, raising concerns about a possible pandemic. Supply chain experts quickly warned companies to ensure they had contingency plans in place to deal with possible resulting disruptions.<sup>69</sup>

According to our expert panel, designing supply chains which are flexible and robust enough to endure every possible shock is an unrealistic goal. Remarks from panellists suggest that no supply chain can anticipate every possible shock.

The importance of striving towards a flexible, agile supply chain is underscored, though, by our experts' high ranking of the desirability of this thesis. The speed and severity of the economic downturn in the latter half of 2008 also highlighted the importance of having flexible and robust supply chains. In many industries, demand dropped precipitously. Traditional supply chain planning activities rely purely on the examination of historical patterns of demand to determine production level, raw-material purchases, transport capacity, and further important factors. Such systems are often ill-equipped to manage unanticipated drops in demand; in some

cases a severe external shock might result in bankruptcy. As our Delphi respondents note, longer and more global supply chains are especially at risk. Supply chains which are able to respond more quickly to changes in demand, or "pull" rather than "push" inventory and parts, stand a better chance of withstanding severe shocks.

One way to achieve more robust and flexible supply chains may be an increased level of information sharing and collective decision making amongst autonomous supply chain partners. If supply chain partners exchange their knowledge more intensively, it may be possible to achieve superior operational performance in terms of flexibility in supply chains.

**Planning for the worst is crucial. Implementing an existing plan is generally far more effective than scrambling to react to a crisis, so devising scenarios around various contingencies makes good sense.**

While in some countries cultural barriers to scenario thinking exist, devising such plans can be critical to maintaining operations in the face of a severe external shock. There will be many solutions – at least theoretical ones – however one expert expresses the central question whether a company can identify which solution is best applicable to their specific situation.

## Spotlight on Automotive: Detangling the Complex Web

### Why logistics are vital to the Automotive industry

Automotive supply chain networks are extremely complex systems. Original equipment manufacturers (OEMs) assemble vehicles composed of numerous subassemblies (brakes, transmission, power train, etc.). Some of these systems are produced by Tier 1 suppliers, who in turn often rely on Tier 2 suppliers to supply parts or components. Automotive production lines represent huge fixed costs, so inbound logistics are critical. As an example, just one Ford plant in Michigan, US receives 200 trucks daily from its suppliers. Deliveries from Europe make up only 5% of materials received, but that still means five to eight forty-foot containers per day. Multiply this by nearly 600 plants across the world, with varying requirements, and you begin to have a sense of why logistics are important for the sector.

Even with the current economic downturn, around 55,000,000 light vehicles are forecast to be shipped in 2009. Many of these will travel long distances over sea, road or rail, so ensuring that vehicles make it to their final purchaser on-time and undamaged presents a substantial task for outbound automotive logistics. Finally, cars require consistent maintenance over the life of the vehicle, including a reliable supply of spare parts, so aftermarket logistics pose an additional challenge.

### "Build where you sell" - Regionalisation will be the long-term driver for T&L companies active in the automotive industry

Transportation costs have long been an important criterion in site location for OEMs. The oft-quote maxim "build where you sell" will probably remain a key factor in determining the location of production sites in the future. In practical terms, North America and Western Europe are already mature automotive markets; growth will continue to come primarily from emerging markets such as Russia and East Asia. These regions are therefore also likely to be the primary locations for new assembly plants. Car-makers looking to market vehicles in such growth markets will need to assemble vehicles in those regions and establish long-term relationships with local suppliers or global suppliers who have established a local presence. Within a given region, governments may play a significant role in determining where production sites are located. Local or federal authorities may seek to protect existing manufacturing capacity over the short- to medium term, particular in light of the multiplier effect that automotive production plays on overall GDP growth. Tariffs could also have a strong impact on trade flows.

However, overall carbon footprint of vehicle production may become an even stronger driver, as the world shifts to a low-carbon economy. Only a few OEMs already report making a concerted effort to reduce the carbon footprint of vehicles, however growing pressure to make this information transparent should result in a more general emphasis on getting vehicles from factory to garage as efficiently as possible.

### Getting the supply chain up to speed

Speed and cost efficiency are already critical in the automotive supply chain, and these will continue to be taken for granted. Many auto manufacturers currently

achieve speed by constructing extensive supplier parks proximate to manufacturing facilities; these are likely to continue to be important in the future. Suppliers will also be expected to collaborate on design and R&D; this will promote risk sharing and speed up the development timeline on new vehicles. It will also make solid supply chain risk management even more critical, as supplier failures would potentially impact not only production, but also the development of new vehicles. OEMs and first-tier suppliers of the future will need to assess and monitor the financial stability of their entire network of suppliers. While such oversight is already critical, it may prove challenging when operating in far-away markets; collaborations such as joint ventures and strategic alliances will be necessary to ensure smooth technology transfer.

### Third party logistics providers may help add flexibility to the supply chain

Third party logistics providers specialised in the automotive industry handle a large portion of the flow of parts and vehicles. Within the industry, there is a split between companies which see logistics as integrally linked to control of the supply chain, and part of their own core competence, and those who prefer to outsource the logistics function. Outsourcing some activities to third-party logistics concerns can be one way of adding greater flexibility to the supply chain. For example, a third-party provider may be able to access an additional supplier network in the case of a severe shock impacting one or two key suppliers. Given that carmakers are already grappling with a wide variety of issues around the design, engineering, marketing and manufacture of automobiles, it looks likely that more may choose to see the logistics function as non-core activity which may be better served by third-party providers.

### New products, technologies and players

If high energy prices and the need to lower carbon emissions spur the industry to undergo a true paradigm shift and the majority of vehicles are based on alternative power trains, pure electric vehicle (PEV) models, and/or fuel cell technologies, we may see the emergence of new manufacturing locations where the enabling technologies emerge. Some of the first PEVs expected to hit the market in 2009 and 2010 will be produced not by traditional OEMs, but by smaller design houses. These may be located in traditional automotive regions

such as Western Europe, but also in emerging countries like China or India, that invest heavily in these new technologies hoping to take a leading position.

### IT as competitive advantage and value add for T&L

Real-time control of the flow of goods will facilitate a continuous dialogue with component suppliers, enhancing the flexibility of the supply chain. This agility will be even more critical in 2030, when most assembly lines will be technologically advanced "smart lines" capable of producing different vehicles on the same platform, or potentially use a module approach to produce a wider variety of vehicles. Ensuring that the right parts are available in sequence will require a high level of transparency throughout all levels of the supply chain and will be absolutely vital to achieving cost efficiency.

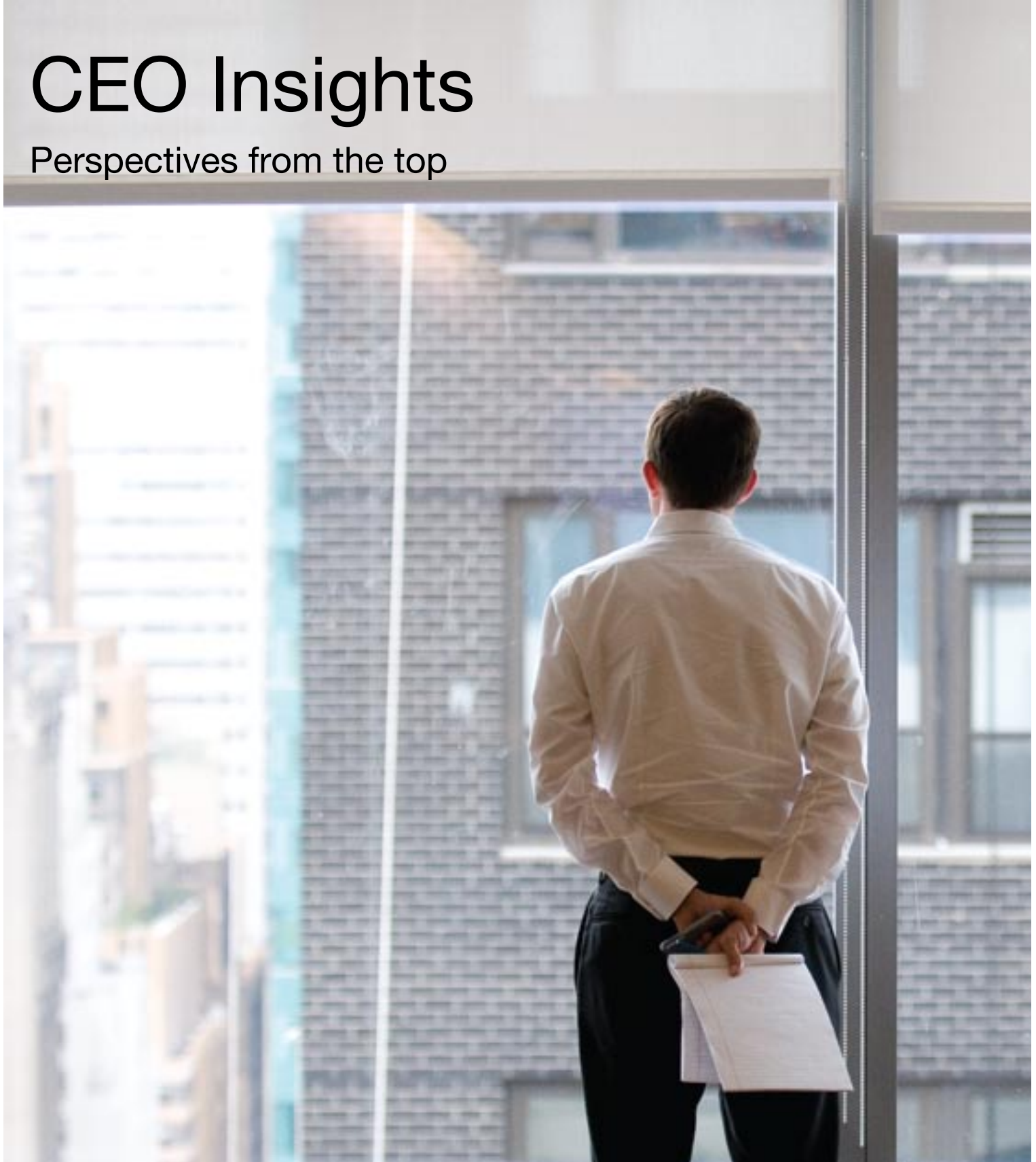
Car-makers are likely to offer greater levels of customisation in vehicles, creating significant complexity. Third party logistics providers may have a role in this process, such as taking over the assembly of C-parts and contributing to the process of end-point customisation.

### Key Takeaways

T&L companies serving the automobile industry will need to adapt to greater regionalisation of production sites and increasing pressure to enhance the carbon footprint of vehicles — including the transport from factory to garage. T&L companies will also need to remain abreast of changes in the industry; significant leaps in technological innovation could lead to a shift in manufacturing processes — or potentially also a decline in transport volumes, if smaller, lighter vehicles become the norm. Logistics service providers supporting the sector can gain significant advantages if they help ensure flexibility, for example by helping keep the line running in the case of a severe external shock at a key supplier. Those who implement cutting edge technological systems with the capability to monitor and adjust the flow of goods in real-time will support the industry's shift towards smarter, more flexible production lines — and in doing so guarantee a significant portion of the industry's logistics spend going forward.

# CEO Insights

Perspectives from the top





**Tom Gorman**  
CEO of CHEP EMEA

*How would you describe the current economic outlook and its likely impact on CHEP Europe in the long-term future?*

I believe that we may have found the bottom, however we are not likely to bounce back too soon. The CHEP business falls mainly into two sectors – fast moving consumer goods (FMCG) and automotive (10 percent of the business). Automotive was down 30 percent by the end of our last fiscal year (June 2009). FMCG also saw a decline, although nowhere near as severe. I continue to be concerned about the current unemployment rate across Europe and, because of this factor, I believe the recovery is more likely to be ‘U’ shaped than ‘V’ shaped. Although I am confident we will grow our business through new customer wins, I expect it will take some time still before “organic” growth returns. CHEP has a strong position in Iberia, UK and Ireland. These economies have been most severely impacted by the reduction in construction and decline in real estate activities and I believe their recovery will be slower.

*Broadly, how are environmental issues affecting CHEP Europe?*

CHEP has five pillars against which performance is measured: growth, cost competitiveness, customer satisfaction/quality, people and sustainability. CHEP’s business model is all about recycling and re-use of pallets. CHEP has historically not been as good as we should have been in presenting our strong environmental proposition to our customers. CHEP’s pallet pooling model, for example, reduces the amount of lumber used to build pallets and the amount that goes to waste/landfills. In addition, all of our timber comes from sustainable resources.

Customers are more conscious of environmental issues and the impact of their business on the environment and in terms of resource utilisation. CHEP has developed an environmental calculator which calculates the environmental benefits of the CHEP pooling model. This is a strong selling tool. We are also growing our Total Pallet Management (TPM) offer with our customers. TPM is an alternative approach to our standard offering whereby CHEP handles, inspects and sorts pallets at a customer facility. The TPM model reduces transportation costs significantly, takes trucks off the road and reduces the carbon footprint.

*Corporate social responsibility and stakeholder management are new challenges and required areas of action for companies today. Our expert panel is largely in agreement that in 2030 the carbon footprint of logistic processes will be allocated to the causer and factored into the price of the products. Some observers see this development as a form of punishment for the causer. Do you agree? Do you think financial incentives are the only way to make corporations take the graveness of environmental risks such as global climate change into account?*

This is a common thought. Reducing the carbon footprint is likely to end up with increased prices, which consumers are more than likely going to have to bear. Financial incentives have more impact on changing behaviour and while I may not think they are the only way to effect change, financial incentives do

sharpen the focus of organisations and drive creativity in terms of looking for more efficient solutions and offsets to the increased costs.

*Our panel of experts almost uniformly agrees that \$1,000 per barrel is an unrealistic oil price and unlikely to occur by 2030. Nonetheless, the transportation & logistics industry's current dependence on oil, and concomitant risk exposure due to price volatility, is unquestionable. What kind of developments, initiatives, or activities do you see in your industry and CHEP to reduce the current and future dependency on oil?*

I agree that \$1,000 per barrel is unrealistic. Although I was surprised how “easily” the rise from \$40 to \$140 per barrel was absorbed by most economies, a 10-fold increase is likely to be quite a different story. To help overcome the risk of higher oil prices, CHEP is focussing on constantly making sure we have our network optimized, developing smaller footprints closer to our customers, and also through further integration with customers (e.g. TPM).

*Will energy efficiency become a more important criterion than speed in supply chains in the future? How do you think this might impact manufacturing industries dependent upon just-in-time or just-in-sequence delivery?*

Yes. I believe as the cost of one input goes up businesses must respond by looking for added efficiencies or trade-offs elsewhere in their business. Energy costs now comprise a larger portion of a business' operating costs and, absent any premium for speed, this may drive people to become more focused on efficiency than speed. At the end of the day economics trumps everything. Management will behave rationally and they are not going to implement anything unless it makes economic sense or they can charge a premium. If energy costs increase, then companies are likely to trade something to compensate.

*We have talked about some potential future developments; there are many other trends that could have an impact in the sector. How do you see transportation and logistics in 2030?*

The key developments have been the shift in optimising logistics vs. manufacturing. Much of our economic growth and industrial development has been based on cheap oil. As a result, the focus has always been on optimising manufacturing and not logistics. With the increase in energy costs, the optimisation of transportation is increasingly becoming important and I see this trend only increasing with time.



**Harry Hohmeister**  
CEO of SWISS  
International Air Lines

*How would you describe the current economic outlook and its likely impact on your business in the long-term future?*

The immediate outlook for the airline industry is fairly bleak, largely due to the impact of the global recession, which is being reflected in a persistent decline in demand. At the beginning of June, the International Air Transport Association (IATA) revised its airline financial forecast for 2009 to a global loss of US\$9 billion. Airlines such as SWISS which depend on business travel and intercontinental travel are more strongly impacted by an economic downturn than players serving single markets.

While there is clearly a strong negative impact on our business from the current economic climate, we still believe strongly in the future of our sector. Globalisation will continue and cannot be reversed, despite the short-term disturbances we are currently seeing. The airline industry has been a growth industry for the last 40 years and it will remain one for the next 40 years. We at SWISS want to play our part in that growth.

SWISS has focused on managing capacity risk, cost and clients in order to weather the current economic conditions and position the company for the future. We practice strict capacity management, rapidly adapting our flight offerings to demand. Cost management is also critical. Since the share of costs beyond our control, such as fuel costs, has significantly increased, it is even more important to improve and optimise the cost structure that we are able to influence. At SWISS we were already concentrating on effective cost management prior to the crisis, helping us to accelerate efficiency gains. Finally, we are building strong relationships with our customers, whose needs are changing constantly, especially in view of demographic shift in certain parts of the world. Controlling capacity and costs and responding to customer needs will create competitive advantages for SWISS and help to position the company for a strong future.

Although we have been practising rigorous cost management and flexibly adapting our capacity in response to the recent downturn in demand, SWISS cannot escape the present storms in the airline sector, and this is reflected in the broadly break-even operating result that we achieved this year so far.

*Broadly, how are environmental issues affecting your business?*

Environmental issues play an important part in our business and are affecting us regardless of the current economic turbulence. Flying an aircraft has an impact on the environment in terms of safety, energy use and noise. We have to deal with these issues and at the end of the day it is always the society as a whole who will have to define how to balance conflicting interests. The main aim for the future will be to improve technology in order to minimise the environmental impact. At the same time, it is indispensable that infrastructural improvements are achieved. In many instances, these will require adequate measures by political bodies. The aim must not only be to reduce present emissions but also to achieve traffic growth in climate-neutral ways.

Fortunately, in the aviation industry there is no conflict of interest: what is good for the environment also makes good economic sense. We have already

made investments in bigger and more fuel efficient airplanes, which have the additional advantage of emitting less noise per passenger. We are also investing in the next generation of airplanes equipped with gear turbo fan engines and new aerodynamic dimensioning, which will reduce the specific fuel consumption and CO<sub>2</sub> emissions by 25 percent.

*Corporate social responsibility and stakeholder management are new challenges and required areas of action for companies today. Our expert panel is largely in agreement that in 2030 the carbon footprint of logistic processes will be allocated to the causer and factored into the price of the products. What do you feel the impact of this shift might be on transportation & logistics?*

I am not sure whether we can really talk about a shift. Successful companies always had to take Corporate Social Responsibility into account in order to be accepted both internally and externally. The carbon footprint is one example of such an endeavour. At SWISS, we have started to lower ours quite some time ago and today, the average fuel consumption of our fleet is around 3.8 litre per person and per 100 kilometre (63 miles per gallon). At the same time, an aircraft is ten times faster than ground transportation. Therefore it seems important to keep in mind that in the future, different modes of transport are not an “either-or” option, but must complement each other in order to meet the different needs of societies. Making consumers aware that driving a car results in twice the emissions of a similar flight would be a positive development. The aviation industry is already focused on improving energy efficiency which automatically means improvements in emissions.

*Whether or not alternative energy will grow to dominate the overall energy mix generated substantial controversy amongst our panel of experts. What is your own view on developments in this area?*

When the world population increases up to 9 billion people, we will need a negative CO<sub>2</sub> household. In my opinion, there are two means to achieving a positive development in terms of a CO<sub>2</sub> neutral climate.

The first approach is to identify alternative energy sources which are not based on food crops or other significant resources for humankind. Fuel cells are one promising development, but it will likely take the next 40 years until they are completely operational. These types of alternative engines will not yet be available in 2030, they will most likely arrive somewhere around 2040 or even 2050.

The other alternative is achieving the reduction of emissions by optimising flight operations. One way is increasing the fuel efficiency of the fleet, which in turn lowers fuel consumption and thus CO<sub>2</sub> emissions. As I mentioned, SWISS is already making significant investments in new aircraft. The creation of an efficient air space infrastructure (i.e. Single European Sky) also has the potential to realise enormous savings in air transport. These could be realised immediately through optimised flight routes, and should be a political priority. Improvements in infrastructure and operational measures with regards to shorter and more direct flight routes and fuel-saving procedures for approach and departures are indispensable.

*Will energy efficiency become a more important criterion than speed in supply chains in the future?*

Definitely. This became very apparent in the aviation sector when Boeing discontinued their supersonic project and focused on building the 787. The supersonic was designed to fly 1600 km per hour, which would have increased energy costs by from 60 up to 70 percent. Instead of building ever faster planes, the industry wants to improve energy efficiency - and that's clearly the direction the industry is going.

*In how far do you agree or disagree that the scarcity of energy resources will strongly decrease individual mobility until 2030?*

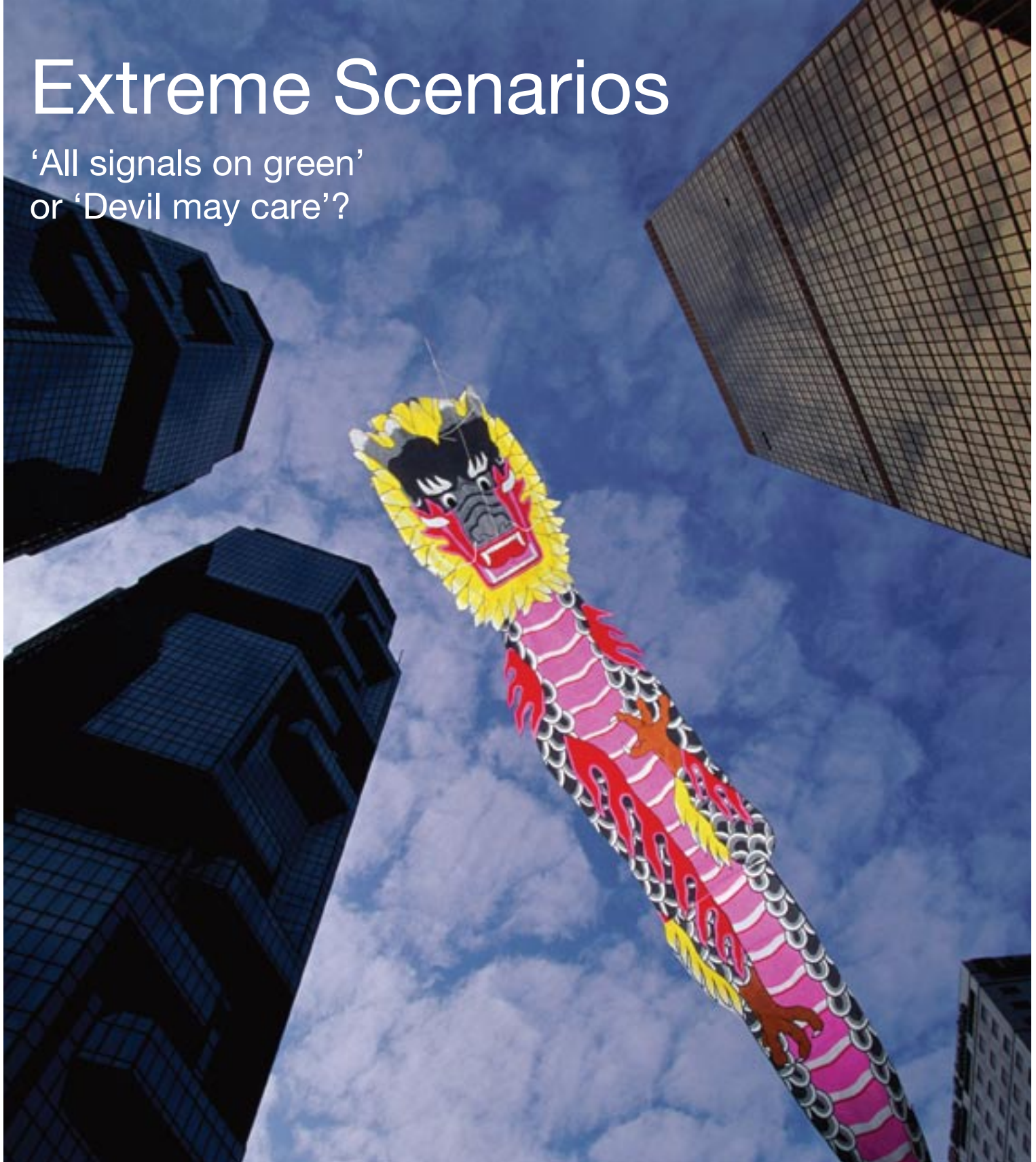
Taking into account all modes of transport, from the bicycle up to the airplane, I think we will see a change in the modal split. In my opinion, individual transport will return to the experience of the 1950's. In that period, energy accounted for a much larger share of people's income. This shift may result in a slow-down of long-term growth globally, say from six percent GDP growth annually to four percent. However, I think mobility is a basic need of humankind and this will not change in the future.

*We have talked about some potential future developments; there are many other trends that could have an impact in the sector. How do you see transportation and logistics in 2030?*

In addition to energy-related issues, one of the other important topics for the future is regulation, including measures such as the EU Emissions Trading System. We need to make sure that regulations achieve the goal of promoting greater efficiency in air travel, including making sure that the industry's competitive position and gains in this regard are acknowledged. I count on politics and infrastructure at airports will support efforts to achieve improvements in efficiency.

# Extreme Scenarios

‘All signals on green’  
or ‘Devil may care’?



"Extreme scenarios" relate the impact of two theses to each other and create radical pictures about possible futures. Thinking through the range of possibilities implicit in these extreme scenarios allows researchers to gain a perspective on how discrete developments may interact in complicated real world environments. Consequently, decision makers are able to analyse whether their strategic plans are capable of dealing with those extreme scenarios.

For the development of the successive extreme scenarios, the focus was set on two controversial theses:

**2030: The oil price has risen to \$1000 per barrel because oil production peaked years ago (Thesis 1)**

**2030: Consumer behaviour has changed so that locally produced products are strongly preferred (Thesis 6)**

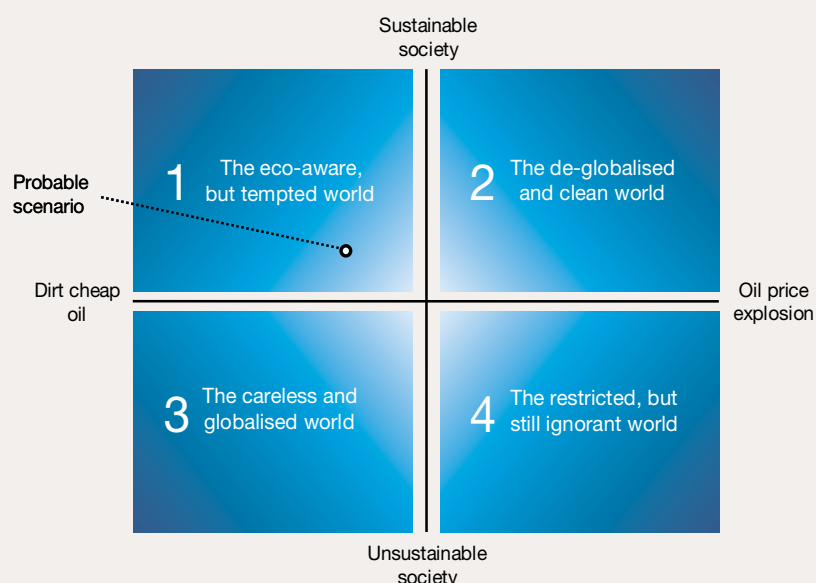
The theses were chosen due to their high impact on the Transport & Logistics industry and the experts' consensus about the topic. Further, the selected theses represent disparate aspects of our topic.

The oil price is undoubtedly a key parameter affecting the T&L business. This is unlikely to change in the future;

rather its impact will increase as oil reserves diminish. The comments from our Delphi panellists clearly underline the view that rising oil prices have an enormous potential to de-stabilise the industry. However, there are also profound arguments why and how alternative energy sources could solve the energy problems of the future and thus make the T&L sector independent of oil price fluctuations and supply restrictions. Consumer behaviour also has a significant impact on the T&L sector; the design and characteristics of marketplaces are fundamentally influenced by customers' behaviours and expectations. Customers have a significant impact on how a specific industry develops. In the T&L industry, changes in consumer attitudes, such as a shift towards a more sustainable way of thinking, could drive fundamental structural changes, e.g. supply networks on a local or regional rather than a global level.

Drawing upon the qualitative Delphi data and further trend research, we have formulated narratives that tell possible stories for the extreme pole of each quadrant which is presented in Figure 8. Since industry environments get more complex analyses of surprising and extreme issues need more attention. Extreme scenarios help to broaden perspectives and to span the whole range of future space as related to the focal points.

**Figure 8**  
Extreme  
Scenarios



## Extreme scenario 1



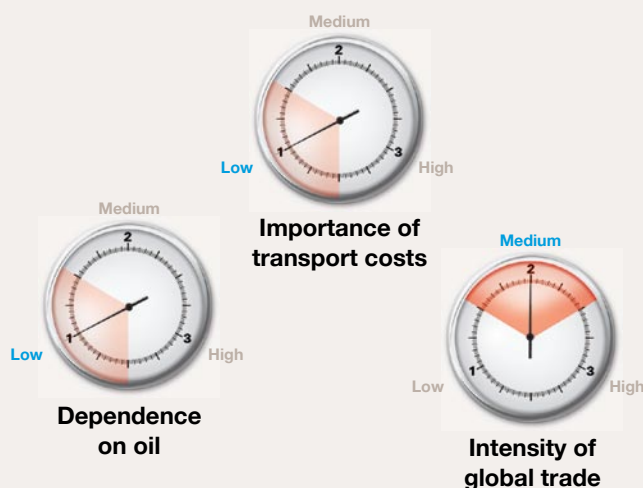
### The eco-aware, but tempted world

2030: Since oil prices have become stable and alternative energies are used widely, logistics service providers do not have to worry about energy prices. Alternative energy sources have solved energy problems and bottlenecks of energy supply. Oil dependence has dropped dramatically. Transport costs only play a minor role in the T&L sector, as sufficient energy is available at a low cost.

Even though the number of vehicles on the world's roads has more than doubled over the last 25 years, fuel consumption and greenhouse gas emissions have fallen significantly. This is due to major advancements in drive technologies and environmentally friendly propulsion systems. By 2030, a large portion of road vehicles are powered by electric fuel cells which have become a powerful alternative to conventional internal combustion engines. In addition, customers are increasingly concerned about their environment, actively pursue sustainable consumption and have a strong preference for environmentally friendly products. In order to purchase green and sustainable products, consumers are willing to pay a surplus. In fact, price premiums of around five percent compared to 'normal' products are acceptable if products fulfil the sustainability criteria.

A number of companies have consolidated and regionalised their supply chains in order to meet consumers' expectations for environmentally friendly products. Global procurement, production and distribution of products continue to exist when they can be achieved in a sustainable manner. Nevertheless, consumers have developed a strong preference for locally produced products and services. Certification of eco-friendly products has become standard in 2030 and consumers strongly prefer products and services certified with the "eco-seal". Logistics service providers and transportation companies have recognised this trend and have designed their services to comply with the requirements necessary to receive the eco-seal.

### Scenario portrait



### Major changes

- Consumers make purchasing decisions based on what will be best for the environment
- Competition to deliver quickly and cheaply is outdated

### Implications

- T&L companies recognise that cheap and quick delivery does not reflect value for customers any longer
- T&L companies which have developed and implemented a robust and sustainable strategy will be well-positioned



## Extreme scenario 2

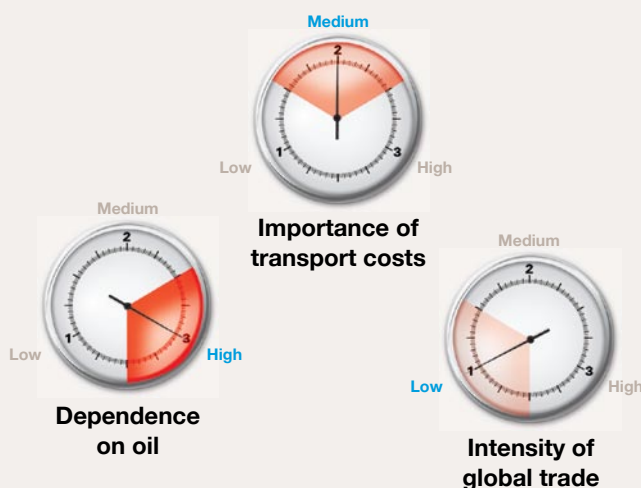
### The de-globalised and clean world

2030: During the last two decades logistics service providers were faced with huge challenges stemming from exploding oil prices. Since alternative energies are still not able to provide the desired potential of a viable energy source, crude oil remains the primary energy source. Slow exploitation of global oil resources, martial conflicts in the environment of OPEC countries, and declining output rates from producing oilfields have increased oil prices to nearly a four-digit number. As a consequence, transportation costs play a much greater role in the overall cost of goods, and resultant price increases have slowed down demand and world trade. Additionally, customers have developed a strong environmental awareness and have changed their behaviours towards sustainable consumption patterns. The demand for 'green' products has gained in importance and regional products are strongly preferred. Consequently, global procurement and production process have gone back to their regional roots.

While cost reductions and financial performance led the CEO agendas of the past - especially in times of economic downturns, executives now additionally concentrate on sustainable parameters. Greenhouse gas emission reduction, reduced energy consumption, better traceability and decreased traffic congestion are seen as imperative to realising long-term success.

All stakeholders in the supply chain are expected to support the accomplishment of green goals and T&L companies have initiated various action plans to trim down their energy consumption. Internal programmes which support 'green supply chain management' have been shown to be an effective tool to absorb exploding energy prices and to contribute to the creation of a healthy environment. Logistics service providers promote agreements with customers specifying less frequent delivery schedules, but including larger shipments per delivery. This helps to compensate for higher energy costs by achieving greater economies of scale.

### Scenario portrait



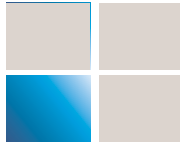
### Major changes

- Most goods and products are no longer sourced globally
- The importance of fast deliveries of goods and products has fallen strongly

### Implications

- T&L companies reduce delivery frequency to cut costs
- Local supply chains have become a valid lever to address high energy prices

## Extreme scenario 3



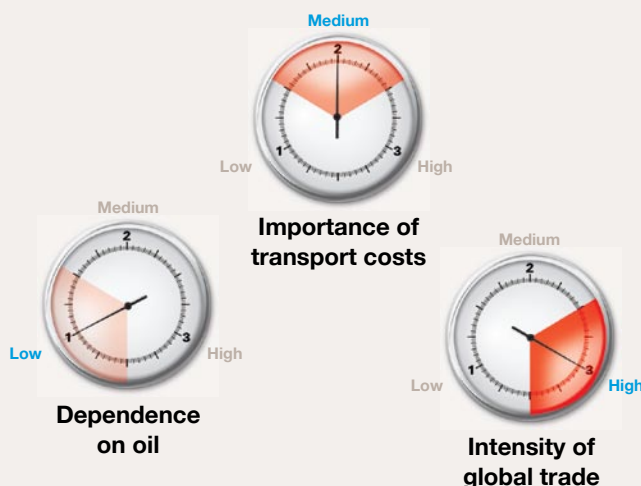
### The careless and globalised world

2030: Over the past two decades consumers have not changed their consumption patterns in a significant way. Their purchasing decisions are primarily price driven. Sustainable and/or environmentally friendly products or services remain niche products or services. Consumers have no reliable means of distinguishing between environmentally friendly or 'unfriendly' products since uniform standards or certifications are not in place. Governmental actions and regulations promoting sustainable consumption and production patterns are rather rare or non-existent. However, the dependence on volatile oil prices has declined sharply when compared to 2009. Innovative practices allow for the exploitation of unconventional oil sources such as oil sands, oil shale, and extra-heavy oil, so that up to 6.5 trillion barrels of oil can be recovered economically. In addition, effective and efficient alternative energy sources are available and have replaced crude oil as the primary source of fuel. The new energy options allow for increased energy consumption while simultaneously reducing greenhouse gas emissions.

As a consequence of the independence of oil and the resulting low energy prices, the level of globalisation and worldwide sourcing activities has further advanced. The division of labour is taking place on a global scale and employees have to be very flexible and mobile. Given the increased emphasis on truly global supply chains, the demand for global logistics and transportation services has increased correspondingly. This in turn means high demands on global network structures. Small and medium-sized T&L companies often cooperate in delivery networks in order to stay competitive on a global scale.

Customer demand for timely and speedy deliveries has increased significantly. Time-based competitive models now play a major role in the T&L business. As prices for mobility have plummeted and disposable incomes have increased, individual travel has also grown strongly. Further, the number of vehicles on the road has increased steadily. While the global vehicle population counted around 700 million passenger cars and 250 million commercial vehicles in 2009, the number has doubled by 2030. This represents additional challenges for logistics service providers due to crowded city centres and congestion on major traffic arteries.

### Scenario portrait



### Major changes

- The mobility level of individuals has increased substantially
- Worldwide sourcing activities have further advanced
- Sufficient CO<sub>2</sub> neutral energy is available

### Implications

- Energy problems have been solved
- T&L companies have extended their global scale activities to maintain high levels of competitiveness

## Extreme scenario 4



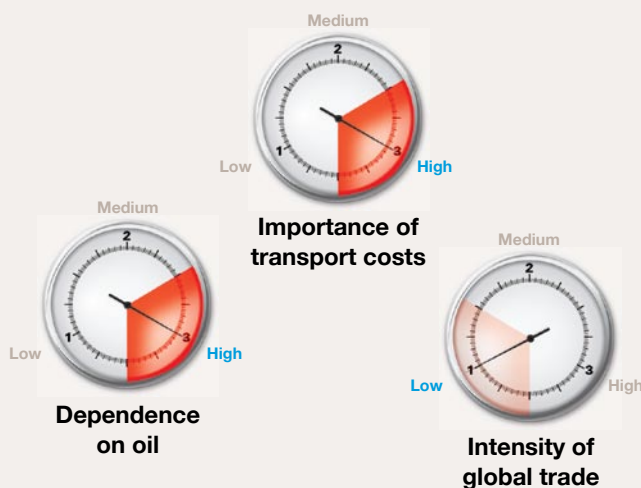
### The restricted, but still ignorant world

2030: Efforts to develop viable, cost-effective technologies around alternative energy sources could not deliver the desired results. Crude oil is still the primary source for energy supply in 2030. The major oil-consuming countries and regions – China, India, EU, Japan, and the US – compete for scarce fossil-based raw material. Oil prices have exploded in response to high demand and have at times neared four-digits. Extraordinarily high transport costs have placed severe limits on individual mobility. High energy prices have made mobility a luxury for the well-to-do, while the poor and middle class struggle to stay mobile. The demand for low-consumption cars and public transport systems has grown steadily.

Since consumers have not developed a distinct preference for sustainable and environmental friendly products, price is still the predominant criterion in purchasing decisions. However, due to increased energy prices, transport has become extremely expensive. Companies have shifted away from low-cost country sourcing except in regions that are geographically proximate and some have "insourced" manufacturing activities. In order to compensate for increased energy costs, production facilities have moved close to the place of consumption. Global trade has decreased as well and "regionalisation" is the buzz-word in 2030.

Furthermore, high energy prices have forced a strong modal shift, so that rail and water transport have increased in importance. As a result, logistics service providers had to rethink their transport strategies. Many position themselves as intermodal experts today.

### Scenario portrait



### Major changes

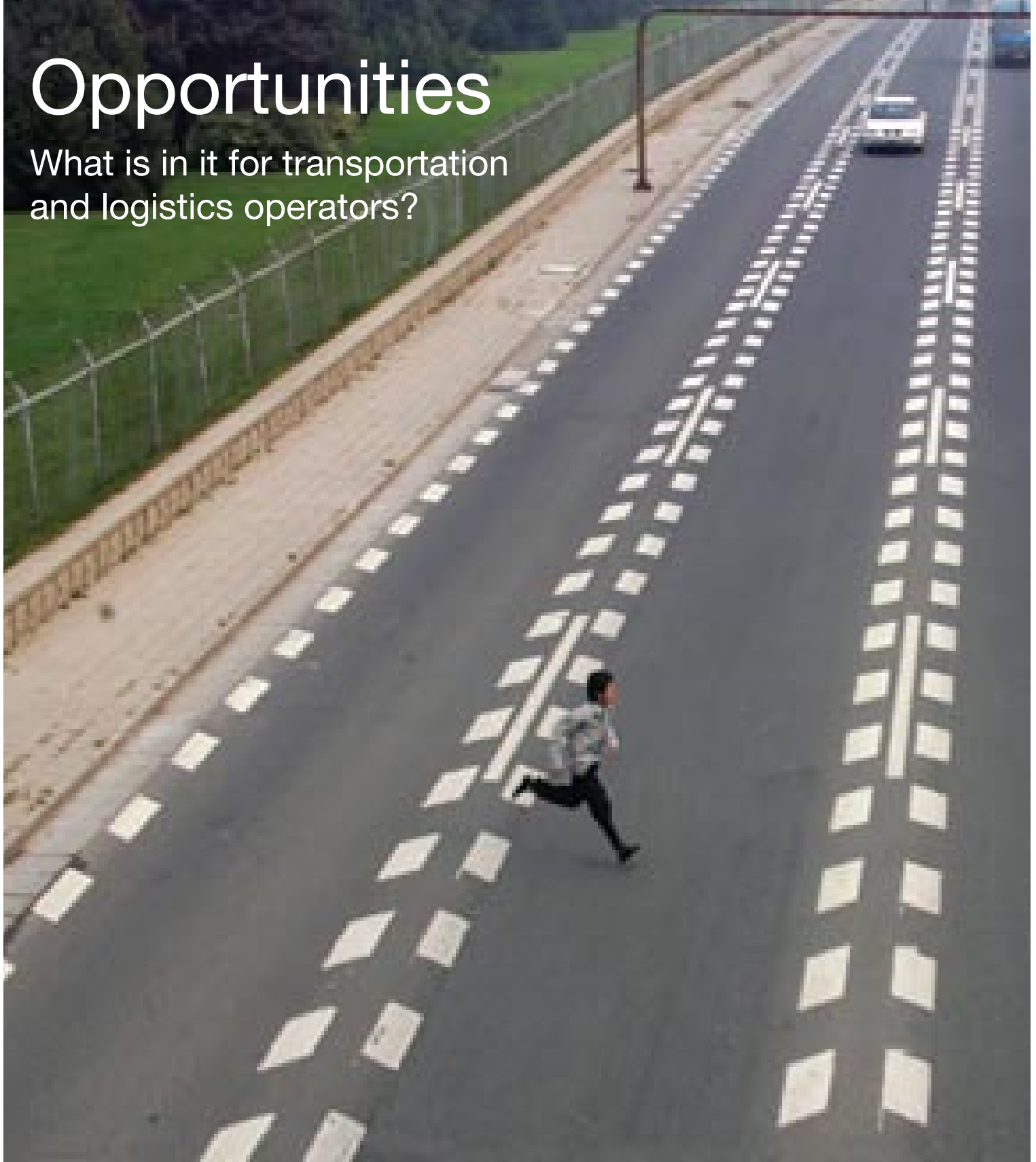
- Levels of mobility have strongly decreased as many people cannot afford to be mobile any longer
- High energy prices made low-cost country sourcing uneconomical

### Implications

- Due to high energy prices global trade has strongly decreased
- Companies have started to "insource" various business activities

# Opportunities

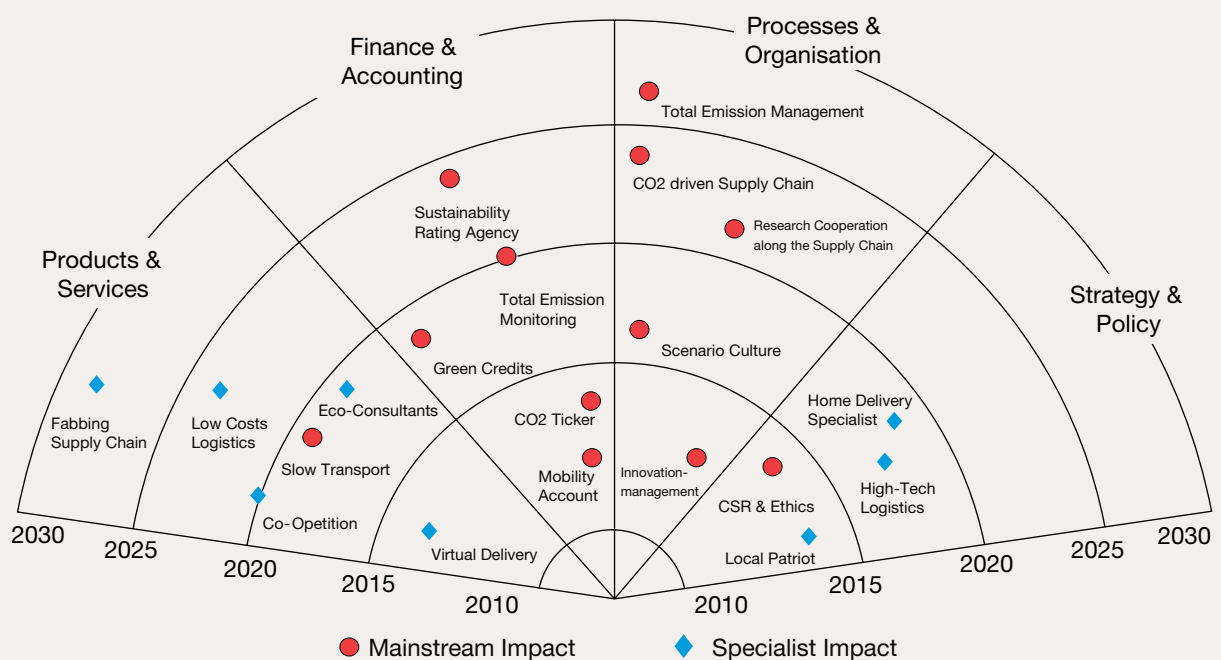
What is in it for transportation  
and logistics operators?



This chapter takes a look at some promising future opportunities for transportation and logistics operators. Areas addressed include Products & Services, Finance & Accounting, Processes & Organisation and Strategy & Policy. In this discussion we differentiate between mainstream and specialist opportunities. While mainstream opportunities are likely to affect the entire industry, specialist opportunities will only be relevant for distinct logistics service providers.

It is important to stress that the 'opportunity radar' (see figure 9) is the subjective outcome of several future workshops, based on the scenarios described in the previous chapters. It is designed to provide a pragmatic, but creative perspective into the future. In order to provide a tool which supports decision-making, the radar presents opportunities with different degrees of innovativeness. Some of them are already near implementation, while others remain visions by current standards.

**Figure 9**  
Opportunity radar  
for transportation &  
logistics operators



## Opportunities in Products & Services

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### **Virtual delivery**

Innovative companies may have found a new service to deliver letters in an efficient and speedy way. Instead of sending physical letters to the final recipient, letters are sent to providers who digitalise any kind of document and forward it to the recipient in an electronic way. Thus, it may become possible to reduce delivery costs and negative environmental impacts while simultaneously creating value for customers through fast and electronic delivery.

### **Eco-Consultants**

Those companies which recognised the market for green logistics and supply chain management early may be able to build on their expertise and provide eco-consultancy services to customers. Sustainable, green, and environmentally friendly supply chain solutions demand highly specialised expert knowledge. Eco-consultants would give advice on how to design supply chains and how to reduce greenhouse gases and further harmful emissions produced within the customer's supply chain by providing sophisticated IT tools and the required competencies to customers.

### **Slow Transport**

Speed currently plays a paramount role in modern life and culture, however energy awareness could become more significant in the future. Instead of getting things done and delivered very quickly, it may become more important to reduce the energy consumed. Consequently, logistics service providers may offer new business models that concentrate on slower transports at lower costs and higher energy efficiency, thereby specifically addressing the needs of a growing customer base. In addition, customers may be able to influence speed and delivery conditions actively through web and mobile interfaces.

### **Co-opetition (Competitive collaboration)**

Cooperation between competing businesses in various business processes will gain increasing acceptances as a means to cut costs and achieve competitive advantages. Competitors may increasingly look to partner in order to provide some aspects of logistics services more effectively (e.g. warehousing and/or transport of products). Logistics service providers may also collaborate in other ways; for

example, they could cooperate in order to handle the challenges of mega- and inner-city supply. One possible example: if several logistics service providers were able to agree to run deliveries only one day per week in a congested urban area, with each provider accessing the city on a different day and performing "last mile" deliveries for all the cooperating competitors, they could significantly optimise network and route planning.

### **Low Cost Logistics**

Low Cost Logistics could be a promising business model, particularly if oil prices increase exponentially. Customers could assemble logistics services according to their individual requirements, specifying precisely which aspects of the logistics service portfolio are desired. In the most extreme case, the logistics service might include solely the transport of goods, while customers take over administrative processes and work steps. In order to make such a model happen, logistics companies will need to implement corresponding IT infrastructure, including real time control systems, and achieve cost transparency.

### **Fabbing Supply Chain**

Many observers believe that fabbing will be the next revolution for the desktop. Many institutes and organisations worldwide are working to make this vision happen. By 2030, personal fabrication of products via a home computer could be standard. Blueprints may be sold online through Internet vendors, or created using user-friendly CAD software. Consumers could then create simple pieces of merchandise or replacement parts on a 3D printer. Alternatively, fabbing may give rise to an extensive network of small entrepreneurs selling over the internet who "fab" required products for individual customers. Fabbing may also play a greater role in standard manufacturing settings. Innovative logistics service providers can ensure that they are well-positioned to take advantage of a future three dimensional printing wave by getting involved now, e.g. in research cooperations with universities. This could give them a crucial advantage against competitors in the creation of a "fabbing supply chain." Thus, they could potentially assist in setting up pipelines which deliver the necessary raw materials for the fabbing process, or organise specialised reverse logistics.

## Opportunities in Finance & Accounting

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### **Mobility Account**

Environmentally aware companies may introduce mobility accounts for their employees. These accounts would monitor the carbon footprint caused by employees' business trips; employees would receive an overall "carbon budget" and would need to ensure that emissions generated by their travel did not exceed a designated total over a certain time period. Mobility accounts would demonstrate a high level of commitment to sustainability and could thus have significant marketing and PR value for individual T&L companies, as well as potentially lowering costs related to a company's overall emissions profile.

### **CO<sub>2</sub> Ticker**

Companies which are tracking their carbon emissions will also be able to employ new calculation methods and measurement approaches in order to document all carbon emissions which are caused during the production and transport of a certain good. This information will then be displayed in a "CO<sub>2</sub> Ticker". Initial examples of such calculations are already in place. CO<sub>2</sub> tickers could be nearly standard for all products. Such a trend would have a major impact on the T&L industry, as emissions produced during the transport of goods would need to be taken into account in the ticker. Companies able to reduce overall emissions, thus contributing to a lower overall ticker number, might have a competitive advantage.

### **Green Credits**

Unlike the mobility account for employees, 'green credits' could represent a positive incentive system to act in an environmentally friendly way. Whenever people engage in activities to improve environmental conditions, they receive credits which can be exchanged for other products or

services similar to incentive schemes now offered by credit card issuers, airlines, and retailers. Filling stations might offer such credits for filling up eco-friendly fuels, e.g. hydrogen, compressed natural gas (CNG), biogenous fuels. Logistics service providers may, in turn, provide such credits, if customers order a greener solution.

### **Total Emission Monitoring**

In the future, ambitious interest groups may be able not only to monitor CO<sub>2</sub> emissions generated by companies, but also to measure and evaluate all emissions including noise or nitrogen oxides (NO<sub>x</sub>). Tools and methods may be developed which are able to handle the complex process of total emission monitoring. Various logistics service providers may be interested in implementing them in their company in order to create higher levels of transparency for customers concerning environmental footprints.

### **Sustainability Rating Agency**

While companies have primarily been rated on their creditworthiness in the past, future public pressures could drive the institution of rating agencies for companies' sustainability, including both environmental friendliness and CSR activities. Investors would then be able to base their investment decisions not only on a company's financial situation and outlook, but also on its environmental and social impact. Due to their integral role in global supply chains, logistics companies' operations would potentially have an impact on the ratings of their customers. Logistics service providers would therefore likely face strong pressure to achieve high sustainability ratings. Companies receiving strong marks would likely derive significant competitive advantage over less sustainable competitors.

## Opportunities in Processes & Organisation

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### **Innovation Management**

Even though in the service sector innovation management has been institutionalised for many years, it has not yet been systematically implemented by many logistics companies. However over the coming years, logistics companies may actively manage their innovation processes in order to maintain and increase competitiveness, as well as to tailor services better to customers' needs. Currently innovation management is practiced primarily in large companies. Applying a more systematic approach could provide substantial benefits for small and medium-sized enterprises (SMEs) as well.

### **Scenario Culture**

Companies are increasingly recognising that they can increase their competitiveness and business intelligence if they “think in scenarios”, i.e. think about “alternate futures”. By doing so, companies are able to recognise future trends and market developments and to align strategies and activities accordingly. For those companies which have not yet begun using such an approach, implementing a scenario culture may pose a significant opportunity. Developing systematic contingency plans in order to better cope with external shocks will also be imperative for T&L companies and a powerful means of managing a diverse set of business threats.

### **Research Cooperation along the Supply Chain**

In the future, companies may enhance their research efficiency significantly by participating in research initiatives. While in the past research collaboration took place with only few research partners, future projects may include research cooperation with partners along the entire supply chain, supported by research institutes and universities.

Those companies which initiate research projects together with suppliers and customers, may be able to leverage their knowledge significantly. By including several different supply chain partners in the research process, companies could better understand market demands and how they can be delivered most effectively and efficiently.

### **CO<sub>2</sub> Driven Supply Chains**

Companies may be able to realise competitive advantages over the long-term by reducing CO<sub>2</sub> emissions in their processes, documenting such reductions, and actively promoting them to the marketplace. In order to reduce CO<sub>2</sub> emissions companies may need to modify workflows within the supply chain. Some possibilities to increase efficiency include the reduction of delivery frequency, adjustments of vehicle technology and the introduction of clean vehicles, the optimisation of planning systems, and an adjustment of loading units. Many of these techniques will also reduce energy consumption and cost accordingly.

### **Total Emissions Management**

As awareness over total environmental impacts grow, many companies may engage more strongly in activities to reduce their negative environmental impact. Companies which have already implemented total emissions monitoring systems may look to go one step further, and strive to decrease not only their CO<sub>2</sub> emissions but also all other emissions related to their activities. Hence, companies would look to document and reduce impact due to noise, dust, nitrogen oxides (NO<sub>x</sub>) and so forth. Logistics service providers who aim to reduce any kind of emissions may be able to win additional customers who search for the most environmentally friendly logistics partner.

## Opportunities in Strategy & Policy

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### **Local Patriot**

There is a strong indication that consumers' demand for locally produced products will increase significantly in the future. As a consequence, selected logistics companies could position themselves as local patriots. They would provide services only within an immediate regional area and support an increased local flow of goods. This would promote local business and could initiate a renaissance of local production in Western countries.

### **Corporate Social Responsibility & Ethics**

In the future, companies may aim to create sustainable supply chains which fulfil the global emphasis on sustainability. By concentrating on the creation of sustainable supply chains, companies may be able to make a positive contribution to society. Those companies which strongly concentrate on setting up sustainable supply chains may be able to differentiate themselves from their competitors and to deliver additional value to supply chain partners.

### **High Tech Logistics**

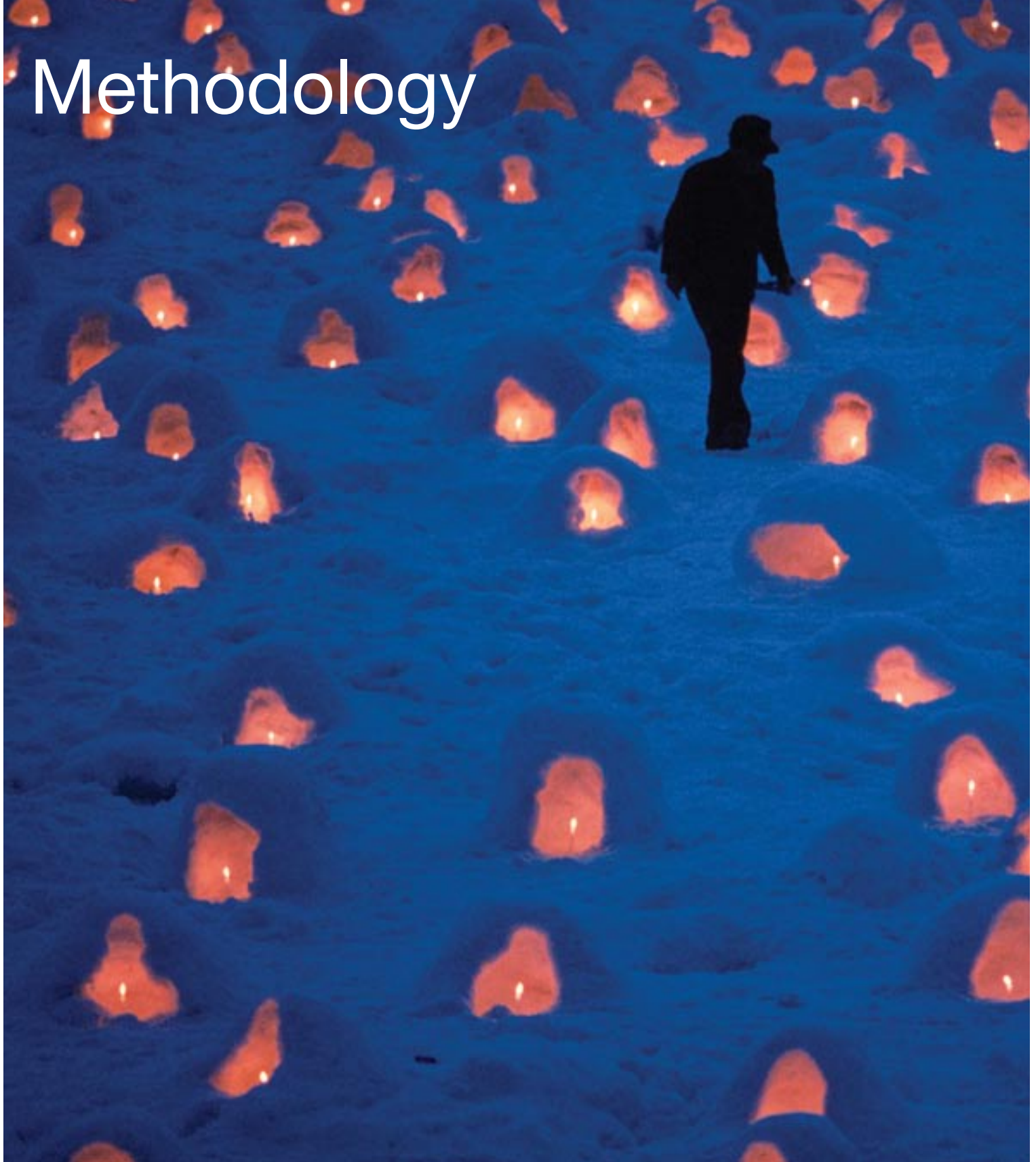
Information technologies have achieved major advances in recent years, opening the door for innovative logistics

services. Technology-oriented logistics service providers could position themselves as high-tech logistics providers providing the latest edge technology for interaction and manipulation. Thus, they would offer almost every possible ITC interface, so that customers are able to actively intervene at any time of the delivery process. To give an example, customers could easily track the current location of a specific good in real-time and change its destination and delivery time frame via a mobile device.

### **Home delivery specialist**

The current level of individual car traffic looks unlikely to decrease in the long-term, so cities are likely to remain congested. The access to downtown areas may be even more restricted. This in turn causes a complex supply situation that requires tailored and intelligent city solutions. Logistics service providers who are able to develop a full, flexible palette of intelligent city solutions which fulfil any new traffic restrictions could find a promising market as home delivery specialists.

# Methodology



## RealTime Delphi Innovation

Our global thought leadership programme “Transportation & Logistics 2030” employs a future methodology known as the Delphi technique. A brand new Delphi innovation of the Supply Chain Management Institute (SMI) was applied with significant advantages for both surveyed experts and the monitoring team.

The classic Delphi technique was developed at U.S. RAND Corporation in the 1950s in order to overcome general group inefficiencies, such as bandwagon, underdog, and halo effects, and to systematically develop expert opinion consensus concerning future developments and events. The usual Delphi forecasting procedure takes place in the form of an anonymous, written, multi-stage survey process, where feedback of group opinion is provided after each round. We designed our Delphi as an Internet-based, almost real-time survey that increases the validity of results by streamlining the classical procedure and making the whole process more interesting and comfortable for the surveyed experts. Using this technique, much of the analysis of the data results can also be automated.

Based on extensive desk research, expert consultations, and workshop sessions, PwC and SMI developed 18 key Delphi projections for T&L 2030 with a strong focus on energy efficiency and speed in the supply chain (see list on page 58). Invited experts were asked to rate the theses’ probability of occurrence (0-100 percent), impact on T&L if occurred (5-point-Likert scale), and desirability (5-point-Likert scale) as well as to provide (optional) reasons for all answers. After the first round, answers for a projection had been given, the statistical group opinion of all participants was calculated immediately and visualised in a second round screen (see figure 10)

Experts could additionally access all of the supporting statements other experts had already provided for their evaluation of the projection. Based on this data, first estimations could be re-assessed and adapted. After completion of the questionnaire, experts could return to the Delphi portal via their personalised invitation link at any time. They were then directed to a “consensus portal”, with the possibility to monitor the ongoing Delphi process as well as to enter each thesis evaluation screen independently in order to revise their own answers. The final results of the RealTime Delphi survey formed the framework for the opportunity and discontinuity analyses. Based on the extensive qualitative survey data and the desk research, foresight knowledge was expanded in further expert workshops.

Figure 10  
RealTime  
Delphi screen

2030: Larger means of transport (gigaliner trucks, ultra-large container ships) have become prevalent in order to compensate for rising transportation costs.

| Comparison                                                                                                              |                      | Revision of your answers        |                                                                 |
|-------------------------------------------------------------------------------------------------------------------------|----------------------|---------------------------------|-----------------------------------------------------------------|
| Group response                                                                                                          | Aggregated arguments | Your final answer               | Your additional arguments for...                                |
| <b>Probability of occurrence</b><br>0% <input type="text" value="60%"/> 100%<br>You: 60%                                | See comments         | 60 %<br>(0-100%)                | a low probability (optional)<br>a high probability (optional)   |
| <b>Impact on Transportation &amp; Logistics (in case of occurrence)</b><br>1 <input type="text" value="4"/> 5<br>You: 4 | See comments         | 1 2 3 4 5<br>very low very high | a low impact (optional)<br>a high impact (optional)             |
| <b>Desirability of occurrence</b><br>1 <input type="text" value="3"/> 5<br>Out of group opinion!                        | See comments         | 1 2 3 4 5<br>very low very high | a low desirability (optional)<br>a high desirability (optional) |

Tutorial Back

## Delphi Panel

The objective of Delphi studies is not to obtain a representative sample of a population as it is with most conventional surveys. Rather, Delphi research aims for a high inclusion of expertise. The panel was composed of C-suite representatives from prestigious global companies, subject matter experts in strategy, as well as experts from business associations and academics from the fields of logistics. We invited 64 experts to participate in the RealTime Delphi. Key selection criteria were industry and educational background, work experience as well as function in and outside the organisation.

Overall 48 of the invited experts participated in the study, representing a response rate of 75 percent. This is a significantly above-average response rate, indicating the timeliness and relevance of the topic and assuring a high quality of the data. The majority of participants (60 percent) were C-level executives.

The study aimed to achieve a comprehensive global perspective. Participants were based in 20 different countries

of all continents, ensuring a balanced and global view of the future. Sixty-seven percent of respondents come from developed countries. A significant share (33 percent) of the respondents originates from emerging countries, which assures that this perspective is largely represented as well.

For a more differentiated and heterogeneous group, academics, politicians, and industry practitioners were included. Nevertheless, the key focus was set on practitioners, which finally represented the largest share of the group. All transport modes were adequately represented and therefore included into analyses.

The industry share included predominantly large companies composed of listed, family-and state-owned companies.

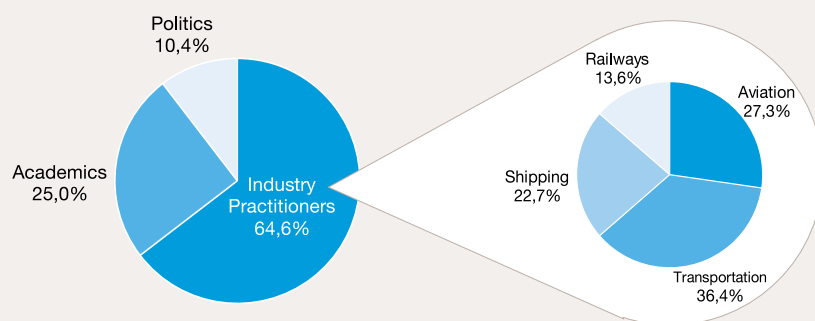
Since the RealTime Delphi approach forms a new and innovative survey design, all experts were thoroughly briefed before starting with the questionnaires. In addition to providing a written flyer explaining the technique, a flash tutorial was offered. In total, 39 of the 48 experts additionally accessed this tutorial, leading to a high “familiarity rate” of 81 percent.

**Figure 11**  
Geographical  
origin of Delphi  
panellists



Represented countries: Australia, Belgium, Brazil, Canada, China, France, Germany, India, Mexico, Netherlands, Rumania, Russia, Saudi Arabia, Singapore, South Africa, Spain, Switzerland, Turkey, United Kingdom, United States of America.

**Figure 12**  
Segmentation of  
Delphi experts



## Delphi statistics

The Delphi was very dynamic. During the survey process of 5 weeks each participant took part on average in 3.7 Delphi rounds, i.e. first and second round per thesis as well as 1.7 further logins for revision purposes. The maximum number of rounds measured was 7. The statistical group opinion per thesis was provided in form of a box plot, also known as a “box-and-whisker plot”. It represents a diagram showing a row of univariate numerical data (e.g. from 0 to 100 percent) as well as several characteristics of the series of data (e.g. median, distribution, outliers). In addition to the statistical group opinion, the comments and arguments

already submitted by the experts for each projection could be reviewed. After conclusion of a full survey cycle, i.e. first and second round screens of all theses, a consensus portal was activated which gave an overview over the current divergences from the group. From this point on, the respondent could access each thesis separately at any time until closure of the portal in order to check for updates and to revise own estimates. The group discussion came up with 822 written arguments equalling 17.1 comments per expert on average. The high amount of comments underlines the quality of the data and provided a sufficient basis for later scenario writing.

## Overview of theses

EP = estimated probability (0-100%); I= Impact (5 pt. scale, 5=very high); D= Desirability (5 pt. scale, 5=very high)  
Measures of C = consensus (interquartile range  $\leq 25$ ); dissent (interquartile range  $> 25$ )

|                                | No | Projections for the year 2030                                                                                                                                                                                                             | EP  | C  | I   | D   |
|--------------------------------|----|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|----|-----|-----|
| Energy/<br>Emissions           | 1  | The oil price has risen to \$1000 per barrel because oil production peaked years ago.                                                                                                                                                     | 27% | 10 | 4.6 | 1.7 |
|                                | 2  | The global energy turnaround has now advanced to the point so that in some countries alternative energy accounts for up to 80% of the overall energy mix.                                                                                 | 52% | 38 | 3.8 | 4.0 |
|                                | 3  | By using standardised measurement and evaluation systems (i.e. emissions trading, toll systems), the carbon footprint of logistics processes in supply chains must be allocated to the causer and factored into the price of the product. | 69% | 20 | 4.1 | 3.9 |
| Consumer behaviour             | 4  | Due to the scarcity of energy resources, the mobility of individuals has strongly decreased.                                                                                                                                              | 46% | 30 | 3.5 | 2.2 |
|                                | 5  | Work environments, everyday activities, and leisure options are better integrated, which has led to considerable reductions in transport.                                                                                                 | 58% | 28 | 2.7 | 3.6 |
|                                | 6  | Consumer behaviour has changed such that locally produced products are strongly preferred.                                                                                                                                                | 60% | 20 | 3.9 | 3.5 |
|                                | 7  | Personal influence on the logistics process has become more important for customers than the speed of delivery. Customers actively intervene in controlling the delivery process of goods.                                                | 56% | 15 | 3.8 | 3.2 |
| Transport modes                | 8  | Larger means of transport (gigaliner trucks, ultra-large container ships) have become prevalent in order to compensate for rising transportation costs.                                                                                   | 60% | 25 | 3.7 | 3.1 |
|                                | 9  | The debate over modal shift is obsolete. The share of road transportation in the modal shift has further increased.                                                                                                                       | 50% | 20 | 3.7 | 2.4 |
|                                | 10 | Autonomous and self-controlled systems (agent systems, automatic guided vehicles) have revolutionised freight transport.                                                                                                                  | 58% | 23 | 3.9 | 3.7 |
|                                | 11 | In order to cope with infrastructural bottlenecks, service providers control monopolies for deliveries and waste of disposal of entire districts within large megacities.                                                                 | 50% | 23 | 3.3 | 2.7 |
| Design of future supply chains | 12 | The reduction of transportation costs has become the predominant criterion in determining where to set up production sites.                                                                                                               | 59% | 20 | 3.8 | 3.3 |
|                                | 13 | The minimization of energy consumption is the paramount criterion in supply chain design, rather than cost efficiency and speed.                                                                                                          | 55% | 28 | 3.7 | 3.7 |
|                                | 14 | Global trade and transport only exist for valuable, time-critical or specialised goods. Local procurement, manufacturing and distribution dominate the commodity markets.                                                                 | 45% | 30 | 3.9 | 3.0 |
|                                | 15 | Continuous real-time control of the flow of goods eliminates disturbances in the supply chain and thereby significantly increases resource efficiency.                                                                                    | 71% | 20 | 4.0 | 4.3 |
|                                | 16 | The logistics world has developed solutions to design flexible and robust supply chains that are resistant to external shocks (economic crises, pandemics, supply shortfalls, catastrophes).                                              | 45% | 25 | 3.8 | 4.5 |
| Innovations                    | 17 | Three-dimensional printing (rapid prototyping, fabbing) has minimized global logistics flows because customers are thereby able to produce simple items and spare parts at home or in decentralised small-scale factories.                | 40% | 35 | 3.5 | 3.4 |
|                                | 18 | Nanotechnology has significantly improved many means and procedures in logistics (e.g. transport, maintenance, repair and overhaul).                                                                                                      | 57% | 25 | 3.6 | 3.9 |

Figure 13 Overview of theses

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