Transportation & Logistics

Transportation & Logistics 2030

Volume 2: Transport infrastructure – Engine or hand brake for global supply chains?

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For more information on the T&L 2030 series, a download of T&L 2030 Volume 1 and an outlook on T&L2030 Volume 3, please visit www.tl2030.com.

Welcome

Welcome to the 2nd volume of Transportation & Logistics 2030 (T&L 2030). This report is dedicated to one of the burning questions facing the sector: How will transport infrastructure be able to keep up with increasing freight volumes and growing demand for fast, efficient, reliable and environmentally sustainable transport solutions?

The resonance received by the first T&L 2030 report, published in October 2009, motivated us to continue the series, and also inspired some of the insights of this next volume. We learned that for some, 2030 seems far in the distant future, a time-frame beyond imagination; and our undertaking to develop scenarios up to 2030 a bit overly ambitious. At the same time, though, we've heard a strong consensus that business leaders and governments need to put an even stronger focus on long-term, scenario-based thinking and planning.

In April 2010, volcano Eyjafjalla caused a scenario that took everyone by surprise. 100,000 flights had to be cancelled, millions of passengers could not be checked in. According to the International Air Transport Association losses of revenue of airlines amounted to 1.3 bn Euro. Supply chains were disrupted in the automotive and other industries, causing production downtimes. Governments, airlines, logistics service providers - did they successfully put their contingency plans into action?

The need for long-term planning applies to the development of transport infrastructure in particular. Ports, airports, roads, railroads, bridges, tunnels – they all have in common that their life cycles span many decades, if not centuries. This requires long-term forecasting of the demand for transport infrastructure, its impact on the economy and the environment. The finance needed for construction, operation and maintenance also needs to be planned over a long time-frame. In this report, we take a closer look at some of the key issues in these areas.

This study was prepared by a team of experts from the Transportation & Logistics industry practice at PricewaterhouseCoopers and the Supply Chain Management Institute at the European Business School. It draws upon a rigorous mix of desk research and the results of a Delphi survey among 104 selected subject matter experts from 29 countries around the world. In this report, we summarise the findings of this survey, our key assertions and some conclusions that transport operators and users may draw. In addition, we take a look at transport infrastructure from a government as well as an engineering & construction angle, describe some 'extreme scenarios' and present some promising future opportunities for both governments and businesses.

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

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Foreword

Transport itself is somewhat paradoxical. For example, the transport minister of a Western European country declared that he would like to invest more in the infrastructure due to “the tremendous increase in freight transportation”. The odd thing is that his ministry announced a decrease in the amount of transports between 1995 and 2005: from 3300 to 3100 million tons. What actually increased is the transport service provided for goods, measured in tonne kilometres: There were less goods transported but over longer distances and/or in smaller batches. Such paradoxes perplex even the minister: Who could have predicted them ten years ago? Any manager who relied on scenario techniques, rather than trusting solely to well-known trend extrapolations and single-point forecasts.

The present study fills in some of the shortcomings of previous years. It conceptualises circumstances not previously considered and draws plausible and consistent scenarios, for example for the feared division of rural areas from urban strongholds of goods traffic. In fact, the surveyed experts are less worried about the second global rural exodus because they are expecting it. Scenarios for financing transport infrastructure have already been run through. It is certain that the government will no longer be able to handle the necessary infrastructure single-handedly. Who will help out? Above all, who realises that not the construction, but rather the maintenance of transport infrastructure will be the most important financial challenge in the coming years?

Of course the relief from traffic on motorways, rural roads, and in downtown areas of cities is an important topic. However, at least equally important for the prosperity of a country is its competitive position, which is influenced by its transportation infrastructure. In particular, linking digital and physical infrastructure is a subject relevant for the future and in danger of being underestimated.

In addition to calling attention to underestimated dangers, the study reveals those opportunities and potentials to governments, alliances, non-government organisations, industry and service providers, which salvage the actual promise for a better future. Only he who recognises an opportunity can exploit it.

Dr. Heiko von der Gracht

Director, Center for Futures Studies and Knowledge Management
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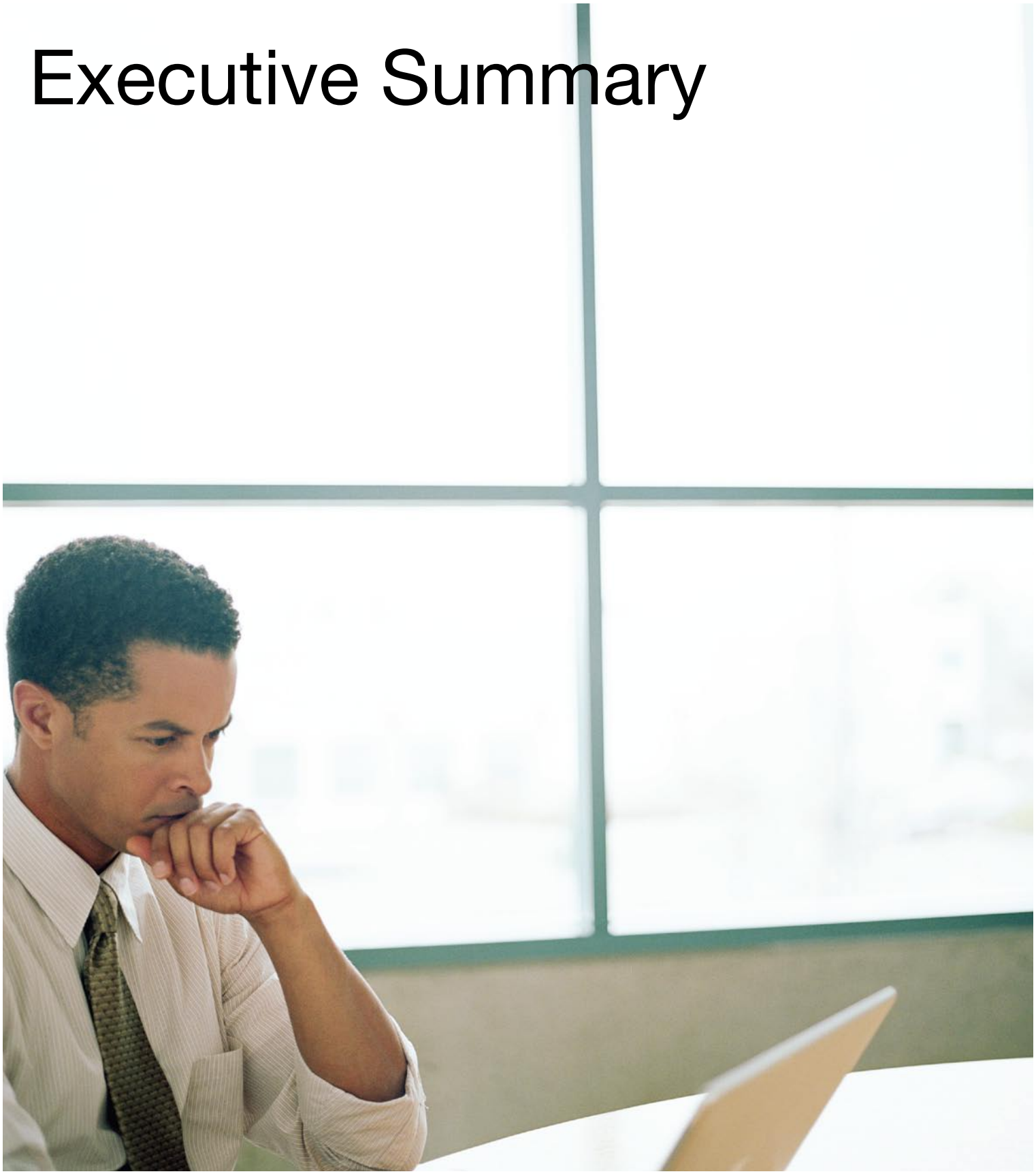
Executive Summary



Transportation needs are growing strongly around the world. Continuing globalisation, coupled with high growth rates of population density and GDP in some regions, means that the flow of goods and people will continue to increase over time. Massive investments are being made or planned, posing huge challenges for all parties involved. Some of the key questions include:

- Where are the greatest needs for transport infrastructure development in the coming years and decades?
- What are the most effective ways of financing transport infrastructure? What will be the roles of the public sector and private investors?
- How can megacities and economic hotspots be appropriately equipped with transport infrastructure while not decoupling rural areas?
- Will transport infrastructure continue to be a driver of economic growth?
- How can transport infrastructure be developed in an environmentally sustainable way?

This report

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addresses these questions and develops some scenarios about the future of transport infrastructure. It draws upon a rigorous mix of desk research and the results of a Delphi survey among 104 selected subject matter experts from 29 countries around the world. These experts evaluated 16 theses regarding their probability of occurrence, their impact on the transportation & logistics industry and their desirability. The editorial team, composed of members of the Transportation & Logistics industry practice at PricewaterhouseCoopers and experts from the Supply Chain Management Institute at the European Business School, interpreted the responses received from the Delphi panel, drawing on the background of their advisory and research experience.

In the first chapter of this report 'Findings of Delphi Survey', we summarise the findings of this survey, outline our key assertions and highlight some conclusions that transport operators and users may draw.

Section 1 looks at some significant trends in supply & demand. The quantity of goods needed to serve the world's rapidly growing global population will increase over the next twenty years. And the demand for transport infrastructure is unlikely to be fully met in the thesis period — if ever. At present, industrialised countries look likely to continue to keep a leading position in terms of transport infrastructure provision. While many emerging countries are recording record levels of investment in transport infrastructure, they are unlikely to bridge the existing gap completely by 2030. Urban areas are also likely to receive the bulk of future projects, as investors "follow the money" and focus on faster growing cities and megacities. Governments may need to offer incentives to ensure that rural areas remain connected.

Governments will also need to take a closer look at actions which help manage demand, including regulatory measures such as road tolls or congestion charges. While such regulation has certain drawbacks, and political opposition may be fierce, they potentially offer significant benefits, both in terms of reducing traffic volumes and by generating funds to reinvest in transport infrastructure. Efficient pricing based on external cost matches supply and demand at its most efficient point, leading to direct economic benefits by reducing externalities (i.e. congestion, pollution) to the optimum level. Large-scale implementation of road pricing is foreseen, so users should be prepared to pay more for using transport infrastructure in the future.

In Section 2 we take a closer look at a number of questions related to financing transport infrastructure. Governments are aware of the need to build a strong infrastructure foundation, but many are facing enormous challenges in devoting sufficient capital resources to such projects. And while the availability of capital for investment in transport infrastructure varies from country to country, companies alike are facing significant hurdles in most places. Logistics service providers looking to make strategic decisions about entering new markets need to understand those markets fully. This means assessing both the probable availability of capital and the willingness of governments to invest in transport infrastructure.

Such investments must of necessity include sufficient provisions for maintaining existing transportation infrastructure. For many governments, ensuring sufficient funding for maintenance actually poses a greater challenge than generating capital for new projects. Public officials

need to find an appropriate balance between investments in transport infrastructure and an ongoing financial commitment for the maintenance of existing facilities, and should ensure that maintenance needs are incorporated into the funding structure of all new projects.

Simply shifting all responsibility to private financiers will not be the answer, though. Instead, public authorities and private investors will need to investigate various options for sharing responsibility and risk. Rather than a one-size-fits-all approach, governments will need to identify a range of strategies and work together with private investors to create a win-win situation on individual projects.

Concerns around financing will be paramount at all levels of infrastructure, local, national or international. At the local level, funding is likely to remain a key responsibility of public authorities and local officials will need to be sensitive to the needs of voters. Governments will be in charge of transport infrastructure procurement, but they will focus on contributions from the key beneficiaries of new infrastructure. In contrast, private investment funds will increasingly be the strategic drivers of international large scale transport infrastructure projects. Such funds are likely to invest in national transport infrastructure only if the deal size is substantial and thereby economically essential, or if it offers a programme of opportunities.

Section 3 addresses several factors which will impact competitiveness over the next twenty years.

Getting transport infrastructure right is critical. The presence or absence of transport networks which facilitate efficient supply chains is already a factor in investment decisions around the world; the ability to offer a solid infrastructure is likely to become an even more important criterion in determining a country's or region's competitiveness in the future. Transport infrastructure remains a deciding factor for the economic prospects of a country.

Those regions which are able to implement Infrastructure 2.0 — by which we mean a system fully integrated with modern information and communication technology (ICT) — will benefit most. ICT will be a key enabler for the development of cutting-edge transport infrastructure and transport infrastructure development should focus more on integrating digital infrastructure. Individual regions will also be able to increase their competitive advantage by taking full advantage of the potential of logistics clusters. The close collaboration of industry, academia and government in such clusters will activate new potentials in transport infrastructure development.

In section 4, we look more closely at perhaps the most significant challenge to be faced over the next 20 years: ensuring the sustainability of transport infrastructure. Transport infrastructure and transport networks have profound effects on the environment. These impacts will need to be assessed from a holistic, long-term perspective to ensure that greenhouse gas emissions and other negative impacts on the environment are minimised to the greatest extent possible. Efforts to reduce demand and optimise capacity will play a part. An emphasis on innovation will also be critical in finding more eco-friendly transport solutions. Such programmes will be economically necessary, as increased regulation around greenhouse gas emissions in the form of emission trading systems or other mechanisms looks likely.

Ultimately, environmental costs will become an integral part of assessing the full costs of a transport infrastructure and will need to be calculated into the business case for any project. When assessing the environmental compatibility of transport infrastructure solutions, the entire life cycle of construction, operation and deconstruction should be considered.

The second chapter 'X-Industry perspectives' provides views of transport infrastructure from different angles. The first look is from the perspective of the builder of infrastructure, represented by a CEO from the Engineering & Construction sector. Keith Clarke, CEO of Atkins Plc. shares his views that good infrastructure design will be more efficient, using less land and fewer material assets, as well taking into account the whole life carbon impact. Clarke believes that transport infrastructure operators will need to recognise that the environmental impact of their activities is an intrinsic business cost, a fact of life which may mean more efficient, but marginally slower travel, will be used to increase capacity while minimising costs and environmental impact.

How will the public sector respond to the challenges posed by transport infrastructure? PwC's Government & Public Services Industry Leader, Jan Sturesson, provides a view from the perspective of government. He anticipates four main developments over the next twenty years: a) An increase in private finance and a focus on user-charging. b) A more stringent management of demand through regulatory measures. c) The need to design sustainable and technologically sophisticated solutions for urban centres. d) The need for governments to manage and prioritise this supply and demand of transport infrastructure.

Decision makers need to prepare for the worst. Today, most businesses have long-term strategies in place which are based on the most likely, foreseeable future developments. However, recent history has proven that contingency planning based on different scenarios is gaining importance. Thus, in the chapter 'Extreme scenarios' we elaborate on extreme scenarios that may be the result of unexpected developments. Extreme scenarios can help broaden decision makers' awareness of future developments which are not very likely, but which could potentially have a fundamental impact on the industry or on specific companies.

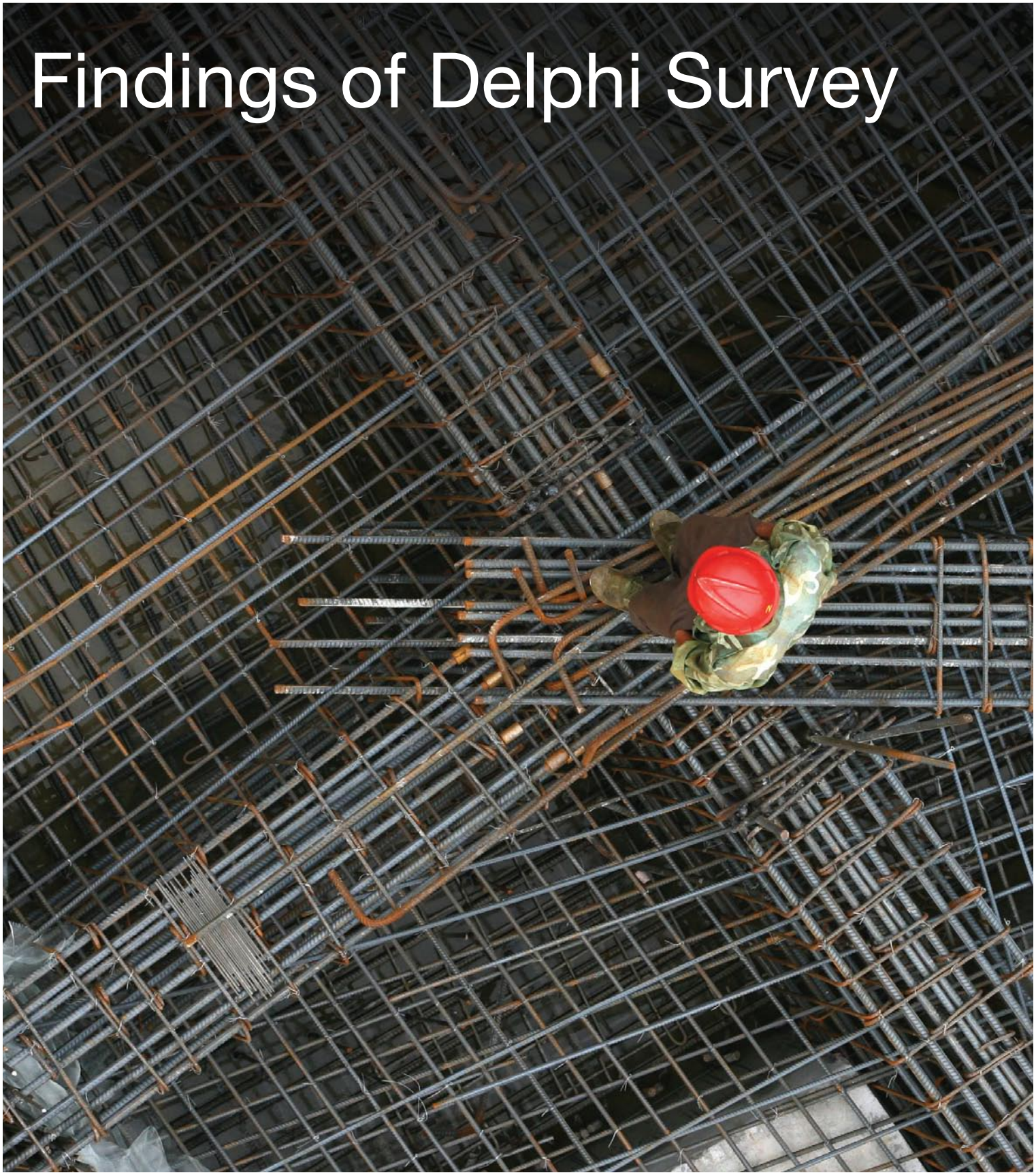
In order to demonstrate this method, two of the 16 theses were chosen, both dealing with the financing of transport infrastructure: 1. Financing the maintenance vs. Financing new transport infrastructure; 2. Governments as investors in transport infrastructure vs. Shift of investment to the private sector. The two theses were juxtaposed, creating 4 extreme scenarios which hold very different implications for the transportation and logistics industry.

How should businesses and governments respond? The chapter 'Opportunities' highlights some promising future opportunities. Logistics service providers may choose to specialise on rural areas, for example, while governments may set up incentives to help stem the rural exodus. Many of the opportunities revolve around potential innovations, such as the use of continuous conveyor systems for containers, CO_2 absorbing materials, bacteria-produced roads, self-healing materials or morphing materials. Companies may look upwards and build Sky Trains in crowded urban settings, or below the ground, to develop underground distribution systems for cargo. Other opportunities may stem from more effective use of existing technologies — for example, using IT to improve urban freight transit efficiency, extending automated guided vehicles outside of intra-logistics settings and incorporating cars for freight into existing high speed passenger trains. Applying techniques already in use in other sectors also offer possibilities, such as re-usable infrastructure. Some opportunities are based on very simple concepts — foldable containers could reduce costs significantly, given that 30% of containers are currently transported empty.

Opportunities will also arise around financing, including infrastructure sponsoring, the development of "transport infrastructure corporations" and a far more widespread use of flexible pricing. Sustainability will also continue to gain in importance, so applying infrastructure impact analyses or total value of ownership methods will be critical. Visionary governments may even go so far as to construct Eco-Cities.

This report addressing 'transport infrastructure' is the second publication of our Transportation & Logistics 2030 series (Volume 2). The first report of the series took an in-depth look at the implications for the sectors of diverse issues around 'energy & emissions' (Volume 1). We recognise that transportation & logistics is a complex industry and that many factors will determine its future. Further reports in the series will address additional challenges facing the sector. We encourage you to visit www.tl2030.com for further information and future reports.

Findings of Delphi Survey



Section 1

Trends in supply & demand

Theses

1) 2030: There is no longer a shortage of transport infrastructure since sufficient investments have been made.

2) 2030: Industrialised countries have lost their competitive advantage over emerging countries in terms of transport infrastructure.

3) 2030: Transport infrastructure development strongly focuses on urban areas, while rural areas are neglected.

4) 2030: Strong regulatory measures, such as road tolls and congestion charges, compensate for the increased need to invest in transport infrastructure.

5) 2030: Infrastructure shortages (e.g. insufficient transport infrastructure) have forced the division of megacities into decentralised, autonomous „sub-cities“.

Please find detailed information and explanation about the Delphi methodology as well as the parameters 'probability', 'impact' and 'desirability' on p. 61 ff.

A drop in the ocean — Massive investments in transport infrastructure will not be sufficient to close all infrastructural bottlenecks by 2030.

In 2010, the world economy is still showing the impact of the economic crisis which began at the end of 2008. In some regions, the first signs of recovery are already evident — notably in emerging markets. Some sectors are also beginning to recover. The recent credit crunch and global recession graphically illustrated that the economies of the developed and emerging markets are closely linked; but emerging markets seem to be somewhat more resilient.[1] The trend towards globalisation is unlikely to reverse; indeed, it may even accelerate. The OECD projects that world trade will grow 6% in 2010.[2] Global trade in goods and services is likely to rise more than threefold to US$27 trillion in 2030. Half of the increase is expected to come from emerging economies, mainly from the next generation of economic powerhouses, China, India and Brazil.[3]

The overall health of the world economy has direct relevance for transport infrastructure, as GDP is a main indicator to forecast demand for transport infrastructure, in particular that is needed for freight. A PwC analysis suggests that, by 2019, the output of emerging and developing countries will be nearly equal, but this parity will not last for long as the E7 (China, India, Brazil, Russia, Indonesia, Mexico and Turkey) will retain much stronger growth potential. From 2020 onwards, the E7 will break away from the G7, with combined E7 GDP being projected by PwC to be around 30% higher by 2030 than total G7 GDP.[4] While such forecasts are certainly indicative of general trends, the impact of the economic crisis has shown that long-term projections must be handled carefully. In 2010 uncertainty about the pace of recovery from the crisis remains.

Population density is a key indicator for the assessment of future needs for public transport infrastructure development. The world's population is continuing to expand and is expected to grow by 1.4 bn by 2030. According to the United Nations, in 2015 emerging markets will already account for nearly three quarters of the world's urban population.[5] India stands out as a country which will need extensive infrastructure enhancements, given that its already-high population density will increase by further 22% by 2030 (see Fig. 1). Estimates suggest that India will be home to a whopping 452 people per square kilometre. In contrast, sparsely populated Canada will host only four people per square kilometre and France, representing the golden mean, will host just 121 people per square kilometre in 2030. Saudi Arabia, Turkey and the United Kingdom are also expecting significant increases in population density, as are the smaller emerging economies of Vietnam and Indonesia, part of the so-called "Next-11". Countries being identified to possess a high potential of becoming the world's largest economies in the 21st century along with the BRICs. Other countries such as Russia will experience no change in population density, and in some countries such as Germany, Poland and Japan, population density is even likely to decrease. In particular, the growing "hotspot" areas must find solutions to provide stable and reliable transport infrastructure for their burgeoning populations.

As globalisation continues and populations grow, significant stresses will be placed on the backbone of global supply chains — transport infrastructure. In many regions, transport infrastructure capacities are already inadequate, over-burdened or aging. Whether or not available investment will be able to keep up with future demand is questionable.

Transport infrastructure investment needs vary widely amongst individual countries. Mature and developed economies, in which most of the transport infrastructure is constructed, need to refurbish and replace existing infrastructure. Emerging economies as India, China and Brazil must build and develop new infrastructure to meet basic requirements. By 2030, it is estimated that more than US$41 trillion will be required on a global level for infrastructure development and maintenance over the next two decades.[6] This requires a significant increase in infrastructure spending over the next twenty years, since actual global spending comprises only US$1 trillion annually.[7] In order to meet rising demand, investments will need to pick up the pace in coming years.

Governments around the world are already beginning to address the challenges that rising trade flows and population growth will bring, necessitating innovative and effective transport infrastructure solutions. Many landmark projects can be found in emerging markets. Russia intends to construct 20,000 kilometres new railway lines by 2030, representing an increase of 24%.[9] India has started a national highway building program to expand the expressway system by around 20,000 miles in 2009, while China's aggressive infrastructure spending will account for 80% of total infrastructure spending in the East Asia region between 2006 and 2010, with annual investments of US$ 350 bn. Egypt's transport infrastructure stimulus plan aims at setting up basic infrastructure in major cities beyond Cairo.[10] In April 2010, Abu Dhabi announced its Economic Vision Plan 2030, in which US$ 82.9 bn is earmarked for transport infrastructure investments.[11] The Brazilian government has also announced a new Growth Acceleration Program (PAC 2) that will provide US$ 880 bn in infrastructure and public projects as the second phase of the economic stimulus programme to be

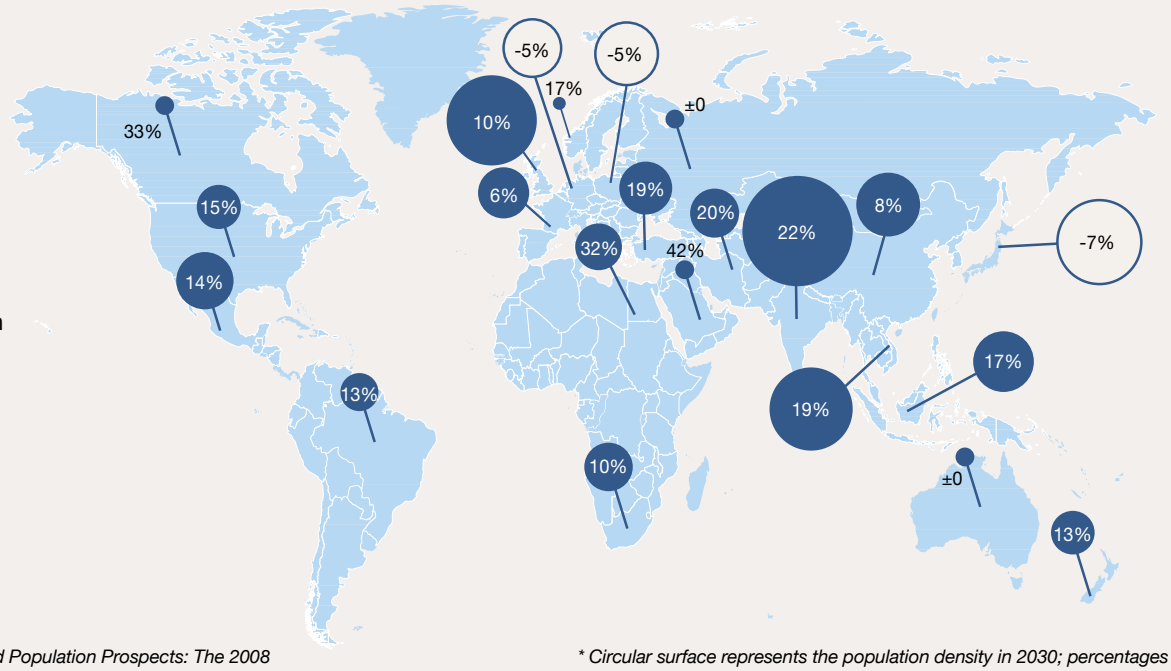


Figure 1
Population density in 2030

Source: World Population Prospects: The 2008 Revision Population Database[8]

** Circular surface represents the population density in 2030; percentages represent the increase from 2010 to 2030 in selected countries.*

invested between 2011 and 2014.[12] In order to meet the requirements for hosting the FIFA World Cup in 2014 and the Summer Olympics in Rio 2016, Brazil needs to ramp up infrastructure investment substantially.

Many mature markets also have significant infrastructure needs. In the US, President Barack Obama has proposed a long-term stimulus programme to upgrade the country's transport infrastructure. Massive investments of up to $500 bn in transportation and highway infrastructure would be spent from 2010 to 2016. The proposal is favoured by the House of Democrats, however it has yet to be approved by the House of Representatives and the Senate.[13]

Will stimulus packages and promotion programmes such as these be sufficient to close foreseen infrastructure gaps in the long term? According to the OECD, new road construction requirements vary between US$ 200-300 bn each year. New railways construction requirements account for another US$ 50-60 bn each year, driven mainly by needs in the BRIC countries, plus Indonesia. China in particular has made a significant commitment to investing in major rail-building programmes, including high-speed rail.[14]

Overall, the Delphi panellists believe that transport infrastructure will continue to be insufficient in 2030 (probability 70%). Somewhat surprisingly, politicians represent the most pessimistic respondent group; while transport infrastructure users were the most optimistic. Although they rate the chances of achieving a sufficiently robust transport infrastructure as fairly unlikely, the Delphi panellists believe that the positive impact of such progress would be substantial (4.1). They rated such an eventuality as very desirable (4.2); and they believed it could have the most significant impact on the transportation and logistics industry.

The panellists detailed a number of operational benefits to a uniformly sufficient infrastructure, such as accelerating the supply chain process and thereby the economic growth of a country and promoting multimodal infrastructure, e.g. transshipment platform networks. Collaborating across transport modes could help companies realise reduced waiting times, resulting in significant cost reductions, as well as environmental and social benefits.

Still, many panellists suggested that achieving such a goal will be difficult, both for political and financial reasons. For example, it was noted that forecasting of the right

infrastructure mix is notoriously difficult and usually lags behind the needs of business. As one panellist put it, "History tells us that while we may have some parts of infrastructure at the right levels or exceeding demand — we rarely, if ever, get the whole network right. Road, rail, air and sea are invariably misaligned on both national and international levels."

The expert panel also offered some insights into how infrastructure gaps could be overcome — for example, one view held that in many developed markets, existing capacity is not sufficiently exploited; if this deficit were overcome, only a relatively small additional investment would be needed. Another saw the need for innovative new business models which rethink transportation. Improvements in technology (such as high-speed or high-capacity transport modes) were also cited as ways in which the gap might be bridged by 2030.

Logistics service providers should be prepared to continue to operate in imperfect transport infrastructure systems and will need to adapt their business models to the prevailing infrastructure provision. Flexibility and scenario planning will be key to analyse and forecast future infrastructure facilities, not only for logistics service providers, but also for all supply chain players, transport infrastructure operators, users and owners.

The catch-up dilemma — Though emerging countries record high investments in transport infrastructure, industrialised countries keep their leading position in terms of transport infrastructure provison.

As a result of historic underinvestment in transport infrastructure, emerging countries are facing an "infrastructure gap" and need to make significant capital investments to reach the infrastructure development levels witnessed across developed countries. Despite the difficulties in making accurate projections, current estimates of essential infrastructure investment needs in the developing world (so-called "catch-up" expenditure) through 2010 account for US $465 bn a year.[15] In the last decade, emerging countries have started to invest heavily in transport infrastructure in an effort to bridge the gap. According to the International Transport Forum report, transport infrastructure investment has accelerated strongly since 2003 in Central and Eastern Europe (CEE) and the Russian Federation, while its pace remained subdued in Western Europe and the United States.[16] The level of investments measured by the share of GDP in these regions is approximately twice as high as in the United States and Western Europe.

"Economic growth will require continued capital expenditure in transport infrastructure over the coming decades. Emerging countries such as Russia will catch up in regards to the supply of transport infrastructure, owing to demand-driven investment from the private sector, as is already becoming apparent in the port industry."

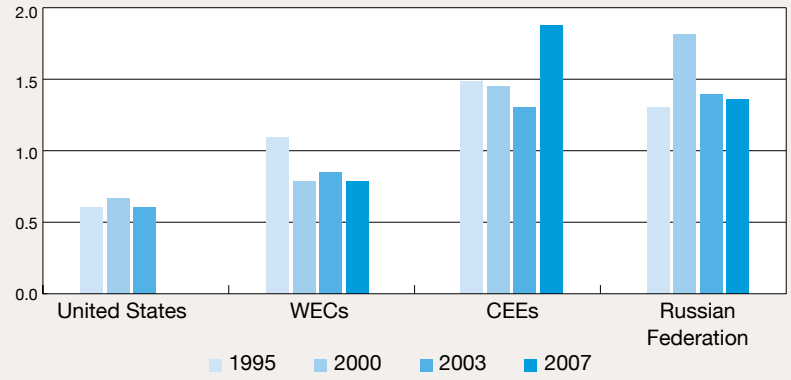
Roy Cummins
Chief Commercial Officer
Global Ports Investments Plc
Russia

Such increased levels of investment are present in other emerging markets as well. We have already noted the high levels of GDP growth anticipated in some emerging markets, making it likely that some of the emerging countries of today may be the industrialised ones of tomorrow. Can a concentrated focus on transport infrastructure dissolve bottlenecks in these markets? China's aggressive infrastructure spending (growing by 20% annually) accomplished in two decades what the United States realised in 50 years.[17] So certainly catch-up demand is also a topic in some developed countries, like the United States, which will need to play catch-up after years of low spending levels on infrastructure.

For emerging countries, though, the challenge of ensuring sufficient levels of investment in transport infrastructure may be compounded by the difficulty of attracting finance from the private sector. A country's national credit rating depends upon government stability and economic performance; some emerging nations are still facing relatively low national credit ratings. Consequently, they are very dependent on multilateral institutions such as the World Bank. In contrast, most mature economies profit from robust credit ratings.

Our Delphi experts uniformly agree that industrialised countries will maintain a leading position in terms of transport infrastructure provision. They rate the probability of emerging countries moving ahead as very low, although they see such a reversal of position as fairly desirable.

Figure 2
Inland transport infrastructure investment trends (% GDP)



Source: International Transport Forum (2009)

Many of the panellists point out that significant differences amongst emerging countries make it difficult to provide one consistent answer, though. China may overtake industrialised countries, however India likely will not. Some note that the substantial investments now underway will not be sufficient to redress the combination of existing global infrastructure backlog and growth in demand for emerging as well as developing countries. Further, given the long-term planning cycles necessary for transport infrastructure, twenty years is seen as a too short time-frame to speak about overtaking; although emerging economies may close the gap with developed markets somewhat.

With regards to the growth prospects of emerging countries, enormous investments are needed in transport infrastructure development. But until the massive investments in transport infrastructure in emerging countries are implemented, logistics service providers will still face significant difficulties in transport operation. They will need to develop innovative supply methods (local adaptability, simplicity).

Rural exodus — Transport infrastructure development strongly focuses on urban areas following the global trend of urbanisation.

Over 60% of the world's population will live in cities by 2030 — a figure clearly indicating the global megatrend of urbanisation.[18] Urban areas will continue to attract greater levels of commercial investment in the future and global capital flows in transport infrastructure are likely to reflect this trend.

Today, half of the world population still lives in rural areas.[19] Only 69% of rural residents have access to reliable transport, as measured by the Rural Access Index (RAI) developed by the World Bank. The RAI measures the number of rural inhabitants living within two kilometres of an all-season road as a proportion of the total rural population. According to the World Bank, the RAI has significant links with other parameters such as poverty, since physical isolation contributes to poverty.[20] Taking a closer look at the RAI in different countries of the world (Fig. 3) different ratings can be identified in developed as well as developing countries. In India, 301 million people do not have access to rural transport. While the situation in China is far better according to the RAI, China still has 23.5 million people who live without access to transport. In order to improve connectivity, in 2009 China announced the "Logistics Industry Rejuvenation Plan" which focuses on enhancing the connection between more developed coastal markets and less well-served interior markets. The aim is to promote rural development and improve internal supply chains.[21]

One key obstacle to the provision of rural transport infrastructure is that often development does not go beyond the implementation of basic infrastructure, when a more holistic approach that assesses adequate financing and coordination with other transport services is critical.[23] Rural transport development needs to take into consideration the access needs of rural communities. The goal should be to design transport infrastructure at a low cost which supports the establishment of networks within a rural area.[24] Additionally, the infrastructure model needs to be

designed as a hub and spoke system providing appropriate connectivity between rural and key urban areas.

Currently transport infrastructure investments tend to follow global capital flows; in practice this means transport infrastructure investments focus on urban areas. Cities benefit from so-called agglomeration effects, where clusters of economic activity reduce costs and enhance productivity for individual companies, thereby attracting additional companies also looking to benefit from local suppliers, labour pools and other factors contributing to economies of scale and network effects. This cycle creates economic growth which restarts capital flows. The result of this interdependence between investment and economic activity may be positive for urban areas, but is effectively a vicious circle for rural regions, which receive less investment in infrastructure and as a result are less able to drive economic growth.

Our Delphi panel rates a continued focus on investments in urban areas as very likely. Many panellists see continued growth in urban populations and their relative economic strength as deciding factors. Some panellists also point out the importance of ensuring that the agricultural products raised in rural areas remain well connected to cities and ports. If rural connectivity is not provided, the complex supply chain network for freight transportation will operate less efficiently, disrupting the flow of goods and negatively affecting logistics processes. One panellist also suggests that the internet could potentially "change the game", though, and could shift the relationships between cities and outlying areas.

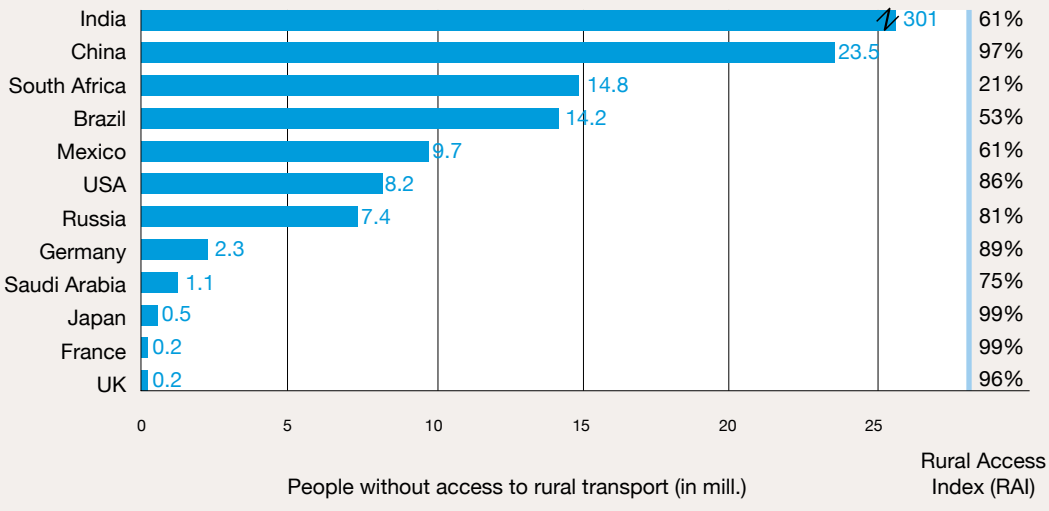
Wealth is likely to continue to concentrate in urban areas. Governments will need to provide financial incentives to private players to encourage infrastructure development in rural areas, where servicing costs will continue to be higher. For logistics service providers, offering service to rural areas will likely be less profitable and smaller in scale, although a concentration on rural areas could prove to be a business opportunity for niche logistics service providers.

Call for regulation — Although the drawbacks of regulation are well-known, strong arguments promoting regulatory measures such as road tolls or congestion charges will prevail.

Governments of some cities have already successfully instituted regulation designed to help efficiently manage existing infrastructure capacities. Primary examples include the congestion charges instituted in London, Singapore and Stockholm. Do these successes prove the claim that the key challenge regarding transport infrastructure bottlenecks is not only the provision of new infrastructure capacities, but also the more efficient management of existing capacities?

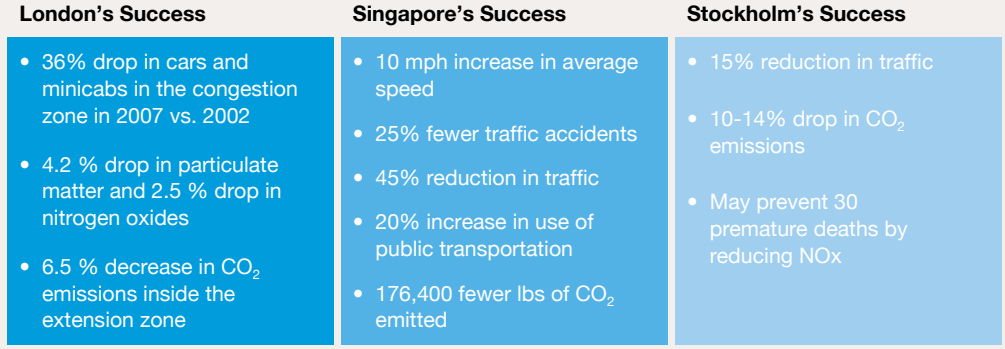
Certainly such programmes have some clear advantages. Congestion pricing provides the opportunity to differentiate between private and commercial transport infrastructure users, to distinguish between public or private usage and to manage demand on a cost-efficient basis. Additionally,

Figure 3
Access to rural transport measured by total population and the RAI Index



Source: World Bank[21]

Figure 4
Impact of congestion charging on city zone



Source: Environmental Defense Fund, Transport for London [27] [28]

in case of infrastructure usage exceeding an optimal level, e.g. high levels of congestion, delays etc. can in some cases be reduced by active intervention.[25] Another advantage of congestion charging schemes is the "early warning function": if the collected charges exceed the level determined by the maximum capacity, road capacity is operating at its limit and needs to be extended.[26]

In London, Singapore and Stockholm, congestion charges have achieved success in reducing traffic and emissions (see Figure 4). Still, critics point out that congestion charging systems require expensive capital investment and have relatively high operating costs.[29] For example, the costs of operating and enforcing the Central London Area charge diminished the users' benefits provided by the scheme by 50%. If such a scheme could be implemented and operated at no cost, benefits would be twice as high or tariffs could be kept at a lower level.[30]

Efforts to implement such regulation face a variety of different types of risk around demand and enforcement which must be managed and are also highly political. Charging fees have to level off at a moderate level, so that traffic in the charging zone is not wholly deterred, as a certain level of traffic is required to generate revenues covering at least the operational costs of the charging scheme. It can be politically unpopular to introduce congestion charges or tolls, particularly on existing infrastructure.

Public toll roads represent another potential regulatory measure and diverse schemes are in place. These differ in their technological applications, scope of included user groups and charging procedures. In 2005, Germany implemented a satellite-based electronic tolling system for trucks. The toll is calculated according to the number of axles and vehicle emission class. In January 2009 fees were raised according to emission classes in order to incentivise the use of lower-emission vehicles. This measure had the added benefit of raising an additional US$1.3 bn for transport infrastructure.[31] Some emerging countries have also introduced toll roads, e.g. China, South Africa, and other such roads are planned in Uganda, Nigeria and the Philippines.[32] [33] The Netherlands are planning to go a step further than Germany and implement a satellite tracking system on all vehicles over the next decade.

Another important example of regulatory measures which facilitate user-based financing can be found in Norway. Between1996 and 1999 Norway financed more than 28% of the country's total annual road construction through tolls collected from road users throughout the country.[34]

The Delphi panel agrees that regulatory measures are somewhat likely to compensate for transport infrastructure investments (60%), and rates such a development as desirable. The panellists offer a number of arguments in favour of such measures. Some believe that congestion charges will lead to better capacity exploitation and represent the most probable source of funds to invest in transport infrastructure. Others believe that increasing environmental awareness will be a trigger for such measures, which look to internalise external costs. One panellist cites the impact of the recent recession, which changed country specific transport infrastructure funding requirements

and revised cash flow positions. These changes resulted in a need to find new sources to fund expansion and maintenance. Regulation and tolls are then seen to play a role, especially in developed countries where growth rates are expected to be minimal.

There were significant differences in how various respondent groups viewed the probability of regulatory measures, with politicians giving by far the lowest probability rating (49%), most likely due to foreseen issues with political feasibility. Transport infrastructure users attribute the highest probability that toll roads, congestion charges and the like will prevail (68%). Developers, operators, associations and academia clustered between these two groups.

Regulatory measures, if risks are balanced appropriately, offer the prospect of a two-fold dividend: they help to provide funds to reinvest in transport infrastructure and to reduce traffic volumes. Efficient pricing based on external cost matches supply and demand at its most efficient point, leading to direct economic benefits by reducing externalities (i.e. congestion, pollution) to the optimum level. Large-scale implementation of road pricing is foreseen, so users should be prepared to pay more for using transport infrastructure in the future.

Megacity, the (un)solved puzzle — many pieces or one big picture?

Transport infrastructure is perceived as one of the greatest economic and environmental challenges for megacities.[35] Whereas North American and European cities are mostly concerned about the maintenance of their ageing transport infrastructure, emerging cities face the challenge of rapidly building up new basic transport infrastructure capacities.[36]

In many areas semi-independent satellite cities have developed over the course of time. These have often evolved from strictly residential areas to areas with an independent commercial base. Completely independent satellite cities are often former suburbs; they represent new towns within the metropolitan area and shift the focus away from one core city centre.[37] Urban and metropolitan areas have also often evolved from mono-centric systems to poly-centric urban forms — well-known examples are New York, London and Paris. Megacities in Asia, however, grew more rapidly than European ones and are generally more centralised, with satellite cities not able to take pressure away from the core city centre.

Transport infrastructure represents a key success factor to attract economic investments, however how transport infrastructure and city structures interact and influence each other's development remains unclear. Does transport infrastructure influence the structure and infrastructure net of urban areas, or does it follow urban developments which are happening due to other factors?

The responses of our Delphi panel reflected uncertainty around the cause/effect relationship of transport infrastructure and the fragmenting of megacities into broader areas including satellite cities (probability 50%). Some panellists argue that if the division of megacities occurs, it will be driven by other factors above and beyond infrastructure issues, e.g. concerns around how to govern, finance and provide services to large areas. In the view of some panellists, technology development will drive improved centralised efficiencies in city traffic management and congestion pricing, and the allocation of resources will require consolidated management or at least governance and administration. These factors would decrease the likelihood of such fragmentation. Others believe that increased congestion and growing environmental awareness will prompt a widespread division of megacities into sub-cities.

All-embracing logistics coverage in megacities must overcome significant challenges to provide last-mile services in densely populated areas, a costly exercise. Some Delphi panellists therefore argue that decentralisation into regional networks is economically reasonable.

The impact of transport infrastructure on megacities' structure and development remains uncertain. Governments should actively encourage the development of transport infrastructure supporting poly-centric city structures which prevent congestion and other problems associated with an unchecked urban sprawl. Governments must manage urban transport infrastructure and undertake long-term transport planning in order to deliver sustainable urban areas. Regardless of how city structures develop, logistics service providers will need to rethink city delivery services programmes and develop innovative city logistics solutions (e.g. last-mile services, home deliveries).

Section 2

Changes in finance

Theses

6) 2030: In emerging countries, there is more capital available to invest in transport infrastructure than in industrialised countries.

7) 2030: Financing the maintenance of transport infrastructure is more difficult than attracting investments in new infrastructure.

8) 2030: Financial pressure on governments has become so intense that almost all investment in transport infrastructure has been shifted to the private sector.

9) 2030: Governments are no longer able to contribute to the funding of local transport infrastructure (e.g. main roads and subways), thus user-based financing structures are prevalent.

10) 2030: International transport infrastructure (e.g. major ports and airports) is controlled by private investment funds, which are strategic drivers of large-scale transport infrastructure projects.

Cash is King — But the financial power for investment in transport infrastructure varies from country to country. Whether a country is already industrialised or emerging does not shed any light on the availability of capital.

The rapid economic growth and development of emerging countries in recent years indicates that the focus of economic power is shifting. According to a PwC economic analysis, today's economic powerhouses ('G7', including the US, Japan, Germany, UK, France, Italy and Canada), will be overtaken by the current emerging economies 'E7' by 2050. By that date the E7 economies are projected to be around 25% larger than the current G7, when measured in dollar terms at market exchange rates (MER), or around 75% larger in purchasing power parity terms.[38] Established industrialised countries will see their relative GDP shares decline, although per capita incomes will remain much higher than those in emerging markets. Other studies claim that the new generation of leading economies will come from the Eastern hemisphere including China, India, Japan, Korea and Indonesia, while the Western hemisphere lags behind.[39] Such a shift in economic power would argue for greater availability of capital in emerging nations.

National economic performance is one indicator of the availability of public finance for transport investment. Since much of the financing burden for transport investment is shifting to the private sector, though, it is by no means the only one. International capital flows are already very global, and likely to remain so. Foreign direct investments (FDI) inflows represent capital provided, either directly or through other related enterprises, by a foreign direct investor. Transport infrastructure stimulates FDI inflows to a country, since companies looking to invest will benefit from better accessibility and reduced transport cost. FDIs experienced an immense decrease in 2008, down about 21% to US$1.4 trillion.[40] Developed countries mainly supply FDIs to emerging countries, accounting for 84% of global outflows.

How do investors decide where to invest? The socio-political environment of a country is one critical factor in assessing the viability of transport infrastructure projects. In order to attract private contractors and investors, a certain amount of political stability is necessary. If the environment is not conducive to investment, necessary capital will go elsewhere. Even if access to finance exists, an uncertain, unstable and confusing policy framework could create huge risks in accomplishing transport infrastructure projects in time and within estimated costs. Delays or cost overruns could jeopardise the financial viability of the project.

As already noted, investment needs vary widely from country to country, ranging from the development of completely new systems to the renewal and/or upgrading of existing transport infrastructure. These diverse types of projects require different amounts of capital and vary in their attractiveness for investors, both foreign and domestic.

Our Delphi panel is divided in their views as to whether or not there will be more capital available in emerging countries to invest in transport infrastructure until 2030; they rated the probability of such a shift as uncertain (52%). One argument holds that the time frame of twenty years is too short to close the existing financing disparities between emerging and industrialised countries. Others suggest that emerging countries will first need to invest in industrial development. Transport infrastructure is not likely to be a top priority. Further, emerging countries are often dependent upon FDIs and capital flows from industrialised regions. At present it is difficult to forecast the availability of such resources in 2030.

Another set of panellists offer views on why emerging markets may indeed have greater access to capital in 2030; a few are already observing this trend in China and India today. Some panellists believe that emerging countries will profit from capital migration, since returns on investment of transport infrastructure projects are higher. One panellist notes that "well-behaved" emerging markets, e.g. those with stable political regimes, will receive the "biggest piece of the cake". Others see higher investment flows in transport infrastructure as a normal consequence, given that countries looking to catch-up in terms of infrastructure will need to establish transport, mobility and connectivity.

Logistics service providers looking to make strategic decisions about entering new markets need to understand those markets fully; this means assessing both the probable availability of capital and the willingness of governments to invest in transport infrastructure.

A tougher nut to crack — Financing the maintenance of transport infrastructure will be a greater challenge than attracting capital for investments in new transport infrastructure.

Many developed countries have not kept up with the deterioration of existing transport infrastructure, which in

some cases has also not kept pace with increasing trade volumes. As a result, some systems are in dire need of repair and modernisation. Moreover, the financial weight of maintenance is often underestimated.

According to the OECD, over the period from 2010 to 2030, US$ 220-290 bn per annum will be required globally for infrastructure construction including maintenance and replacements.[41] For roads, the largest part of road infrastructure requirements arises from the need to maintain, upgrade and replace existing roads. Recommendations vary on the amount required for maintenance. In 2002, the European Conference of Ministers of Transport (ECMT) recommended a share of 1-2% of GDP.[42] World Bank researchers Fay and Yepes have proposed a more differentiated analysis with different recommendations for low and middle income countries, as well as fully developed countries. According to their model, the maintenance expenditure needs in infrastructure vary between 3.3% for low income countries, 2.5% for middle income countries and 0.76% for high income countries.[43] Required investment rates for maintenance are higher in developed countries, whereas developing countries have higher investment needs in general than developed countries, including slightly more investments in new infrastructure.[44]

Investments in infrastructure maintenance generate double returns. First of all, maintenance expenditures in the required amount will fully utilise and probably extend the lifecycle of transport infrastructure facilities. Secondly, as a consequence, investments in new construction may often be deferred. Estimates suggest savings of approximately up to 5% of new construction requirements (i.e. US$ 10-15 bn per annum globally).[45] Further, if existing infrastructure is not adequately maintained, resulting shortcomings will negatively influence the performance of infrastructure users and indeed all supply chain players, undermining their ability to provide reliable and cost-effective transportation services. In addition to reduced lifecycle costs and improved asset performance, there are other potential benefits from optimising maintenance expenditures, including greater access to finance, improved risk management and increased regulatory credibility.

Infrastructure maintenance should be seen as a key element of asset management, as it impacts the whole lifecycle of an asset. It is also vital to maintain customer satisfaction and value. In the railway sector in particular, there is a growing pressure on governments to develop new innovations in asset management. Continued underinvestment and business-as-usual transportation policies and programmes will boost the current vicious circle, where individual players quarrel over the use of infrastructure across national boundaries. Failure to develop progressive policies could negatively impact some countries' ability to compete in the world economy. Key issues in relation to asset management include a lack of appropriate asset data and information, the absence of a lifetime performance management regime, inappropriate assessment of lifetime requirements and ineffective work management. Making better use of asset related data and aligning the interests of finance and engineering around asset performance could reduce asset lifecycle costs.

The experts on our Delphi panel are acutely aware of the importance of adequate maintenance of transport infrastructure. They see it as highly probable that financing the maintenance of transport infrastructure will be a greater challenge in the future, since investments in maintenance are thought to be more difficult to attract. Reasons given include low rates of return for maintenance projects, the strong lobby of the construction industry pushing projects for new infrastructure in the sector and strategic decisions by politicians to gain awareness by promoting new infrastructure.

Politicians rate the difficulties in attracting investment in transport infrastructure maintenance highest, closely followed by infrastructure operators and academics. Infrastructure users are again more optimistic than the other respondent groups, even though they are most directly impacted by poor infrastructure conditions.

The panel viewed such difficulties negatively; they gave this thesis the second lowest desirability of all our theses (2.1). Given the prevailing view that attracting investment flows for maintenance will be even more difficult in 2030, a general deterioration in asset condition looks likely. Many feel such an emphasis creates a worst-case scenario which will inhibit long term economic growth.

Maintaining existing transportation infrastructure is vitally important. Governments need to find an appropriate balance between investments in transport infrastructure and an ongoing financial commitment for the maintenance of existing facilities. This can only be achieved by considering funding models which take into account maintenance expenditures. Further, governments will need to focus on lifetime performance, rather than purely on upfront costs and ensure whole life funding for infrastructure.

Public or private? — Despite strong financial pressures, governments cannot completely shift transport infrastructure investments to the private sector.

Many governments have a fiscal mountain to climb as they deal with the combined effects of state bailouts and stimulus packages, recession and the consequences of the financial crisis extending beyond banking boundaries.[46] Yet the current economic environment presents a potential dilemma: while budgets are extremely tight failing to invest could jeopardize future tax revenues, as investment in infrastructure in both developed and emerging markets underpins national economies and has the potential to stimulate economic growth. Consequently, governments are looking to find other ways of financing infrastructure.

"The call for private investments in transport infrastructure has never been louder, since public spending has never faced closer scrutiny."

Christian Leysen
Executive Chairman
AHLERS Belgium NV

Involving private finance to fund infrastructure is not new and can take different approaches, from the monetisation or privatisation of existing infrastructure to concessions or partnerships to develop new assets. Such private finance may come in the form of equity investment, from both corporate and institutional investors, or in the form of debt, whether from commercial banks or capital markets. Private financing does not create "new money", rather it provides access to new sources of borrowing and thereby accelerates the development of new infrastructure projects.[47] Such investments are already happening on a large scale. The global private project finance debt market in infrastructure accounted for US$ 139.2 bn in 2009. Investment in transport infrastructure totalled US$ 25.45 bn (17%), the third largest share of the pie after the power and the oil & gas industries.[48]

An approach that has attracted much attention in recent years is for public authorities to come together with a private sector party as a public private partnership (PPP). There is no universal definition of a PPP. Often it refers to an arrangement that expands beyond financing and also leverages private sector resources, expertise and management practices. The private sector party takes the responsibility for building new infrastructure, including relevant risks. In some cases, the private sector party also manages the operation and maintenance of the asset over the long term. The private sector party is expected to arrange the necessary financing, while the public sector will pay for the availability and operation of the asset. The PPP approach has been applied to a wide range of infrastructure including roads, airports and light rail.

But PPPs are complex arrangements with some pitfalls. Many rely on raising long term debt, yet in the current turbulent economic times debt has become more expensive, lending terms more restrictive and long term debt markets have experienced severe capacity constraints. Figure 5 shows the drop in the value of total debt and equity invested in global PPP deals in 2009.

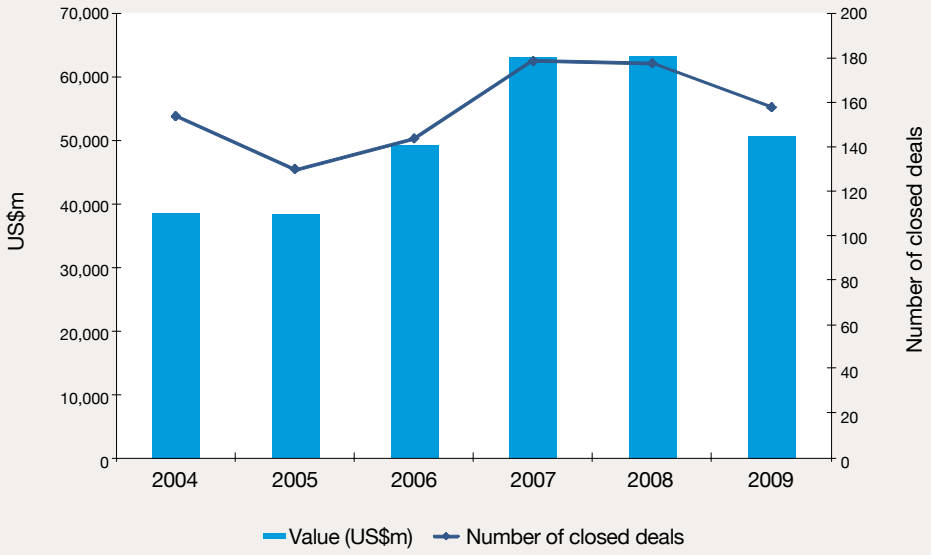
These global numbers do not reveal significant country and sector variations in the extent to which PPPs have been used. More mature markets that have utilised the PPP procurement route over a number of years have typically had more success in engaging the private sector in public infrastructure. Players in mature markets are more likely to have developed the necessary transparency and robust processes needed to execute a PPP successfully.

Views of the Delphi panellists are divided on the question of whether public or private actors will take primary responsibility for transport infrastructure investments. Panellists gave a full-scale shift to the private sector a fairly low desirability rating (2.7).

In general, the panel agrees on the need for co-financing with the private sector, due to the restricted financial situation of governments and their increasing focus on the social sector. Some panellists raise the argument that the private sector is likely to "cherry pick" projects with high returns and will avoid projects requiring long-term financial commitment. Such selectivity would prevent a complete shift to the private sector.

Many Delphi panellists emphasise that the role of governments will remain important in a number of ways. Governments will need to ensure just treatment for all citizens and guarantee the maintenance and security of infrastructure,

Figure 5
Global PPP deals in value of total debt and equity invested



Source: Dealogic ProjectWave

invest in connecting outlying areas and considering socio-economic factors, rather than solely considering profitability factors. One drawback to a shift to the private sector is seen to be that the population would be less able to influence decision-making on infrastructure.

Private investments can help transport infrastructure operators and governments to raise capital for transport infrastructure projects, but are no panacea; their applicability depends on the individual financing case and the approach taken.

Local roads for local votes — Funding of local transport infrastructure will remain a key responsibility of public authorities looking to meet voter expectations.

State and local governments are confronted with citizens' increasing demand for public services at a higher level and quality of service. At the same time, citizens are unwilling to pay for this higher service level through higher taxes. They rely on the governmental responsibility to guarantee services of general interest, for example transport and energy. Public authorities have specific public-service obligations in these areas.[49]

Many state and local governments operating with fewer financial resources are struggling to raise the revenue required to provide the level and quality of services demanded. Some governments have begun moving away from a purely tax-based model and are looking to develop and implement more innovative means of raising revenue.[50] In general, local transport infrastructure projects have not been considered a priority by private investors. The maintenance and funding of small-scale local infrastructure projects has been of very little interest to the private sector, so shifting responsibility for this aspect of transport infrastructure broadly to the private sector looks unlikely.

One possible solution to the funding dilemma might be local congestion charges, however in some cases the implementation of such fees has faced significant barriers. In December 2008 the public of Greater Manchester (UK) voted an overwhelming "No" (80% of voters) in a referendum on the implementation of a congestion charge in the city.[51] The same happened at a referendum in Edinburgh (UK) in 2005, where 75% of the public voted against the introduction of congestion charging in the city.

Another strategy involves shifting to a beneficiary-based financing model which includes infrastructure users as well

as additional "beneficiaries". These other parties who benefit from the transport infrastructure are then also expected to contribute to the cost of construction, operation and maintenance.[52] For example, the extension of the metro system in Copenhagen has been financed partly by property developers, while in San Francisco the Bay Area Rapid Transit (BART) system is funded 50% from tolls and 50% from a regional sales tax. Since all businesses within the BART area benefit from improved transportation systems, they are expected to pay for its development and operation.[53] [54] In the UK, Nottingham City Council is introducing a workplace parking levy (WPL), where employers offering free or relatively cheap workplace parking are charged. The revenues from the WPL will be invested to improve the public transport system.[55]

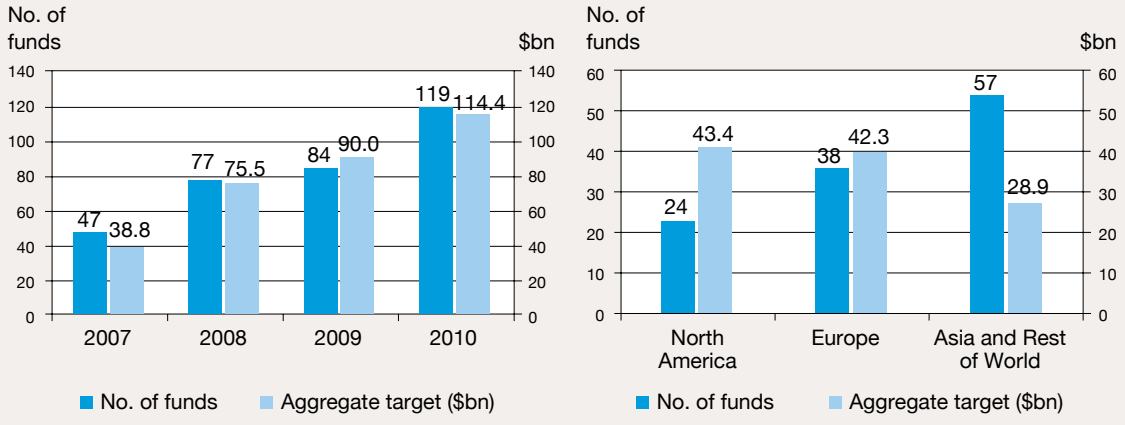
Further, tax increment financing (TIF) is a "value capture" mechanism that has been widespread in the USA for a number of years and is gaining support elsewhere in the world. TIF is a relatively straightforward mechanism whereby a public body takes out a loan secured against future incremental tax revenues so as to finance current infrastructure and development projects. Transport infrastructure, in particular, can increase surrounding land values and lead to regeneration and new investment in the nearby area, bringing with it incremental tax revenues, e.g. through additional business rates.

Our Delphi panel is again split on the question of whether governments would need to rely on user-based financing structures to fund local transport infrastructure. Panellists rate the probability of such a shift as unsure (52%), and also saw such an occurrence as relatively undesirable (2.4). Comments from the panellists suggest that many believe that local infrastructure should remain a key responsibility of governments. Governments have to provide the backbone for a sustainable society, ensuring basic infrastructure for social equity. Some panellists cite political hurdles to switching more fully to user-based financing; such a move would directly affect the cost of mobility, which many voters will not accept.

Not surprisingly, politicians and associations rank this shift the least likely (46%), and also give it the lowest desirability rating. Comments suggest that such a move could create a loss of social cohesion and that aspects of infrastructure investment beyond purely economic arguments would lose importance. Academics and transport infrastructure users are somewhat more likely to see this shift as probable (57% and 52%). They regard the mix of public and private funding as likely, and anticipate an increase in user-based financing models, given that it seems unlikely that the private sector will be able to bear the full demand risk and the public sector will not be able to fund investment fully by itself. Local governments face far greater challenges, e.g. in road maintenance, than do federal governments, and their abilities to access new sources for funding are limited.

New financing models for transport infrastructure already exist around the globe, however governments have to explore these alternatives in order to realise a fit between financing models and local needs.

Figure 6
Infrastructure funds in market and by geographic focus



Source: Prequin Infrastructure Spotlight[58]

Governments will be in charge of transport infrastructure procurement, but they will focus on contributions from the key beneficiaries of new infrastructure.

X-border goes private — private investment funds will be strategic drivers of international large scale transport infrastructure projects.

The impact of recent financial turmoil on the infrastructure market has been significant. The severe retrenchment in debt availability and postponed or cancelled asset deals challenged the market. Additionally, the Private Financial Investment (PFI) sector struggled with debt contraction for long-term debts such as PPPs, resulting in diminishing returns for investors. Even well established funds faced challenges in refinancing short-term acquisition debt.

In spite of this, the financial attractiveness of infrastructure investments supported the continued growth of infrastructure funds in the last decade. Currently, there are a record number of infrastructure funds on the market: 119 unlisted infrastructure funds are seeking an aggregate US$ 114.6 bn in capital commitment.[56] Asia and the rest of the world together account for substantially more funds than Europe or North America, illustrating the growing importance of emerging markets.[57] In terms of capital sought, fund-raising targets of emerging market-focused funds are lower than those focused on more established markets, so the smaller number of funds in North America and Europe are targeting more total volume.

Infrastructure funds appeal to investment managers because of a number of underlying trends suggesting the appeal of such investments over the long-term. In the next twenty years, the world population will increase by 1.4 billion; new inhabitants will generate housing and infrastructure needs of more than US $20 trillion, so demand will remain robust.[59] [60] Further, the long-term lifecycle of infrastructure assets closely correlates with the long-term investment periods that fund managers require for their portfolios.[61] Recent trends towards government intervention and active investment in infrastructure projects have also helped to sustain interest from fund managers.

The majority of investments in infrastructure funds to date have gone into large-scale transport infrastructure projects (airports, ports, toll roads).[62] The most significant funds coming to market are large global funds targeting on an international level, while smaller funds are regionally restricted.

The thesis “2030: International transport infrastructure (e.g. major ports and airports) is controlled by private investment funds, which are strategic drivers of large-scale transport infrastructure projects”, is seen as somewhat likely by the Delphi panel. Panellists point out, however, that such assets are of key strategic importance to national economies. Given the “gatekeeper” role of some of these assets and their vital importance, governments should keep some aspect of control, although infrastructure funds may become an even more important source of financing.

Major private investment funds will primarily focus on international large scale transport infrastructure projects. They will invest in national transport infrastructure only if the deal size is substantial and thereby economically essential, or if it offers a programme of opportunities.

Section 3

The power of competitiveness

Theses

11) 2030: Transport infrastructure is still a key element of the basic services of an economy, but is no longer a deciding factor in the competition between countries to attract investment.

12) 2030: Digital infrastructure (ICT) has become a stronger driver of economic growth than transport infrastructure.

13) 2030: The success of a logistics cluster (logistics region) depends on the close collaboration of industry, government and academia, in addition to advanced transport infrastructure.

Make or break — Transport infrastructure remains a deciding factor for the economic prospects of a country.

Transport infrastructure is a pre-requisite for an economy's success, alongside other competitive criteria, such as educational system, taxation, regulation and crime rate. Recent studies have shown that the ability to deliver integrated transport systems will be a key enabler to realise economic success in the future.[63]

Indeed, an efficient transport infrastructure is a crucial prerequisite for local businesses and foreign investors to operate successfully. Poor transport infrastructure or low public investments increase costs for firms and decrease attractiveness for investors. Studies suggest that transport infrastructure quality has a notable effect on cost levels: improvements in transport infrastructure can directly reduce operating costs in a number of different industries. Researchers have found that an improvement in infrastructure will decrease costs by 11 to 21%, depending on the industry under review.[64] Other findings have shown that an improvement in airport infrastructure from the 25th to the 75th percentile can reduce air transport costs by around 15%.[65]

The important role of transport infrastructure may be even more critical for emerging markets. While emerging economies may be able to offer cost advantages due to lower labour or production costs, these effects could easily be offset by higher transport costs resulting from inadequate transport infrastructure. Investors planning projects in a particular country need to assess carefully the transport infrastructure available before they can make effective investment decisions.[66]

When we asked our Delphi panel to assess the thesis "2030: Transport infrastructure is still a key element of the basic services of an economy, but is no longer a deciding factor in

the competition between countries to attract investment.", the panel reached a consistent conclusion. According to our experts, it is rather unlikely (41%) that transport infrastructure will lose its appeal for investors.

Even though some experts suggest that other issues such as taxes, safety, cost and quality of workforce might be more important than transport infrastructure for investors, the majority of the experts provide arguments which underline transport infrastructure's importance. One group of experts stresses that poor quality of transport increases operating costs in various ways. Firstly, inventories have to be increased, as time-critical supply of goods or raw-materials becomes more difficult when a certain quality level of transport infrastructure is not given. Secondly, delivery of goods or raw-materials becomes more time-consuming and thus, more costly. Consequently, our experts agree that transport infrastructure remains a major factor in the decision making process on where to set up manufacturing facilities and where global trade will take place.

"We should never underestimate the lifelines of a country! The media and politics like to focus on growth and production. However, that has to be amended: whether a nation is attractive for domestic and foreign investors strongly depends on whether its infrastructural lifeline can optimally supply all areas of the value chain."

Prof. Dr. Christopher Jahns
President
European Business School
Wiesbaden, Germany

In addition, some experts highlight that in the absence of sufficient transport infrastructure, the return on investment in research and development and innovation will be lower. Furthermore, some experts on our panel theorise that as globalisation continues, the level of competitiveness between countries will converge over the long run. As differences in such factors as the cost of labour even out, transport infrastructure will become the ultimate criterion for a country to gain competitive advantage. Countries which can provide an effective and efficient transport infrastructure which assists investors in operating as cost efficiently as possible will have the edge.

Integration of transport infrastructure becomes a key competitive factor. In order to secure the future flows of foreign direct investments, it becomes even more crucial to maintain, upgrade and expand transport infrastructure.

Infrastructure 2.0 — Integration and digitisation will take transport infrastructure to the next level.

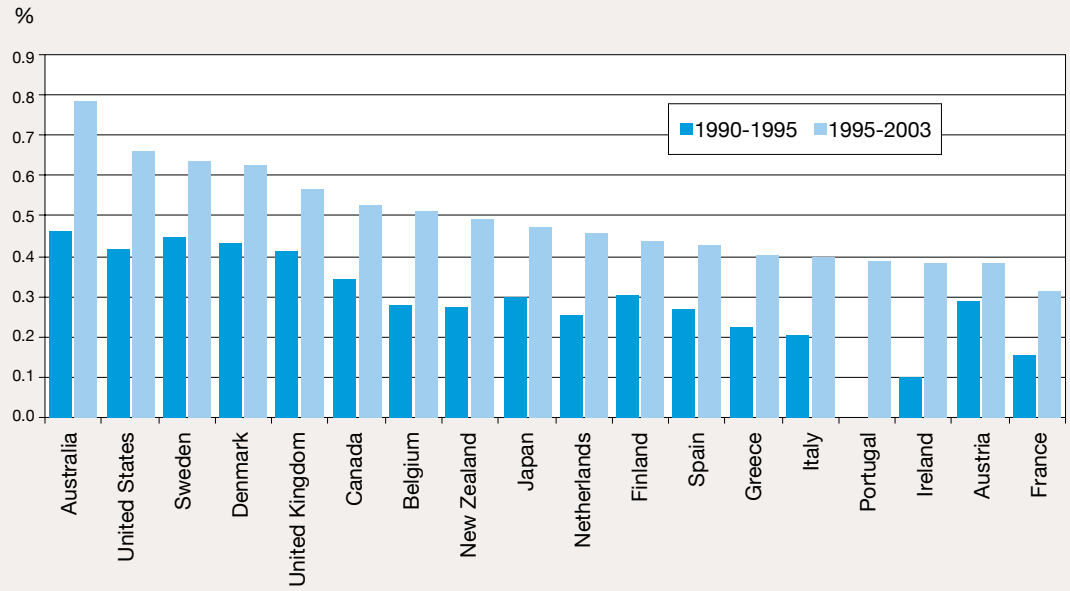
Many economists see digital infrastructure (ICT) as a critical factor for the acceleration in productivity and economic growth during the latter half of the 1990s and the beginning of the 2000s. ICT has ascended to a "General Purpose Technology" which offers the opportunity to transform economic process into a "New Economy".[67] Processes or even businesses which used to be physical in nature are becoming digital.

The strong relationship between ICT investments and economic growth is not purely subjective. Several studies on OECD countries have analysed this relationship and expressed it in precise numbers. ICT investments have been shown to contribute around 0.3 to 0.8 percentage points to a country's GDP growth. For a selection of OECD countries, this relationship is presented in Figure 7.

The stimulation of economic growth by ICT can be observed from several different perspectives. On individual company level, effective ICT infrastructure assists in increasing process efficiency or reducing operating and/or administrative costs. Furthermore, ICT enables firms to access new and larger markets, as new products or services can be offered. From a governmental perspective, ICT is valued due to its positive potential to improve national productivity, including the positive impact on GDP growth mentioned above. Various other studies have also analysed this relationship and found significant correlations. In some cases ICT is credited with the creation of a large number of new jobs and increasing national competitiveness.[68]

The World Economic Forum has stated that the U.S. economy is expected to see a tenfold return on every dollar invested in broadband upgrading. In Europe some estimates suggest that faster broadband deployment could create one million new

Figure 7
Contributions of ICT investment to GDP growth



Source: OECD Productivity Database, September 2005, [www.oecd.org/statistics/productivity]

jobs and growth of up to 850 bn Euros by 2015. Even more potential can be realised in emerging markets: If ICT levels are raised to standards present in Western Europe today, the emerging countries' GDP could be enhanced by US$ 300 to 420 bn and 10 to 14 million new jobs could be created.[69]

While it is highly unlikely that ICT will replace transport infrastructure, it can be used in a wide variety of ways to maximise the capacity and effective use of transport infrastructure. The flow and usage of highways and public transport can be controlled, e.g. with traffic signals, ticketing etc. ICT incorporates the potential to provide the customer, either individuals or businesses, with personalised transport portals showing regular journeys, nearby options by transport mode, current incidents that may affect their travel choice etc. ICT might also become a driver for modal shift by displaying the customer's carbon footprint and comparing available alternatives by cost, time, convenience and environmental impact. Such innovations suggest that the development of digital systems offering high degrees of personalisation or corporate tailoring will become a key element in transport infrastructure in the future.

Overall, our Delphi panellists see the prospect of digital infrastructure over-taking transport infrastructure as a driver for economic growth as somewhat likely (59%), although views varied. Transport infrastructure operators rate the probability lowest, while politicians and representatives of associations forecast a higher probability (65%).

Panellists provide a number of arguments in support of the view that ICT cannot replace the need for transport infrastructure completely. Even in the case of mostly advanced digital infrastructures, various products have to be transported physically and the impact of ICT in this area is low. Our experts also argue that ICT's potential to stimulate economic growth still requires the presence of physical transport infrastructure. Indeed, the presence of transport infrastructure is a prerequisite for the establishment of digital infrastructures. Further, one expert sees humans' limited adaptability as precluding ICT from reaching its full potential for stimulating economic growth by 2030.

Some panellists suggest that transport infrastructure and ICT should be considered simultaneously, as the effective combination of both assists in making transport infrastructure more productive and more advanced.

Transport infrastructure development should focus more on integrating digital infrastructure, as ICT will be a key enabler for the development of cutting-edge transport infrastructure. The success of transport infrastructure deployment will increasingly be influenced by professional integration of ICT.

Knowledge[3] — The close collaboration of industry, academia and government in logistics clusters will open up new opportunities in transport infrastructure development.

The idea of economic clusters dates back to a number of researchers in the 19th century. Michael E. Porter further developed the concept in his modern cluster theory which describes clusters as regional concentrations of specialised companies, research institutions and public authorities. Porter argues that multiple linkages and spill-over effects result in an effective and efficient environment for innovation, the exchange of ideas, knowledge transfer and cooperation.[70] [71]

In recent years various knowledge and innovation regions have emerged throughout the world, creating new jobs, profit, improved reputations and further benefits to stakeholders involved in those areas.[72] Cluster success-stories are a global phenomenon. Efforts to benefit from the close collaboration between academia, industry and government can be observed around the world. In the transport and logistics sector, the cluster in the United Arab Emirates (UAE) stands out as a strong example of how transportation and logistics can benefit from economic clustering.

The transport and logistics cluster in the UAE is an essential sector in the region's economy and was responsible for 10.4% of non-oil GDP in 2005.[73] The strong concentration of knowledge and close collaboration of industry, academia and government helped the area to grow quickly. Dubai's port is now one of the biggest and most efficient in the world. It is ranked among the ten busiest ports in the world (with an upward trend) and handles more than 11,000,000 TEUs per year.[74]

Effective teamwork and exchange of knowledge has brought a small region south of San Francisco into a leading position when it comes to the ICT industry: Silicon Valley. The origin of the cluster can be traced back to 1951 when a small research and industrial park was founded under the aegis of Stanford University. Over time, a number of new companies based their headquarters in Silicon Valley, where revenues of more than US$ 473 bn per year are now generated.[75]

Collaboration across business, academia and the public sector clearly has great potential to spark economic growth, and such partnerships may be critical to the future of the transportation and logistics sector. When we asked our expert panel to assess the thesis "2030: The success of a logistics cluster (logistics region) depends on the close collaboration of industry, government and academia, in addition to advanced transport infrastructure", they rated such a trend more probable than any other of our theses (78%).

In their comments, the experts elaborate on how and why a close collaboration between academia, industry, and government is crucial in dealing effectively with future challenges. Governments will need to make sure that sufficient funds are available to finance transport infrastructure, while academia can provide new ideas and solutions from a broad strategic perspective to improve operational processes. Academia can also serve as a source of truly innovative ideas, such as research currently being undertaken on morphing materials, an area we discuss further in chapter 'Opportunities'. The (logistics) industry can work to increase the cluster's attractiveness and implement value-adding services. The success of such efforts can be increased if the parties involved exchange knowledge on a continuous basis. The Delphi panellists believe that such clusters will be the model of the future to enhance innovation and build the competitiveness of a region.

Our experts also gave this thesis the highest desirability rating of any of our theses (4.3). This vision of the future resonates strongly across our entire panel, which in itself reflects the perspectives of a diverse group of transport infrastructure stakeholders.

Logistics service providers should join logistics clusters and actively collaborate with transport infrastructure operators, governments and academia. Players in the logistics arena should establish and foster knowledge exchange and management across company borders.

Countdown to the 2010 FIFA World Cup

Hosting international events has the secondary effect of stimulating urban development and has also become an efficient lever to realise immense transport infrastructure investments. Large-scale events, such as the world fairs in the 19th century and the modern Olympic Games and FIFA World Cup are providing particular impetus for transport infrastructure investments in those countries hosting these mega events.[76]

Such events place their hosts in the international spotlight of media and press and attract hundreds of thousands of spectators. Organisers must provide suitable infrastructure that meets requirements for safety, quality and cost effectiveness. As transport is one of the key factors on which visitors judge the success of such an event, it is essential that the infrastructure and system leaves a lasting positive impression on all users.

Investments in supporting infrastructure, such as extra or improved airport capacity and public transport are often required to ensure the effective operation of the event. It is also important to provide a range of efficient services to both visitors and residents. Such services must be affordable and reflect the needs of users in terms of transport modes.

The 2010 FIFA World Cup soccer tournament is the first event of this kind to be held on the African continent. It is seen as a great opportunity not only for South Africa as host country, but indeed for the whole continent, to profit from the event.

The tournament has also provided an unprecedented impetus for South Africa to overhaul its infrastructure.[77] South Africa has mobilised investments of several US$ billion for the improvement and enlargement of South Africa's infrastructure in the period leading up to the tournament.[78] Apart from the enlargement and renovation of five existing sports stadia and the construction of five new ones, a number of significant transport infrastructure projects have been undertaken. These include:

- A new terminal at the O.R. Tambo International Airport outside Johannesburg, which has specifically been designed to accommodate the capacity of the Airbus A380;
- The new King Shaka International Airport in Durban;
- An enlagement of the existing highway network in place around the largest cities from two or three lanes to four or five lanes;
- The 80-kilometre Gautrain mass rapid transit railway system which will link Johannesburg, Pretoria, and O.R. Tambo International Airport. It is one of the biggest infrastructure projects South Africa has even seen.[79]

Notwithstanding these initiatives, there is controversy about the manner in which short-term events like the 2010 FIFA World Cup actually deliver sustainable and long-term benefits to the transport and other infrastructure of hosting countries. For example, large investments in transport might displace public funds or delay other projects of public interest.[80]

Section 4

Spread of sustainability

Theses

14) 2030: A decrease in environmental awareness and regulation has accelerated the realisation of large-scale transport infrastructure projects, boosting economic growth.

15) 2030: Transport infrastructure operators are obliged to participate in emission trading systems to obtain pollution permits.

16) 2030: The environmental costs caused by infrastructure development (including emissions resulting from construction) have become a serious deterrent to investments for which there is otherwise a good economic case.

Gaia's green guidance — Transport infrastructure should be built on a solid foundation of environmental assessment.

The word "Gaia" has its roots in Ancient Greek and stands for "land" or "earth". Gaia is primarily a Greek goddess personifying the Earth or "mother nature". The title "Gaia's green guidance" suggests the increasing importance of environmental considerations for transport infrastructure projects.

Few observers would argue that transport infrastructure does not affect the environment. It is widely understood that infrastructure has an impact on the environment — at least an indirect one. The construction of highways and roads may require deforestation and cause biodiversity losses or other negative environmental effects. While infrastructure is needed to enhance economic growth, it is also critical to understand how projects will affect the environment.[81]

Comprehensive assessment of environmental impacts is critical in order to find an acceptable balance between promoting economic growth through the expansion of transport infrastructure and protecting the environment. Indeed, in many countries such assessments are now required by law. The European Community's Directive 85/3777 as amended by Directive 97/11/EC requires member states to ensure assessment of any project that is likely to have a "significant effect" on the environment prior to its approval. The US has required environmental assessments for some projects since 1969, and a number of other countries also have similar legislation in place. Strategic environmental assessment (SEA) has also emerged in recent years as a tool aiming to integrate environmental considerations into plans, programmes, policies and laws.[82] Prior to the emergence of SEA, individual projects were generally viewed in isolation, whereas SEA encourages a more holistic approach during the planning stage and

beyond. Environmental awareness is also growing in many emerging countries, where efforts to make transportation projects more eco-friendly can also be observed.[83]

Although environmental awareness is currently rising, we wanted to challenge our panel to consider whether this trend might reverse. We asked panellists to evaluate if a potential decrease in environmental awareness and regulation might prevail, accelerating the realisation of large-scale transport infrastructure projects and boosting economic growth by 2030. The expert panel gives this thesis a very low probability rating (29%); they agree that such a shift is very unlikely. Surprisingly, infrastructure developers and operators rate the probability of occurrence of this thesis even lower than did politicians or transport infrastructure users. The experts do not believe that environmental considerations will be neglected in order to achieve economic growth.

"I believe that airports play a key role in the overall urban environment and as a result airport operators need to look for innovative ways to reduce their facilities' environmental impact and contribute to a sustainable future."

Brian Gabel
Chief Financial Officer
Greater Toronto Airport Authority
Canada

According to our Delphi panel, environmental considerations have already passed the "point of no return" and the importance of environmental protection will not decrease. Environmental considerations have already become a central element of the mindset in many countries. Some panellists argue that alarming environmental changes can already be observed today, and such negative impacts are likely to raise willingness to increasingly consider environmental aspects in the future. According to our experts, improved technological solutions are now simplifying the consideration of environmental effects during the development of transport infrastructure. Most respondents argue for an increase in regulation related to environmental protection in transport infrastructure projects.

It is also worthy of mention that among all our 16 theses, the present thesis received the lowest desirability score. According to the panel, a decrease in environmental awareness would not only result in adverse climate changes; it would also imply that environmental competition as a driver for innovation and efficiency would be diminished.

Transport infrastructure will increasingly be assessed on environmental compatibility, in addition to its ability to stimulate economic growth.

Independent bodies should be established that rate transport infrastructure on its eco-friendliness.

Fair P(l)ay — The expansion of emission trading systems to transport infrastructure operators is expected.

Emission trading is a key mechanism of the Kyoto protocol, the agreement which established the goal to reduce greenhouse gas emissions in the participating countries to 8% below 1990 levels. Thirty-seven industrialised countries and the European Union have ratified the Kyoto protocol and committed to reduce their greenhouse gas emissions accordingly.[84]

In 2005, the European Union started an emission trading system (EU ETS) as part of the region's efforts to meet ambitious targets agreed in the Kyoto protocol. The EU ETS is the first such comprehensive emissions trading system in the world. Currently, the EU ETS covers electricity generation and other energy-intensive industries; power stations, refineries and offshore, iron and steel, cement and lime, paper, food and drink, glass, ceramics, engineering and the manufacture of vehicles industries all have to participate in the EU ETS.[85] Some additional energy-intensive industries, specifically those producing petrochemicals, ammonia, aluminium, nitric, adipic, and glyoxylic acid will be included from 2013.[86]

The transport sector's energy use is projected to grow by an annual rate of 1.9%, which would make the sector the world's primary energy-consumer by 2020.[87] Transport accounts for 13% of greenhouse gas emissions worldwide and roughly double that (and growing) in some regions. Against these facts, it does not come as a surprise that the focus of policy-makers is shifting onto the transportation

industry, even though it is officially not regarded as 'energy-intensive'. Airlines will be included into the system as of 2012 and there are plans in place to also cover the shipping sector.

Meanwhile, Australia, New Zealand and the US are all taking steps to set up their own emission 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.

Observers generally agree that it will not be possible to stop the advancement of climate change without a strong commitment from developing and emerging countries to cut down greenhouse gas emissions. According to projections, the combined emissions of developing countries will overtake those of the industrialised world by around 2020.[88] China looks likely to commit to a number of ambitious targets, such as its 40-45% carbon intensity reduction pledge for 2020 (over 2005 levels); its 15% primary energy supply target from nuclear and renewable energy sources; and a target to increase its forest cover.

Thus, it seems probable that the transport sector will increasingly be obliged to pay for its emissions. New regulatory measures are foreseen in different countries around the world, however, harmonisation of such measures at the global level seems difficult to achieve.

Regulations place the burden on those emitting carbon dioxide, i.e. transport operators, such as airlines, shipping companies or truck fleet operators. But what about transport infrastructure operators?

We asked our Delphi panel to assess the thesis "2030: Transport infrastructure operators are obliged to participate in emission trading systems to obtain pollution permits." The experts rate such an event as very probable (69%). This result suggests that survey respondents believe that emission trading systems will in future take a more holistic approach and expand their scope. The panellists provide a wide range of arguments to support this assessment. They consider emission trading as an effective instrument to "manage all stakeholder expectations" and to "operate in a responsible manner in balance with the environment." More specifically, they discuss two possible options:

The first option would be to include transport infrastructure operators for the emissions caused by the operation of the infrastructure itself. Certainly, these emissions will usually not reach the magnitude of emissions caused by transport, so transport infrastructure operators (e.g. airports) are less of a priority than transport operators (e.g. airlines). Nevertheless, corporate energy and emission management should be on their radar.

The second option would be to include transport infrastructure operators for the emissions caused by the transport operations of their customers. Certainly, this would not be possible under today's rules of emission trading which are based on the 'polluter pays' principle and exclude duplicate coverage of emissions from the same source. Anyway, the Delphi panel feels that transport infrastructure operators will increasingly be held accountable for the emissions of those transport operations that they enable through the provision of the required infrastructure. Indeed, they do have means to manage transport emission levels. Road tolls or airport landing fees can be varied depending on the emission levels of cars, trucks and aircrafts. Stakeholders will more and more request from transport infrastructure operators that they make use of such measures to contribute to emission reduction in their sphere of influence.

Including all players of the transport infrastructure arena in emission trading will help the industry achieve significant reductions in emissions. Many panellists also stress that it will be a challenge to include developing and emerging countries in any emission trading system, but one that must be overcome. The experts believe a universal applicability of emission trading systems is a prerequisite to improve environmental conditions in a long-lasting manner.

The expert panel also believes that this shift will have a relatively strong impact on the sector (3.9). Some respondents suggest that transport infrastructure operators will need to heavily invest into new technologies in order to cut down emissions. If they fail to do so or technologies do not deliver adequate solutions, transport infrastructure providers will face "sky-rocketing" cost levels. Soaring prices for transport could prompt a change in the global production model towards less transportation.

Following transport operators, transport infrastructure operators should be prepared to be included in emission trading systems or other schemes of emission control and reduction. The entire transport and logistics industry should collaborate to better manage transport emissions and optimise its environmental compatibility.

Do not reckon without your host — Environmental costs may increasingly influence whether there is a good economic case for transport infrastructure projects.

In recent years many countries have underinvested in infrastructure. Currently many observers are also recognising that existing infrastructure may be impacted by some of the effects of climate change. In the short term, extreme weather events and floodings are likely to be factors that could bring temporary disruption (damage or blockage of railways and roads, airport and sea port closures etc.). Such events will result in increased maintenance and repair costs; some companies will want to consider investment to improve resilience. Over the longer term, higher local temperatures and more fluctuation, rising sea levels, changing precipitation patterns or other climate impacts could require more substantial adaptation or relocation of infrastructure. Such adaptation costs of existing infrastructure are not factored into many current investment and cost models, and there are a number of difficulties in doing so. Operators will need to assess the likelihood or frequency of events occurring and how long it will take before impacts will have a material effect on infrastructure.

The prices for transport are generally lower than the costs they really cause. At present, environmental costs such as air pollution, noise or CO_2 emission do not have to be paid by the actual causer. According to a report by the Commission of the European communities, environmental costs could easily reach more than 210 bn EUR by 2020 if the situation does not change.[89]

There is no single solution, and intensive work is needed on all fronts to find adequate ways to address likely impacts. One strategy is to reduce the environmental costs caused by transport. To give an example, the Equator Principles were developed by several leading project finance houses back in 2003 (revised in 2006) and focus on assessing environmental and social risks in project finance. Institutions which have adopted these principles assess the social and environmental case for project financing. Negative impacts on ecosystems and communities affected by the project should be avoided where possible, and if these impacts are unavoidable, they should be reduced or mitigated and compensated for appropriately.[90]

Other attempts have been undertaken by the European Commission which has stressed the urgent need for a transport pricing system that is capable of reflecting all costs involved in transport. The commission has directed the development of "a generally applicable, transparent and comprehensible model for the assessment of all external costs to serve as the basis for future calculations of infrastructure charges" (Directive 2006/38/EC). Through such an assessment, it should be possible to directly quantify the impact of internalisation of external costs for all modes of transport.

In Asia, eco-efficiency concepts as applied to infrastructure development have not been considered to the extent needed in the past, but future transport infrastructure is also expected to focus on eco-efficiency with a goal to develop sustainable infrastructure.[91]

These efforts suggest that a number of countries believe that the full internalisation of external costs of transport will maximise society's welfare. However, what does this 'internalisation process' signify for future transport infrastructure projects? Will the inclusion of environmental costs stall some transport infrastructure projects for which there is otherwise a good economic case? In some cases, the answer may be 'Yes'. The A303 road past the ancient monument Stonehenge in the UK is a single carriageway and represents a tremendous bottleneck. Widening the road above ground was deemed to have unacceptable negative impacts on the local environment, including an irreplaceable part of the country's cultural heritage, so a decision was made for tunnelling. However, ground investigations revealed unexpectedly difficult conditions which would boost project costs. The scheme became unaffordable and was put on hold.

Our Delphi panel assesses the question whether environmental costs will become a serious deterrent to transport infrastructure investments as somewhat probable (56%). Transport infrastructure users are much more confident that environmental costs could deter the realisation of economically reasonable projects, than are the experts from transport infrastructure associations.

The comments provided by panellists suggest a general agreement that environmental considerations will strongly influence future transport infrastructure projects. However, the experts believe that these considerations may not necessarily hinder the realisation of such projects. New technologies may be introduced which will make transport infrastructure in general more eco-efficient. Further, our experts do not see a separation between an environmental and an economic case. Some experts suggest that a good economic case will only be present if the environment is not too negatively polluted. Environmental costs will become

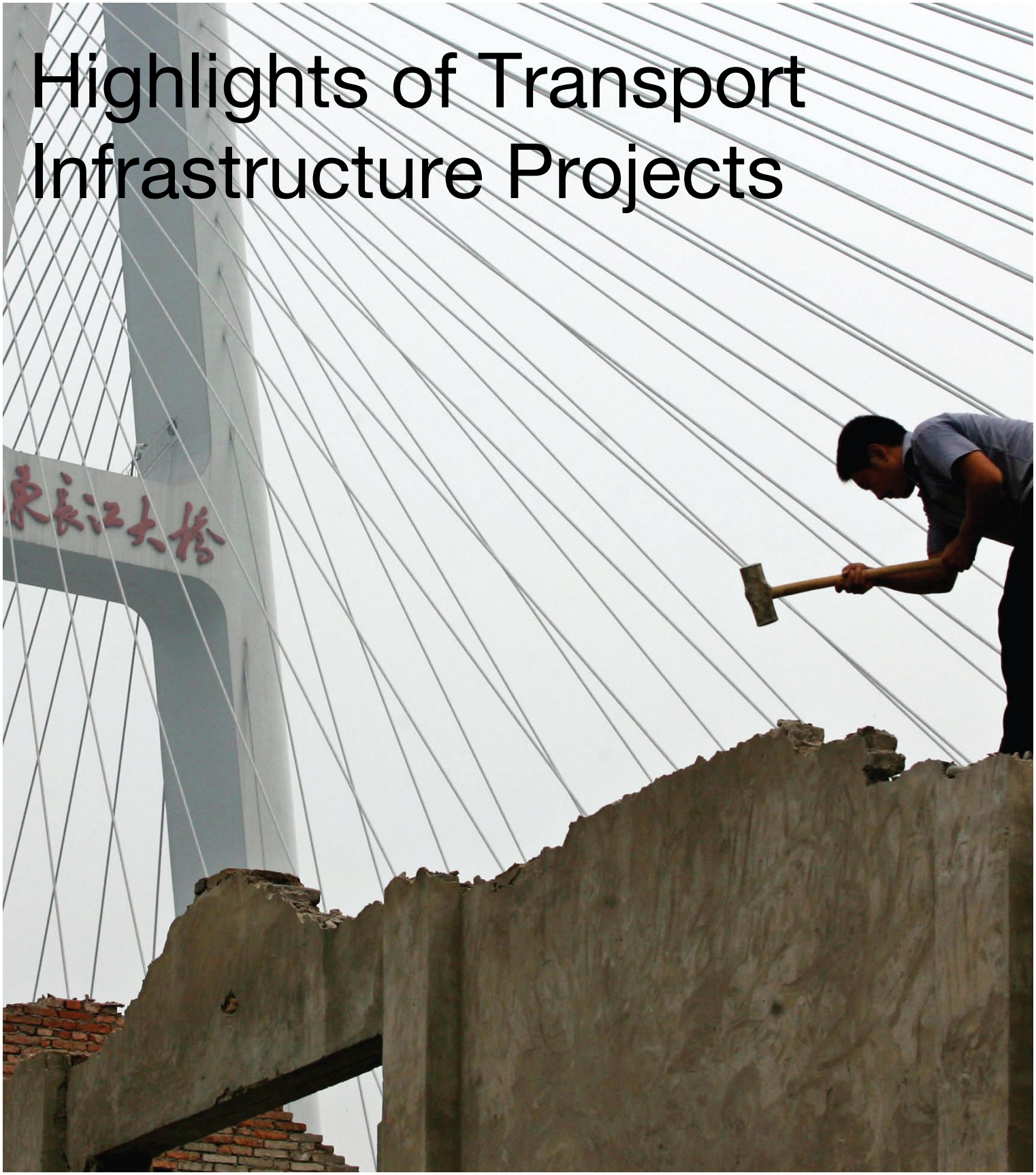
an essential element of the business case calculation. Many panellists see the internalisation of external costs caused by transport infrastructure projects as helping to increase social welfare.

Transport infrastructure developers should be aware that in the long term environmental costs will have to be factored into their economic calculations.

Holistic methods assessing the overall environmental compatibility of transport infrastructure solutions need to be widely implemented.

When assessing the environmental compatibility of transport infrastructure solutions, both harmful environmental effects and environmental benefits should be considered — taking into account the entire life cycle of construction, operation and deconstruction.

Highlights of Transport Infrastructure Projects



Transport has always fired people's imagination. In 1483, Leonardo da Vinci captured man's desire to fly by sketching the most advanced plans of that period for an aircraft, resembling a modern helicopter. Later, the dream of flying became reality. Other visions, e.g. a connection between the British Islands and Continental Europe, were put into practice. Some ideas, like a transatlantic bridge, connecting Europe and the United States, continue to be a pipe dream.

Today's ventures in transport infrastructure development are more down-to-earth than the latter example. Still, they all hold very specific risks and challenges. Many of them are projects of vast proportions which require innovative, unique technologies to implement.

This chapter includes profiles of some of the most prominent transport infrastructure projects from around the world, some already under construction, some still in the early days of feasibility studies.

Marmaray Tunnel

(Gebze – Haydarpasa, Sirkeci – Halkali Commuter Rail Upgrading and Railway Bosphorus Tube Crossing Construction Project)

Country: Turkey (links the European and Asian parts of Istanbul)

Construction time:
May 2004 – October 2013

Cost of project: approx. US$ 3.5 bn

Financing: Funding agreement between the Republic of Turkey and the Japan Bank for International Cooperation and European Investment Bank and Council of European Development Bank.

An exploding urban population in Istanbul makes the connection necessary. The tunnel under the Bosporus will be the deepest built so far, with its deepest point being some 58 m under the water's surface. The area of Istanbul will most likely experience a seismic event of up to magnitude 7.5 during the lifetime of the project. Ensuring structural stability in the case of such an event is a crucial challenge to the whole project.

Fehmarnbelt Bridge

Country: Denmark, Germany

Construction time: 2013 – 2018

Cost of coast-to-coast project:
approx. US$ 6 bn

Financing: Construction of the fixed link (coast-to-coast plus Danish hinterland) will be financed by loans, to be refinanced by toll income from motor vehicles and railway traffic. Construction of German hinterland will be financed by the German Government.

The Fehmarnbelt project is the third of its kind with Denmark as a focal point. In 1998 the Great Belt fixed link connected the eastern and western parts of Denmark and in 2000 the Øresund fixed link connected Denmark and Sweden. New railway connections and travel time reductions achieved by the Øresund and the Great Belt links gave motivation for the Fehmarnbelt link connecting Scandinavia and Continental Europe. For the 19-kilometre long coast-to-coast link, a number of technical solutions, e.g. cable-stayed bridge or tunnel, are currently being investigated thoroughly and equally. These studies focus greatly on the environmental and safety issues associated with the project. A final determination whether to construct a bridge or a tunnel is expected by the end of 2012.

Expansion of Panama Canal

Country: Panama (connects the Atlantic Ocean and the Pacific Ocean)

Construction time: September 2007 – 2014

Cost of project: approx. US$ 5.25 bn

Financing: Panama Canal Authority (ACP) and loans from five multilateral agencies

Larger vessels which are required to carry the ever increasing loads in global shipping lead to capacity constraints for ports and waterways. The enlarged Panama Canal will be able to handle vessels holding up to 12,600 TEU of cargo. Currently the largest vessels able to pass carry 5,000 TEU. This expansion also calls into question when the natural size limits of sea-going vessels will be reached.

Maasvlakte 2, Port of Rotterdam

Country: The Netherlands

Construction time: 2008 – 2013

Cost of project: US$ 4.25 bn

Financing: Port of Rotterdam Authority and European Investment Bank

Directly to the west of the current port, Maasvlakte 2, encompassing 2,000 hectares sand in total, will be developed by land reclamation in the North Sea. The project will have a large impact on the natural and industrial environment, so measures are being taken to compensate. These include the establishment of a sea bed protection area of some 25,000 ha, with resting areas for birds and seals, as well as a new 35-ha dune area along the coast of Delft and between Hoek van Holland and Ter Heijde.

Gotthard Base Tunnel (NEAT)

Country: Switzerland

Construction time: 1999 – 2017

Cost of project: approx. US$ 9 bn

Financing: Swiss Government

Expected to be the longest tunnel in the world after finalisation (length: 57 km), the Gotthard Base Tunnel will encompass the entire railway cargo transit across the Swiss Alps. Due to the size of the project some technical innovations are necessary, e.g. the largest tunnel drilling machine.

US High speed rail programme

Country: United States

Construction time: by 2030.

Cost of project: tbd., including proposed federal contributions of $8bn in 2010, $1bn for the next five years, plus additional funds at state level

Financing: Public

A 17,000 mile long high speed rail system is being planned which would connect major population centres 100 to 600 miles apart. Critics argue that the programme is overly-ambitious and cannot be refinanced from ticket prices since some connections may not be economically sustainable.

Masdar Eco-City

Country: Abu Dhabi, United Arab Emirates

Construction time: 2008 – 2016

Cost of project: US$ 29.7 bn

Financing: Emirate of Abu Dhabi and investment fund EMIRATES 5

Masdar Eco-City is one of three initiatives worldwide to build the first carbon neutral city using only renewable energy. It could become the first eco-city cluster worldwide.

Fossil fuel powered vehicles will be removed and transportation based on electronic personal and freight rapid transit, as well as long route light rail systems. Metro and high speed rail are planned to connect Masdar to a wider transport network via Dubai and Abu Dhabi Airport.

High speed railway from London to Beijing

Country: China, United Kingdom

Construction time: 2010 - 2020

Cost of project: tbd.

Financing: Public & Private

Promoted as the biggest infrastructure project in history, China announced in March 2010 that three railway corridors are planned.

One will connect Beijing and London; the second one will connect the Asian countries Malaysia, Burma, Vietnam and Thailand and China and the third one will connect China, Russia and Germany. China and Burma have already started construction work, however financing seems to be the biggest issue facing the project.

Project information approved by the respective project developers and partners.

X-Industry Perspectives

Keith Clarke
Chief Executive Officer
Atkins Plc
United Kingdom

Perspectives from Engineering & Construction

PwC: Speaking in general terms, do you expect that there will still be a shortage in transport infrastructure in 2030? Or do you think that investments over the coming years will suffice to close all gaps?

Clarke: There will definitely be a shortage of transportation by 2030 in mature and emerging markets. I have not seen an exhaustive investment plan anywhere in the world that actually exceeds the backlog completely.

PwC: From an engineering point of view, what will be the new design and construction techniques of 2030? How will an airport in 2030 be different from an airport today; or a port or urban transport system? Please share your visions with us.

Clarke: The fundamental difference in new infrastructure design will be the need for greater capacity using less land and fewer material assets with significant constraints on the whole life carbon impact, for which energy is a good proxy. Design processes are already becoming more intense and weighted towards the earlier stages of construction. Lastly, the acceptable environmental degradation by any large capital project will be considerably less than those we expect today.

PwC: How would you evaluate the discrepancy in transport infrastructure between the industrialised and the emerging world? How can emerging countries overcome their catch-up demand in transport infrastructure in the coming years?

Clarke: I do not agree that there is a material discrepancy between the emerging and industrialised world in infrastructure other than the degree to which it has historically been developed. If you look at the rate of development, it has been considerably higher for a number of years in many emerging economies, whilst most post industrialised economies have significantly underinvested. The emerging countries will be driven by a growing GDP and population whilst the mature economies need to cope with the more difficult issue of exhausted assets with little economic or population growth to provide the tax base for their replacement. Urban transportation is about a choice of priorities and maintaining a civilised public realm whilst giving certainty of travel time. These present huge conflicts within large urban sprawls. City centres are usually not a problem area but rather the doughnuts around them.

PwC: Will rural areas, especially in developing countries stay disconnected from urban areas as they often are today?

Clarke: Rural areas by definition will have far less investment because the population and overall social need is considerably less, particularly when the demand generators are urban based. The increasing rationing of carbon leading to constraints on speedy travel is likely to accelerate urbanisation rather than spread the population.

PwC: Business and government relations have become more complicated in the wake of bailouts, stimulus spending and financial sector reforms. Consequently, to what extent do you think will investments in transport infrastructure be shifted to the private sector?

Clarke: Whilst the funding of infrastructure will increasingly revert to the private sector, all transportation requires Government participation in policy-setting, both economic and social, as well as delivering the public consensus to the project. It would be naïve to think private investment could or should replace the pivotal role that governments have in deciding transportation policy and priorities between competing assets. What will be important is the relationship between Government and the implementing agencies and their understanding of the strengths and limitations that private finance brings. I do not think there is any reasonable likelihood that globally operated private investment funds will become drivers of infrastructure projects rather than subsequent enablers of what society has already decided is appropriate.

PwC: How will transport infrastructure operators (e.g. ports and airports) cope with increasing transport volumes, while keeping environmental impacts at a minimum?

Clarke: Operators, like any other activity in society, will have to recognise that the environmental impact of their activities is an intrinsic business cost, as carbon rationing is brought to bear through all parts of society. The value of travel is likely to be higher and therefore rationed. The effect of this means that more efficient and in all probability marginally slower travel will increase capacity whilst minimising costs and environmental impact.

"The most successful Engineering & Construction companies will be those that are prepared to innovate and invest in lean processes and those that engage most effectively with government on modern and transparent risk sharing and financing."

Jonathan Hook
Global Industry Leader
Engineering & Construction
PricewaterhouseCoopers

Public Sector – Governments' role in transport infrastructure

The role of stimulus packages for transport infrastructure

In 2008 and 2009 an economic crisis shocked the global economy, with widespread economic stagnation and recession as the result. Many governments took action to revive their local economies via massive stimulus packages designed to jump-start spending and investment and bolster confidence in recovery. Designing an effective stimulus package to achieve economic growth is tricky, though. Government programmes necessarily involve approval processes and other bureaucracy, often causing delays until funds are actually received for a particular project. While transport infrastructure would seem to be a natural area for governments to support via stimulus funds, in reality the economic models underlying such programmes make an application to transport infrastructure difficult. Transport infrastructure — indeed, infrastructure in general — is a long-term investment, with a protracted life cycle, which requires substantial amounts of lead-time to develop, plan and implement. The intended short term impacts expected from stimulus packages are inconsistent with investments in new transport infrastructure. In order to achieve a rapid effect, stimulus packages need to be spent on other types of programmes. Identifying and employing different funding methods for transport infrastructure is imperative.

User-based charging will be at the forefront

While the private sector climate is slowly improving due to the first signs of recovery, the public sector is still fully entrenched in crisis mode. Market observers talk about a potential double-dip or W-shaped recession, characterised by a short-lived recovery, followed by further recession in some countries.[92] Many fear that the next recession will be in the public sector, which is becoming increasingly burdened by lower taxation revenues and higher public spending, including ongoing stimulus packages. For the public sector, the largest challenges of the economic crisis may yet be to come. It is likely that capital budgets will be cut, e.g. in the UK, the government has already announced the intention to cut net investment budgets about 50% over the period from 2010/11 to 2013/14. Representing the bottom of the "funding food chain", local authorities will likely suffer the most, as they possess the least flexibility on taxation matters. Many local authorities will struggle to deliver on their commitment to users, given cuts in the amounts they may receive from central governments combined with reduced local revenue flows. For many local authorities, the only option to fund transport infrastructure in the future may be moving to direct usage charging. This will be a significant shift going forward.

"Infrastructure will continue to be one of the most important assets in a modern society. It will be the task of governments to manage supply and demand and find a balance between smart funding and financing of new and maintaining and upgrading of existing infrastructure. They will need to embrace issues like usability, sustainability, connectivity, liveability and attractive physical appearance to help drive sustainable economic growth."

Jan Sturesson
Global Industry Leader
Government & Public Services
PricewaterhouseCoopers

The question of funding and financing infrastructure

The terms financing and funding are often used in the same context, however they usually relate to different stages in the process of constructing and operating transport infrastructure. Financing refers to the moneys provided by an investor for the construction of a project, while funding infrastructure comprises who is paying for its on-going operation. At present, the development of new infrastructure is generally financed by the private sector, and funded by the public sector. In future, governments will outsource the development and operation of infrastructure to the private sector — a trend which has already gathered momentum in some countries. This means that both financing and funding will to an increasing extent become private, with user-charging often applying as the primary funding mechanism. Governments will maintain oversight, ensure proper service delivery and often act as the agent raising the funding.

Existing infrastructure will continue to be maintained by the public sector, as infrastructure maintenance is paid out of the general tax base. New contract arrangements for future infrastructure projects are also beginning to transfer this responsibility to the private sector.

Government intervention — but how?

Most new infrastructure projects require borrowing of capital and repayment over the course of time, as the substantial costs involved generally far exceed cash reserves. The economic crisis has had a significant impact on infrastructure finance markets around the globe, which are struggling with a lack of liquidity and expensive debt markets. Consequently, private financing is drying up and has become more expensive. In many parts of the world, discussions are underway about how governments may be able to support the finance process; meanwhile, the private sector is calling for government intervention. Several options and models exist; for example, governments may act as co-lender; as guarantor or as guaranteed lender. Each model includes certain risks and pitfalls, and is perceived and executed differently around the world. Governments need to evaluate carefully any proposed intervention to ensure these offer good value; they also need to be aware of the risk that debts will not be repaid.

Government intervention need not necessarily cover the entire cost of the project. In many cases, governments are moving to so-called gap funding as a form of financing which combines private finance with public moneys, where government intervention is focused on covering the gap instead of the whole infrastructure project. Additional subsidies from the public sector via taxation, or through grants or operational subsidies may also be provided in order to achieve sustainable funding. In this way governments can best achieve the key objective of any intervention, namely to achieve certainty of delivery of key public services on a value for money basis.

The key transformations of public sector infrastructure in 20 years

Four main developments will shape the public sector infrastructure in the future. The first is an increase in private finance and a focus on user-charging. Many governments are now capital constrained and have been operating with major deficits during the last decade. This imbalance will not be able to continue indefinitely, so there is likely to be ever-greater pressure to reduce public spending. Consequently, the user will have to pay or pay more for infrastructure. Governments will concentrate on effective, risk-secured intervention mechanisms which only fund any gap in financing, rather than financing the whole project.

The second trend will be a more stringent management of demand. In Europe and the US, capital restrictions, congested urban areas as well as climate change are likely to lead to further government initiatives to reduce the pressure on transport infrastructure. Measures could include regulations designed to reduce private automobile usage, higher taxation on air transport, and new taxes on imports, such as products shipped in from other continents. Active policy action will dampen demand for individual transport modes and push environmental friendly public transport solutions. Improved technology will also help to support this trend, e.g. use of video conferencing, flexible working hours to avoid rush hours, home office etc. In the near-term, governments in Europe are likely to reduce expenditure on new infrastructure except for some sustainability-driven transport infrastructure projects, and focus instead solely on maintaining existing transport infrastructure. Governments will then push to promote ways of using the existing infrastructure more effectively and wisely. Relying solely on existing infrastructure means it may receive higher rates of usage, and deteriorates more quickly, though. Cutting investment now may simply shift the need for additional spending on infrastructure forward some years. While demand management can help to a certain extent, private sector solutions such as toll roads or other privately funded and financed infrastructure projects will undoubtedly also be required.

Thirdly, the urbanisation trend is putting pressure on infrastructure in major cities and economic centres. While government will look to revitalise existing and construct new transport infrastructure, they will need to do so in a smart and effective way making the future of transport infrastructure and its role in global economic growth sustainable. As cities will more and more need to focus on the liveability and attractiveness for citizens and businesses, there will be an increasing need for smart high-tech solutions for people not just to consume, but to experience the transport infrastructure, which will stimulate smarter and more sustainable usage.[93] For example user connectivity through real-time online communication will be a new infrastructure functionality. But also the use of design and art to create interesting physical landmarks attractive to users will support a sustainable future for transport infrastructure. Governments will need to adopt a citizen centric transport infrastructure development perspective.

Finally, governments will need to manage and prioritise this supply and demand of transport infrastructure in a period of time where investment budgets are under high pressure and competing with other budget expenditures like energy, security, safety, social infrastructure and other types of investment.

Transport infrastructure is vital to economic growth and international competitiveness, but pressures on public spending pose serious challenges to future investment. Governments will need to develop strong partnerships with private sector companies, both to fund and finance new infrastructure projects, and in some cases to finance existing systems. Flexibility will be vital, with options like gap-funding making key projects viable when private sector finance sources fall slightly short of the needed investment. Governments may also need to step in as co-lenders or loan guarantors until full liquidity returns to private sector loan markets.

Governments are not the only ones who face changes in the future; companies are likely to face new regulation and individual users will also increasingly be expected to fund, and in some cases limit, their own usage of transport infrastructure, directly or indirectly (i.e. through consumption).

Extreme Scenarios

Extreme scenarios can help broaden decision makers' awareness of future developments which are not very likely, but which could potentially have a fundamental impact on the industry or on specific companies. By including "discontinuities", decision makers can identify a range of alternatives which may occur and enhance their ability to adapt to surprising developments. Furthermore, extreme scenarios are a helpful way to test the future-robustness of strategies and decisions.

In order to develop extreme scenarios, we juxtaposed two theses and created radical pictures about possible futures:

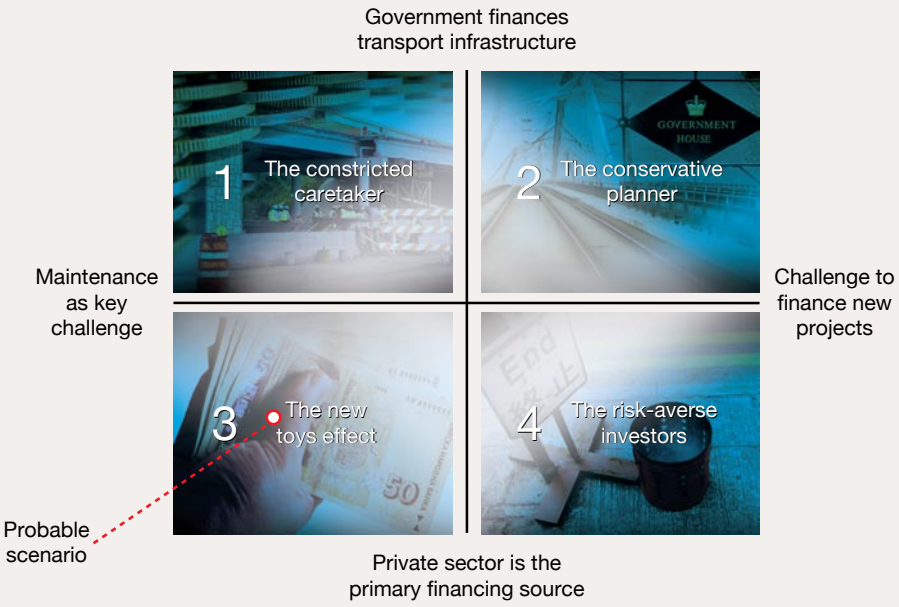
2030: Financing the maintenance of transport infrastructure is more difficult than attracting investments in new infrastructure. (Thesis 10)

2030: Financial pressure on governments has become so intense that almost all investment in transport infrastructure has been shifted to the private sector. (Thesis 6)

Both theses are fundamental to the future of transport infrastructure. How will future transport infrastructure be financed and by whom? What will be a bigger challenge: financing new transport infrastructure or maintaining existing systems? How do these challenges influence each other?

We devised four possible extreme scenarios to tease out the implications the answers may hold. Possible scenarios for the extreme poles of each quadrant (see Figure 8) draw upon the qualitative Delphi results and further trend research.

Figure 8
Extreme scenarios



Extreme scenario 1

The constricted caretaker

2030 — Financing of transport infrastructure is still seen as the task and responsibility of governments. Governments consider transport infrastructure as a lever for economic growth and a key differentiator in achieving international competitiveness. Individual politicians also see transport infrastructure as a way to secure votes and build their own power base. Despite some shortages of cash in national budgets, governments are actively engaged in financing transport infrastructure. However, the maintenance of existing transport infrastructure has become a severe challenge for governments and puts them into the position of 'constricted caretakers'.

During the last two decades, governments' national finances have deteriorated; increased public spending for healthcare and social systems has forced governments to cut expenditures for transport infrastructure maintenance.

The results of these belt-tightening activities have become obvious: the quality of much of the existing transport infrastructure – especially road surfaces and bridges – has decreased enormously. Large potholes and cracks mark the surface of roadways, some bridges may soon no longer be structurally stable, and railroad tracks are deteriorating as well.

Government officials considered investments into new transport infrastructure to be much more important than maintenance and upgrading of existing transport infrastructure assets. As a result of these priorities, governments were able to obtain financing for new transport infrastructure, despite overall budget limitations. These projects also reflect a level of innovation in line with government priorities; efforts to limit risk meant that innovation has had certain limits; however some innovative transport infrastructure solutions have been broadly implemented, especially on the technology side. Sustainability has also been a priority for governments, and such issues have been increasingly considered during the planning and construction of new infrastructure.

"Governments must ensure that the right regulatory and business environment exists to support increased investment in transport infrastructure and the timely delivery of major projects. Pricing reforms reflecting the real total costs of providing infrastructure are an important means of ensuring that infrastructure is used efficiently."

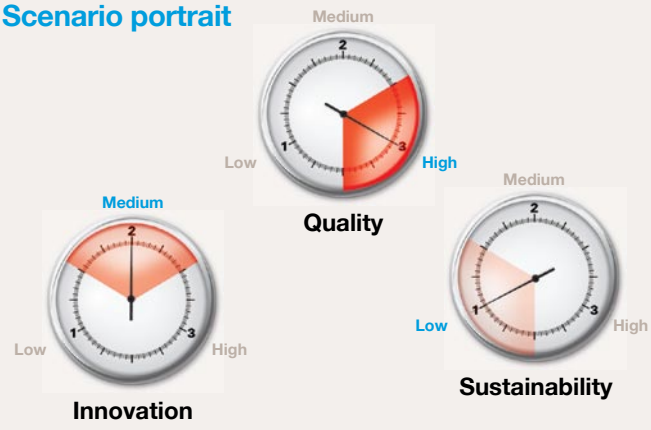
Michael Deegan
Infrastructure Coordinator
Infrastructure Australia

Transport infrastructure quality is now extremely uneven, with crumbling older infrastructure dominating and expensive new infrastructure offering an occasional bright spot. As older infrastructure wears out, the focus on new projects has resulted in a nearly impossible situation. According to different estimates, by 2030 transport infrastructure maintenance will require around 1-2% of GDP per year. Many governments around the globe are hard-pressed to allocate that high a percentage of available funds to transport infrastructure maintenance.

Consumers criticise governments' unfocussed spending and the overall worsening quality of transport infrastructure. Unacceptable transport conditions have resulted in higher levels of congestion during commuting periods, longer travel times and greater damage to the environment.

Logistics service providers have been forced to cope with extremely difficult conditions. As various elements of transport infrastructure deteriorated to unusable levels, established transport routes had to be changed. In some cases providers were obligated to lower their service levels. Difficult road conditions mean that trucks and other vehicles require additional maintenance and repairs. Nevertheless, some innovative logistics service providers have adapted to the situation so that they specialise on serving even those regions which are connected by lower quality infrastructure. However, their higher maintenance costs and investments in more expensive trucks result in higher transport prices.

Scenario portrait



Implications

- Quality of existing transport infrastructure suffers as new transport infrastructure project development is seen as a priority, rather than maintenance
- Innovations in transport infrastructure are realised but limited as governments follow more conservative and risk-averse policies
- Sustainability issues are increasingly considered in new infrastructure development

Extreme scenario 2

The conservative planner

2030 — Tight budgets mean that transport infrastructure must compete with social programmes and healthcare for funding; as a result, most governments have been forced to reduce investments in transport infrastructure. Governments have become ‘conservative planners’, with a strong focus on maintenance, rather than on long-term investment in new transport infrastructure.

Despite heavy criticism, government officials defend their investment strategies by stressing the importance of transport infrastructure maintenance. They believe that construction needs for existing infrastructure should be completed before new construction sites are opened.

Governments have prioritised the use of innovative materials and technologies in order to increase the durability of various types of transport infrastructure. This emphasis has strongly improved the overall quality levels of existing transport infrastructure. However, due to tightened budgets, sustainability has not been accorded priority.

In spite of governments’ reduced emphasis on financing new transport infrastructure projects, the private sector could not achieve an extended role in providing financing alternatives. Many governments are afraid of losing control when the private sector gets involved. Others feel that public-private partnerships are too complex to be managed effectively.

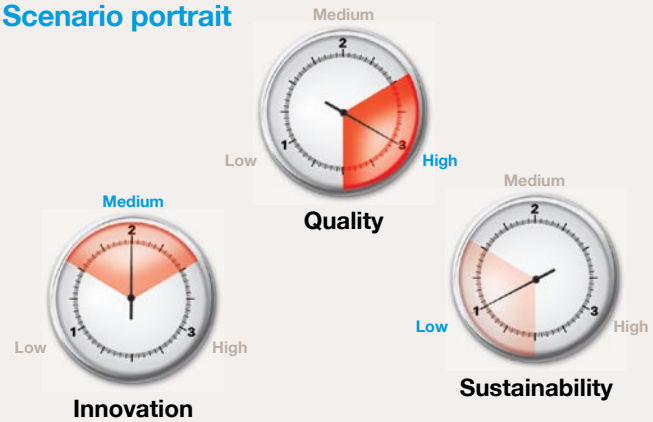
Furthermore, government officials complain about the private sector’s lack of willingness to commit to new long-term transport infrastructure projects. They see the private sector as reluctant to invest when long-term commitments are required, financial returns are rather low, and break-even points take quite a long time to occur.

Moreover, private financiers perceive transport infrastructure investments to be quite risky and unpredictable. Political and regulatory frameworks differ from country to country. In some countries, user charges are accepted practice to provide financing for transport infrastructure investments; in other countries they are not permitted. Thus, it has become quite difficult for private investors operating in different countries all over the world to adapt their business models to the individual financing needs of new transport infrastructure projects in different regions. Further, in some areas regulatory frameworks are unstable, creating a high level of risk.

The consequences of governments’ restrictive investment policies and the lack of private sector engagement in transport infrastructure financing are drastic. Existing levels of transport infrastructure cannot keep pace with increasing transport volumes and transport infrastructure has in many cases become a severe bottleneck for global trade activities. The potential for economic growth is limited by the lack of sufficient transport infrastructure levels.

Since traffic flows frequently come to a standstill due to bottlenecks in infrastructure, overall transport speed and efficiency have decreased, while corresponding costs increased. Logistics service providers have to become even more efficient to deal with the complex situation and to ensure high levels of quality and reliability for their customers.

Scenario portrait



Implications

- Quality levels of transport infrastructure could be significantly improved due to high levels of government spending
- Usage of innovative materials and technologies is given priority in order to increase the durability of transport infrastructure
- Sustainable solutions and advancements are not given priority

Extreme scenario 3

The new toys effect

2030 — Strong financial pressures have forced governments around the globe to include the private sector in transport infrastructure projects. National budgets are heavily constrained, however governments started early in their efforts to develop and set up new financing mechanisms. As a consequence, the involvement of the private sector has advanced tremendously. Private financing plays a role in nearly every transport infrastructure project.

In order to motivate the private sector to engage in transport infrastructure financing, governments have adjusted national legislation so that private investors have greater autonomy to decide how they want to achieve profits and returns on their transport infrastructure investments. Various business models between governments and the private sector to finance infrastructure have evolved. Governments' control over transport infrastructure and the extent to which they maintain property rights differ strongly between the various models. In some cases private investors are awarded concessions for the operation of transport infrastructure for a limited period of time. In other situations private financiers take over responsibility for the entire financing of transport infrastructure and require the end user to pay monthly fees for usage rights.

As a result of the private sector's strong engagement, intensive competition among transport infrastructure operators can be observed. This competition has had several positive side effects. In order to secure competitive advantages, transport infrastructure operators have been strongly motivated to realise innovations in transport infrastructures. Prominent examples include fully automated handling operations and integrated intermodal solutions. Using more sustainable construction techniques and materials, such as CO_2 absorbing cement and surfaces or self-healing materials, has become another key differentiator.

However, governments still face a huge challenge when it comes to transport infrastructure maintenance. While the private sector is willing to contribute to the financing of new transport infrastructure, maintenance seems unattractive. Existing transport infrastructures have started to crumble as a consequence of a lack of spending.

Logistics service providers have to deal with complex administrative burdens when they use transport infrastructure. The diverse financing and controlling models of transport infrastructure create high levels of inconsistency. During long-haul transports, logistics service providers have to use the transport infrastructure of many operators who charge different fees. Thus, identifying the most cost effective transport routes has become a real challenge for the transport business, but also a key capability of the market leading logistics service providers. Businesses are increasingly finding that effective purchasing of transport services is necessary to maintain competitive. Many companies now devote significant resources to providing employee training and education around these skills. Companies take a proactive role in negotiating attractive usage rights with various transport infrastructure operators. Those able to establish preferred conditions have transformed these challenges into unique selling propositions for their businesses and developed competitive advantages.

Scenario portrait

Implications

- Quality levels suffer due to limited investments in maintenance of existing transport infrastructure and high complexity levels in operations
- Transport infrastructure innovations are driven by private investors as well as transport infrastructure operators in order to build up competitiveness
- Sustainable solutions are key differentiating factors in transport infrastructure and assist in attracting investments

Extreme scenario 4

The risk-averse investor

2030 — Factors such as increasing and/or aging populations and decreasing income from taxes strongly limit governments' leeway when it comes to transport infrastructure financing. In fact, transport infrastructures cannot work without the involvement of the private sector. The private sector is strongly involved in financing, but mainly interested in investments in existing infrastructure rather than in risky new transport infrastructure projects.

Many governments are forced to sell their transport infrastructure assets to private investors for whom the acquisition of existing infrastructure is an attractive investment with a low risk profile. Forecasting traffic volumes, the level of utilisation and thereby the expected revenues and profits is a fairly straightforward exercise. Hence, private investors are more than willing to take over existing infrastructure. New transport infrastructure projects are seen as overly risky and are seldom able to attract private investors.

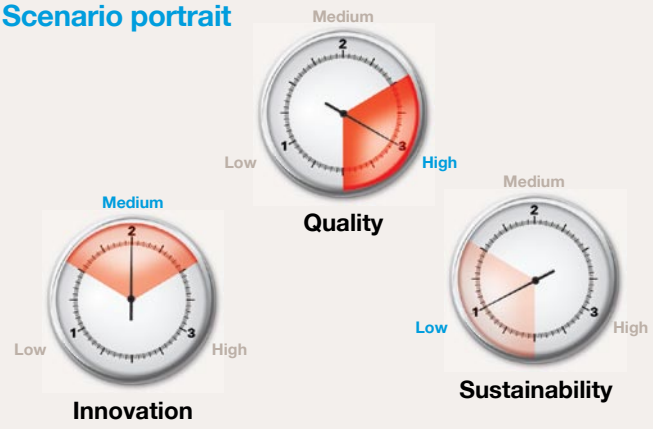
As a result, transport infrastructure is maintained at an acceptable level of quality. Private operators address maintenance issues in a timely manner and seek to ensure continued usability of assets. Nevertheless, maintenance activities are conducted to maximise profits rather than to improve quality for users per se.

Governments in turn miss opportunities to use transport infrastructure as a lever to stimulate economic growth. Overall, they are increasingly faced with difficulties in coping with rising trade volumes and the demand for more transport infrastructure. This challenging situation has meant that sustainability considerations have taken a back seat. As most efforts are dedicated to transport infrastructure maintenance rather than its development and expansion, the implementation of new and innovative transport infrastructure solutions have faced serious constraints. While applying innovations might potentially improve the durability and usability of transport infrastructure, the need to focus limited capital on "fixing what is already broken" has meant that such solutions have been implemented at only a modest level.

The situation is most pronounced in industrialised countries. Here, private investors are very cautious about investments, as most options involve providing a service which is supplemental to existing infrastructure already in place. Thus, profit margins are much lower than in emerging countries where even basic transport infrastructure is still missing to a large degree.

As a consequence of the lack of investment in new transport infrastructure, severe transport bottlenecks are a frequent phenomenon around the globe and existing transport infrastructure struggles to absorb increased trade volumes on important routes. Since transport infrastructures are owned and operated by different providers who charge arbitrary usage fees, logistics service providers have to deal with higher levels of administrative burden and complexity in their daily operations. The complexity in transportation planning has in turn increased dependence on information technologies and control systems. Transportation management has become a high-tech business with new job profiles and higher demands on employee education. Companies' adaptability to changes and new situations has become the key determinant for success.

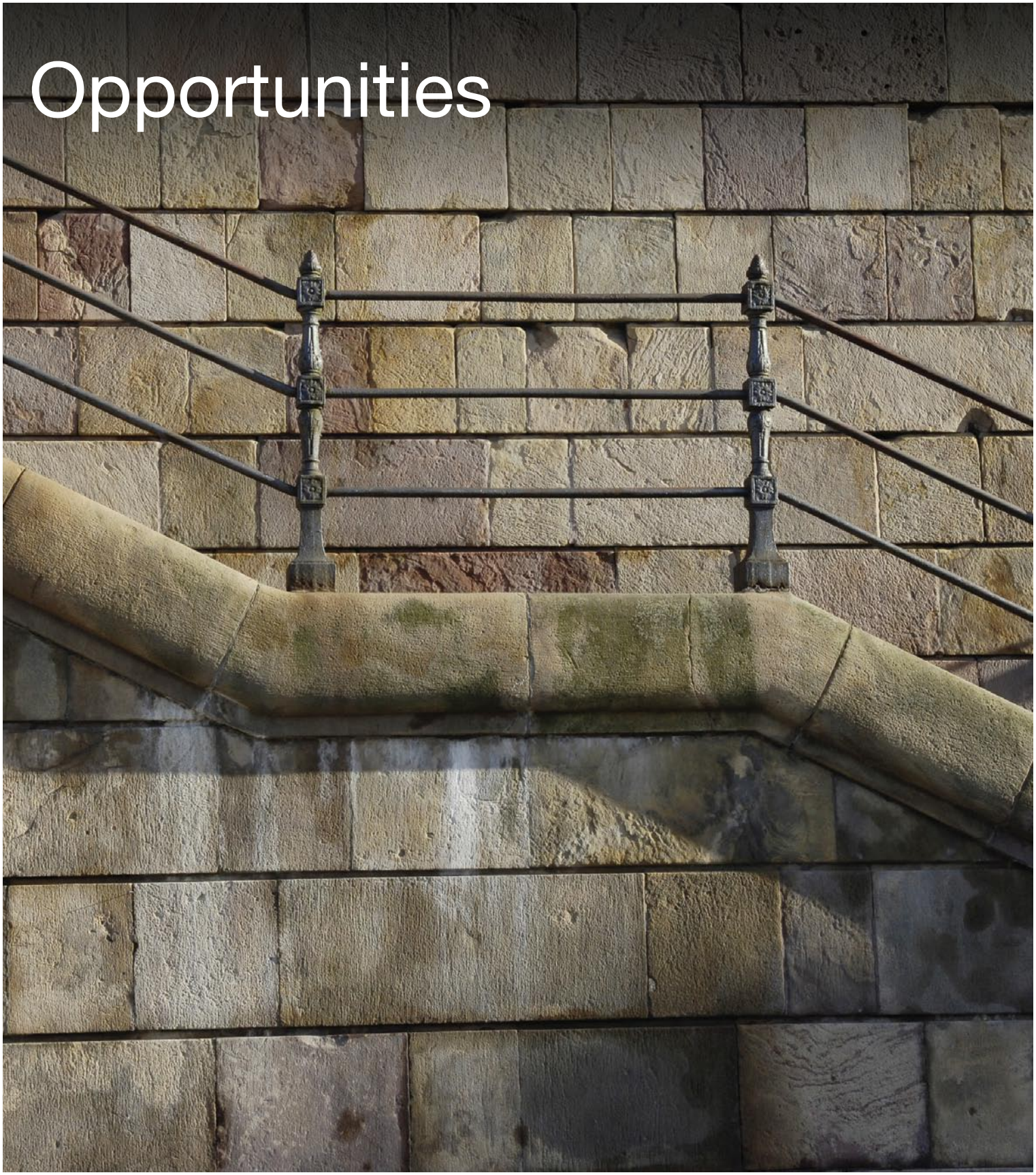
Scenario portrait



Implications

- Transport infrastructure maintenance activities are conducted to maximise profits rather than to improve quality for users per se
- Innovations in transport infrastructure are limited to maintenance solutions rather than transport infrastructure development and expansion
- Sustainability plays a minor role in transport infrastructure; efforts concentrate on risk-averse investments and complexity management in operations

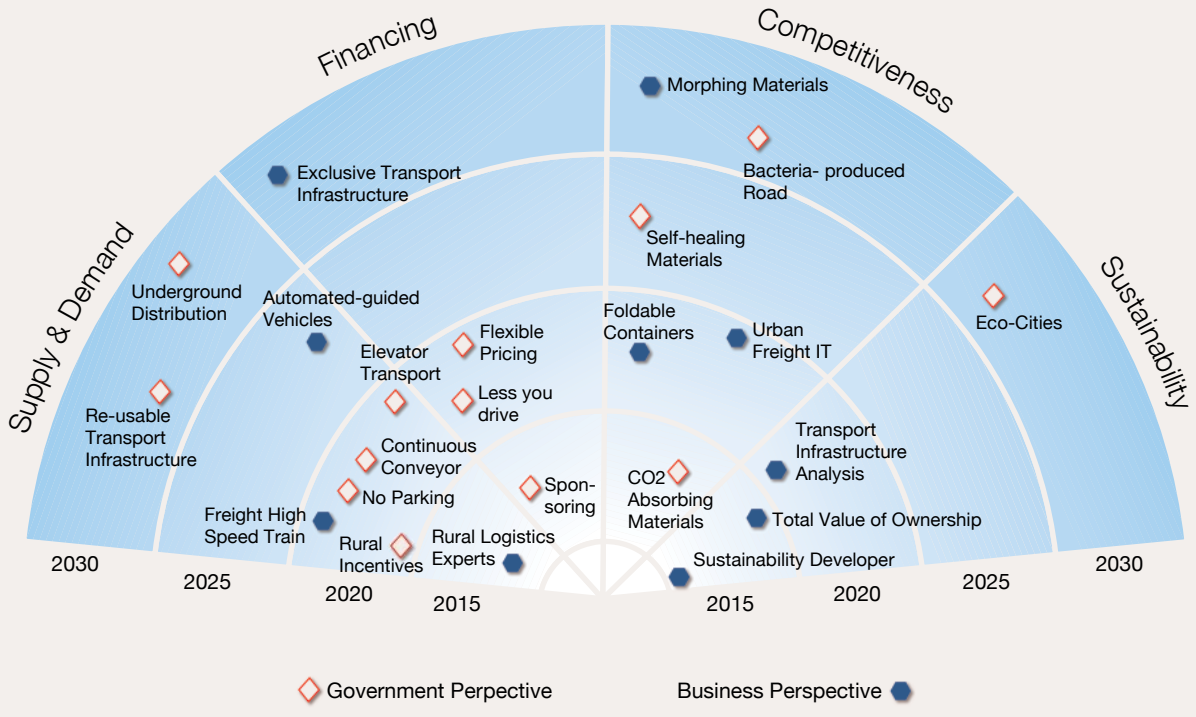
Opportunities



This chapter looks at some promising future opportunities related to transport infrastructure. We present opportunities in the areas of “Supply & Demand”, “Financing”, “Competitiveness”, and “Sustainability”. These opportunities can be differentiated according to their target groups. Some of the opportunities will be more relevant for governments while others are more interesting for businesses, i.e. transport infrastructure operators and users.

It is important to highlight that the “opportunity radar” is the subjective outcome of several future workshops, based on the scenarios described in the previous chapters. The radar 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. While some of them are almost near implementation, others remain visions by current standards.

Figure 9
Opportunity radar



Opportunities in supply and demand

Rural Logistics Experts (2015)
Logistics operations will primarily focus on urban areas, where most businesses are located and the bulk of goods exchange takes place. However, logistics service providers who seek to differentiate their service offerings by specialising on rural areas may enjoy competitive advantages vis-à-vis competitors and successfully service rural niche markets. Innovative logistics solutions which are able to cope efficiently with poor infrastructure will be a key element in their service portfolio.

Freight High Speed Train (2020)
Currently, passenger trains have priority over freight trains in rail transport. One way to enhance the level of service which can be offered to freight customers is by integrating passenger and freight transportation. In this model, high speed trains may be composed of different cars for each, pulled by the same engine and sharing track and signalling infrastructure. Such dual service would also enhance a modal shift favouring railways.

Rural Incentives (2020)
We have already noted the trend towards a "rural exodus", whereby future investments concentrate in urban areas, while rural areas are neglected. Governments may actively counter this development by providing incentives to investors in rural areas, e.g. through setting up basic transport infrastructure, offering public-private partnerships or other financing mechanisms to private investors and tax reductions.

No Parking at Public Institution (2020)
Urbanisation and urban sprawl has lead to extremely congested city centres. Unwanted side effects such as smog negatively impact the economic climate in cities. In order to reduce city transport, public authorities may consider abolishing parking spaces at public institutions except for disabled people, while ensuring good connections to public transport. This mechanism might create advantages in time reductions and less congestion in city centres.

Elevator Transport (2020)
Transport infrastructure operators can create further transport capacity by shifting the development of transport infrastructure upwards. Some examples of such projects for pedestrians include current or future Sky Walks in Hong Kong and Mumbai. Innovative infrastructure construction of the future might include the development of Sky Trains for freight transportation in city centres to lessen the burden on existing transport infrastructure on the ground.

Continuous Conveyor for Containers (2020)
In order to reduce transport bottlenecks in ports and other hubs, containers can be moved away from the point of handling quickly on a continuous conveyor which moves containers to their desired destination in a fully automated way. Post-carriage handling and (hinterland) transportation to other modes of transportation for further journeys can be realised more efficiently as goods can be bundled at an earlier point of time.

Automated Guided Vehicles (2025)
Automated Guided Vehicles (AGV) are already used within intralogistics processes, however implementation outside the factory premises still awaits realisation. While there are still unsolved infrastructural, technical and safety issues today, the potential benefits are numerous: efficient capacity management, short distance between the individual vehicles, no congestion, minimisation of accidents and a consistent speed achieved by all vehicles. In the future, new highway lanes could be constructed next to the existing highway infrastructure. Completely driverless vehicles could use this lane from one hub to another, where their load is then prepared for last mile delivery in city centres by drivers. Alternatively, trucks and cars which are controlled by a driver initially can enter this highway lane, followed by a switch to the AGV modus, giving the driver a break until the lane needs to be exited and the driver takes over again in normal traffic conditions.

Underground Distribution (2030)
Underground cargo transportation has been a vision of researchers for many years. The "CargoCaps" idea provides an innovative concept for an automated transportation system designed specifically to carry freight. Each cap is designed to transport two Euro-palettes in underground pipelines. The caps provide the potential for 24-hour, automated delivery of freight and can help minimise road congestion in urban areas.[94] Currently, financing is the biggest hurdle to implementation, but there may be solutions in the future. Similar concepts like Urban Mole envision the usage of existing networks of underground pipes to transport packages up to the size of a shoebox.[95]

Re-usable Transport Infrastructure (2030)
Re-usable transport infrastructure would be comparable to unit assembly systems. Re-usable elements of transport infrastructure could be developed and implemented so that transport infrastructure can respond flexibly to changing demands. Construction and de-construction would become schematic and efficient processes. A similar technique has already been applied in sports stadiums, where flexible seating can be added and removed to adjust capacity as necessary. More ambitious reassembly projects have included the dismantling of entire plants at one place and their re-erection at other places, e.g. a coke oven plant moving from Germany to China.

Opportunities in financing

Transport Infrastructure Sponsoring (2015)
FedEx Field, Pepsi-Centre, Nissan-Stadium, Gillette Stadium, Signal Iduna Park: many of the world's largest stadiums now bear a company name and logo. Companies, or even private individuals, could sponsor parts of transport infrastructure in return for the right to name key elements. Transport could take place on motorways named after e.g. car manufacturers; or container ships might be (un)loaded in ports carrying the name of a petroleum company. Today already, some railway lines in Japan are named after the shopping centres they serve; in fact, the two were often developed together. Offering opportunities to sponsor transport infrastructure could become a new source for transport infrastructure financing on a much broader scale.

The less you drive, the more you get (2020)
As the demand for transport infrastructure is likely to increase in the future and existing infrastructure provision may be insufficient to deal with higher trade volumes, it appears reasonable to develop mechanisms to reduce demand. This is the idea behind the "the less you drive, the more you get" opportunity. Companies would voluntarily report their average usage of transport infrastructure as well as their average driving speed during past years and aim to reduce it for the future. If they succeed in using less and driving slower, they receive governmental benefits in return, e.g. tax benefits. However, for the concept to become reality, efficient tracking instruments which monitor all transport usage are required.

Flexible Pricing (2020)
Flexible Pricing may offer an innovative opportunity for governments to finance transport infrastructure in the future. This model is already used for small parts of transport infrastructure, such as subways, today, but could be expanded to all modes on a large scale. Before users are allowed to access transport infrastructure, they would have to purchase participation certificates which allow the use of transport infrastructure for a specific time period (e.g. one month). Rebate or discounts might be offered to users who buy multiple-usage tickets or even pay for flat rate options. Payment for transport infrastructure usage could be adapted to individual situations and usage levels. Such a technique would also enable more accurate forecasting of transport infrastructure usage, as users would indicate in advance, through their purchase of tickets, when and to what extent they plan to use transport infrastructure.

Exclusive Transport Infrastructure (2030)
If companies do not want to face the risk of infrastructural bottlenecks in the future, which would limit their trade potential, they could cooperate in alliances and finance bespoke transport infrastructure solutions. Alliance members would be able to use their transport infrastructure exclusively. While it would certainly be impractical for companies to set up nation-wide, parallel transport infrastructures, in congested areas or intersections, dedicated sections of transport infrastructure which are never blocked or inaccessible could provide significant advantages.

Opportunities in competitiveness

CO_2 Absorbing Materials (2015)
CO_2 absorbing materials are not just science fiction, but almost reality. These materials will be able to absorb or bundle CO_2. If such materials were used over a wide area, an enormous contribution to the environment could be made. Today, these materials are not yet market-ready as they emit toxic gases. Nevertheless, as intensive research takes place, it seems likely that by 2015 CO_2 absorbing materials will be ready for launch. If new transport infrastructure projects such as road constructions use these innovative materials, their negative environmental impact could be reduced significantly.

Foldable Containers (2020)
According to recent research results, more than 30% of containers transported around the globe are empty. The costs for transporting empty containers to demand locations are estimated to exceed US$ 5 bn every year. The need to transport empty containers causes cost increases ranging from US$ 100 - 1000 per transported TEU. The solution to this problem may be very simple: Foldable and stackable containers could reduce transportation costs significantly and allow better space management on ships, trucks, and trains. Lightweight construction of these containers would additionally improve transportation and cost efficiency.[96] The application of foldable containers could apply to many areas: comestibles, cosmetics, chemicals, biotechnological or pharmaceutical products could be stored in foldable containers and transported at lower costs around the globe.

Urban Freight IT (2020)
Experts agree that the supply of goods in large cities will become one of the major challenges for logistics service providers and governments in the future. As urbanisation continues, an increasing number of people will live, work, and consume in cities. The provision of goods for city-dwellers will become more difficult, as traffic volumes in city centres are expected to increase and transport infrastructures are overstrained. To cope with this enormous challenge, governments could set up “urban freight IT management systems” which administer the transport of goods within cities. Before goods can be transported into the city, planned transports would have to be registered in the system. The system could act as a coordinating function to facilitate cooperation between competing providers, by automatically checking whether idle transport capacities are available which might be used. According to this vision, only fully loaded vehicles are permitted to enter the city. Partially loaded vehicles must wait for additional goods to be added. Empty vehicles can be avoided and infrastructure utilisation improved.

Self-healing Materials (2025)
A number of science fiction stories already describe materials which are able to restore themselves, and research is not far away from making these stories reality. Bio-concrete is an innovative concrete which contains calcium diverging bacteria. These bacteria are able to close cracks which frequently occur on road surfaces. Once air humidity or small amounts of water penetrate cracks in road surfaces, these bacteria produce calcium which seal the crack within a few minutes. Another solution stems from an area of nanotechnology research. Small “Nanopellets” are scattered on road scratches and as soon as the crack is contacted by the nanopellets, the capsule breaks automatically. The monomer then bleeds into the crack, where it can polymerise and mend the break. Certainly, these new technologies and materials have not reached marketability yet. However, once they are in place, they could play a part in reducing the effort necessary to maintain some types of transport infrastructure. Spending on regular maintenance could be reduced accordingly.

Bacteria-produced Roads (2030)
Bacteria can produce plastics, cellulose fibers, magnetic material and engineering fuel already today. Why should they not produce some simple elements of transport infrastructure in the future as well? The idea of “Bacteria-produced Roads” is that roads might not only be able to heal themselves. Rather, they might be able to reproduce themselves and grow where it is desired. Especially in rural areas where transport infrastructure is lacking, bacteria-produced roads could be an adequate way to provide infrastructure in a quick and efficient way. As a consequence, the construction of new roads would become much easier and possibly much cheaper. Instead of ‘building’ new streets, it would only be necessary to ‘seed’ the specific bacteria where roads are needed. Within a given time period, bacteria would produce the required surface which would exhibit similar characteristics as ‘conventional’ roads.

Morphing Materials (2030)
The idea of morphing materials is based on the observation that very small particles within batteries move from one side of the battery to the other side and back again. Transferring this ‘moving behaviour’ to large-scale structures would represent a break-through innovation. Top academic institutions such as the Massachusetts Institute of Technology (MIT) are already devoting substantial resources to research in this area. It could be possible to design materials, which perfectly adapt to external conditions. The wing of an airplane could morph on demand to the shape that is most energy efficient, a boat could change its hull according to the movement of waters, or a car could shape its body in order to minimise its air drag coefficient. Consequently, energy efficiency could be improved for almost every transport mode.

Opportunities in sustainability

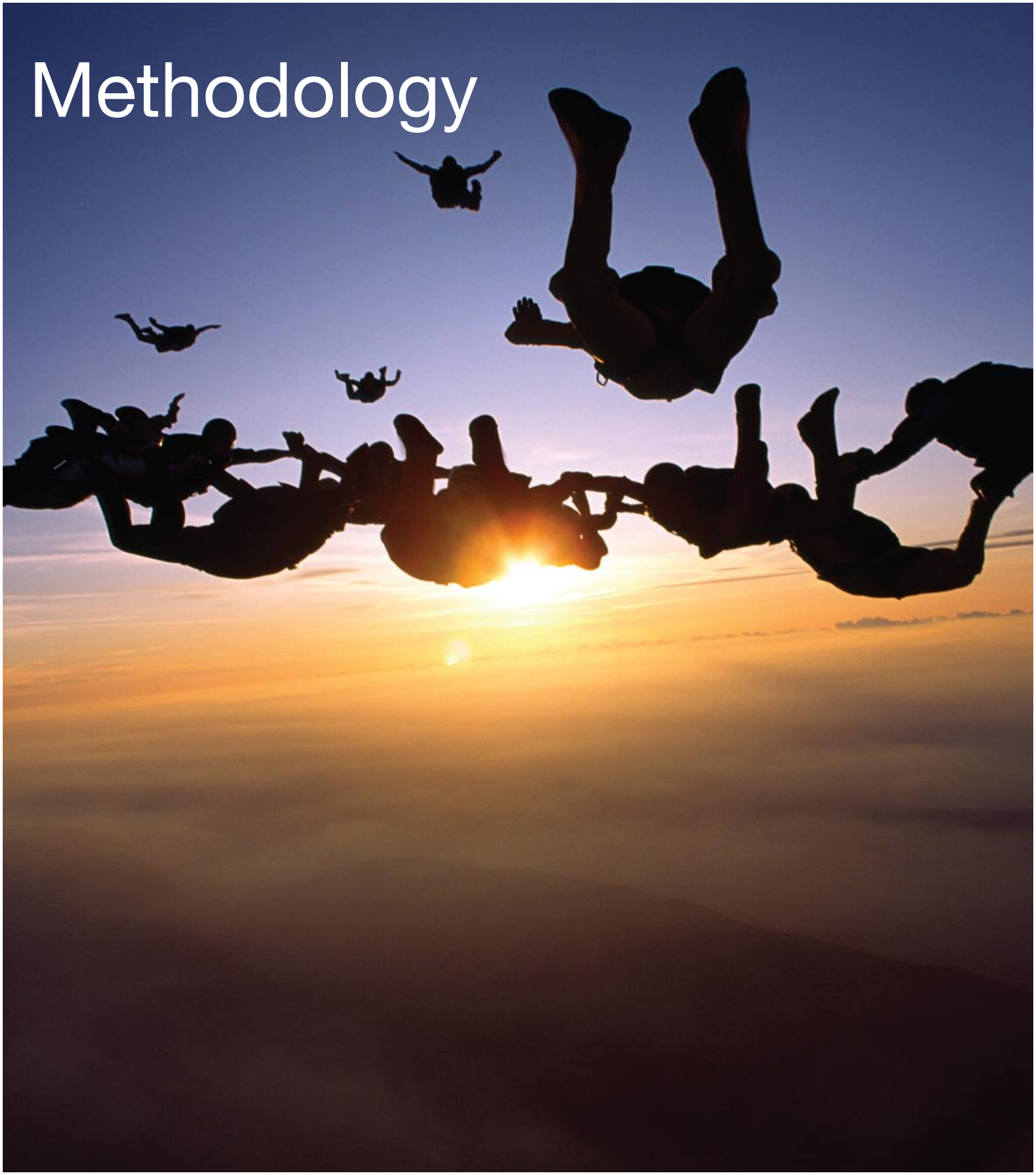
Sustainability Developers (2015)
Consumers increasingly value companies that operate in an eco-friendly manner. Companies, especially transport infrastructure developers, can respond by training their employees to act eco-aware, to work in more sustainable ways and to care more about resource consumption. Additional qualification measures, such as sustainable developer certification, can become effective ways of differentiating a company's activities from those of its competitors.

Total Value of Ownership (2015)
The Triple Bottom Line concept uses new methods to determine the success of a company by measuring environmental and social accomplishments in addition to economic criteria. Environmental assessment, or the 'planet' component, measures how sustainable the company's environmental practices are, taking into account the environmental footprint of the company as well as efforts to reduce energy and waste consumption. This practice is complemented by the use of total life cycle assessment techniques, in order to determine the environmental costs of products from the beginning of sourcing raw materials to recycling the end-product. Logistics companies and governments alike should take note of such developments. Governments may begin to include such measures when issuing tenders. Environmental impact might play an even greater role than price in decisions on transport infrastructure construction.

Transport Infrastructure Impact Analysis (2020)
Transport infrastructure operators need to think holistically about the full consequences when they plan, develop and operate new transport infrastructure. What will be the influence on transport flows? What is the impact on the economy and on the environment? Transport infrastructure operators should consider a comprehensive impact analysis before deciding on future projects. This assessment should include both quantitative simulations and qualitative analyses, such as scenario planning.

Eco-Cities (2030)
The vision of an "Eco-City" describes a city which is designed to create the smallest environmental footprint and lowest quantity of pollution possible. An Eco-City would be largely self-sufficient, with minimal reliance on the surrounding countryside, and use power generated onsite from renewable energy. Further targets of such eco-cities comprise the implementation of zero-emission transport systems, zero-energy constructions, and energy conservation systems and devices. Eco-cities are currently planned in different countries worldwide, e.g. Masdar City in Abu Dhabi, as well as other projects in Australia, China, Sweden, United Kingdom and United States. Transportation would be electronically powered and freight transport would often be located in the underground of the city, while passenger transport can be handled via small vehicles on ground level.

Methodology



RealTime Delphi innovation

Our global thought leadership programme “Transportation & Logistics 2030” employs a future methodology known as the Delphi technique. A new innovation of the Delphi technique developed by 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 by the 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 16 key Delphi projections for T&L 2030 framed around four general themes “Supply & Demand”, “Finance “, “Competitiveness” and “Sustainability” (see overview of theses on page 65). Invited experts were asked to rate the probability of occurrence of each thesis (0-100%), the impact on T&L if occurred (5-point-Likert scale) and the desirability (5-point-Likert scale) as well as to provide (optional) reasons for all answers. Once 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).

The final results of the RealTime Delphi survey formed the framework for the opportunity and discontinuity analyses. Further expert workshops drew upon the extensive qualitative survey data and desk research to develop a nuanced view of future trends and scenarios.

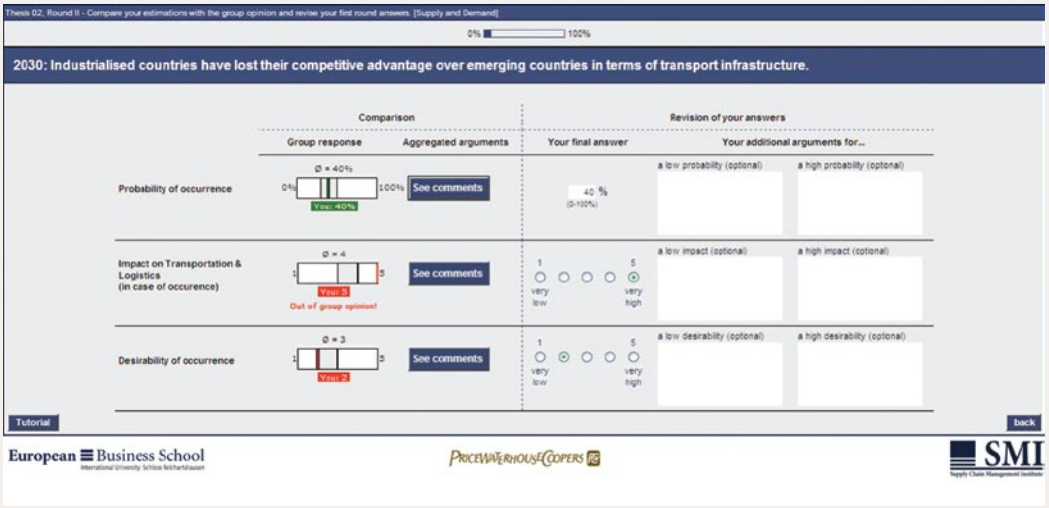


Figure 10
RealTime Delphi screen

Delphi panel

The objective of Delphi studies is not to obtain a representative sample of a population, as with most conventional surveys. Rather, Delphi research aims for a high inclusion of expertise. Our panel included a significant number of experts from business, mainly C-level executives and decision makers from global companies.

Both transport infrastructure users (27%) and transport infrastructure operators / developers (29%) were included to obtain a broad and multi-facetted view of the topic under consideration (see Figure 11). The industry share comprised predominantly large companies, including listed, family- and state-owned firms.

Overall, the expert panel consisted of politicians, transport infrastructure experts from business, representatives from associations and academics from fields related to logistics. Key selection criteria for potential Delphi participants were industry and educational background, work experience as well as function in and outside the organisation. Overall 104 invited experts participated in the study.

Given the well balanced segmentation between the different interest groups and the relatively large panel size, we were able to track where response behaviours differed between respondent groups (see Figure 12). Such variations have also been included in the analysis section of this study.

Figure 11
Segmentation of Delphi experts

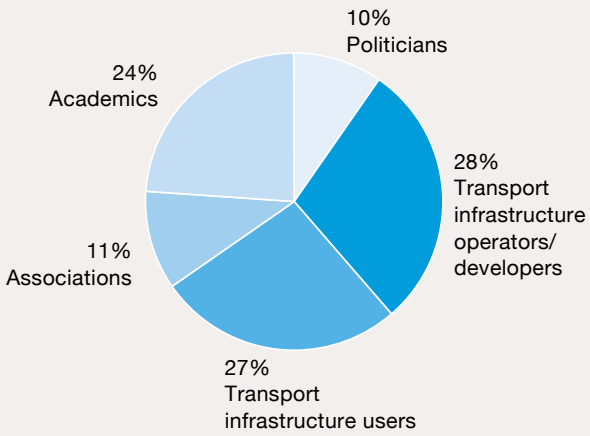
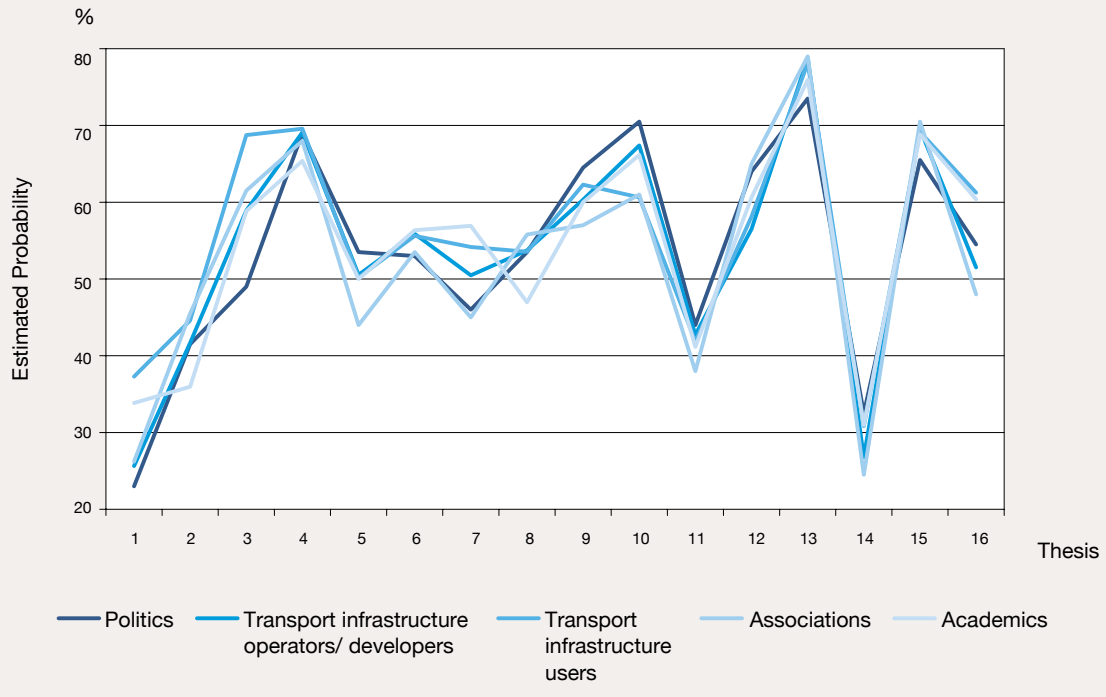


Figure 12
Response behaviour of Delphi panelists



The study also aimed to achieve a comprehensive global perspective. Participants were based in 29 different countries, ensuring a balanced and global view of the future (see Figure 13). In total, 62% of respondents come from developed countries. A significant share (38%) of the respondents originates from emerging countries, so views from both perspectives are well-represented.

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.

Delphi statistics

The Delphi process was very dynamic. During the 8 week survey period each participant took part on average in 3.2 Delphi rounds, i.e. first and second round per thesis as well as 1.2 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. 0-100%) 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 earlier experts – could be reviewed for each future thesis. After the 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, respondents could access each thesis separately at any time until the closure of the portal in order to check for updates and to revise their own estimates. The panel also provided a robust set of written responses; the group discussion included 1359 written comments, or 13.1 comments per expert on average. This lively dialogue provided excellent material for data analysis and scenario creation.

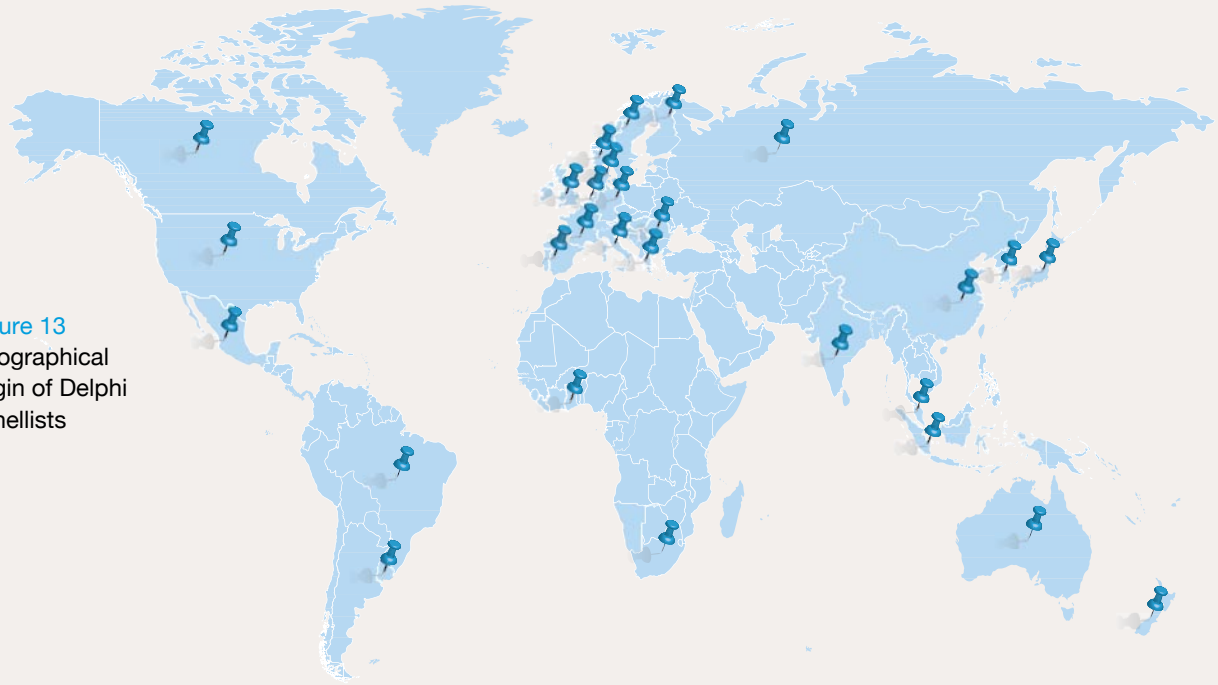


Figure 13
Geographical origin of Delphi panellists

Represented countries: Australia, Belgium, Brazil, Canada, China, Finland, France, Germany, Ghana, Greece, India, Italy, Japan, Malaysia, Mexico, Netherlands, New Zealand, Norway, Rumania, Russia, Singapore, South Africa, South Korea, Spain, Switzerland, Sweden, United Kingdom, Uruguay, United States of America.

Volume 2 in the context of the T&L 2030 series

Volume 1 of the T&L 2030 series addressed the question "*How will supply chains evolve in an energy-constrained, low-carbon world?"*

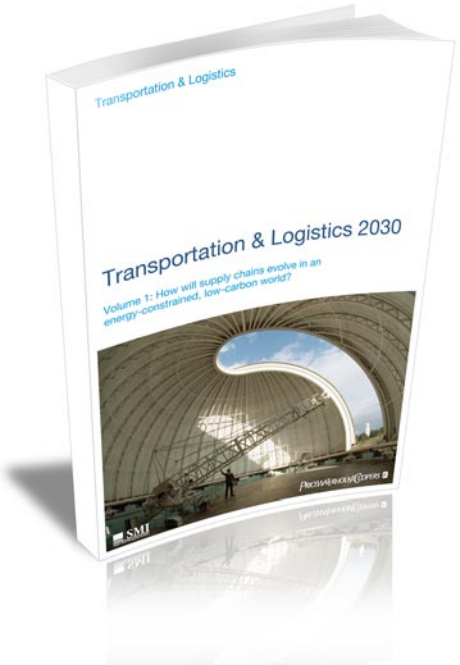
For Volume 1 we successfully applied a new research methodology, combining extensive background research with insights gained from an expert panel via a web-based, RealTime-Delphi survey. The panel comprised expert knowledge from different areas of business and academia; experts were located all around the globe. We continued to use this RealTime Delphi method in this second publication, again with great results in terms of participation rate, amount of qualitative data and global scope.

Most scenario studies are non-recurring reports. The research presented here is unique as it is designed as a scenario series which revisits many of the same concepts and ideas from various perspectives, allowing for a more thorough investigation of their validity and implications.

The outcomes of Volume 2 build upon and support many of the results of Volume 1. In Volume 1 we found that environmental awareness is likely to increase significantly until 2030. Logistics service providers will need to reduce their negative environmental impact and act more eco-friendly. The potential impact of this heightened environmental awareness was also evident in Volume 2, where experts noted that environmental considerations will increasingly play a major role in decisions on whether new transport infrastructure projects will be realised and how.

Changes related to a low-carbon global economy were shown to be critical to the future of the sector in Volume 1. CO_2 emissions resulting from transportation are very likely to be allocated to the causer and factored into the price of the product in the time leading up to 2030. This development was even rated as very desirable by the expert panel. Similarly, in Volume 2 we reveal that achieving a reduction of CO_2 emissions related to the operation and usage of transport infrastructure will be a key focus of future attention.

In Volume 1, experts were asked to assess whether larger means of transport will emerge as adequate solutions to compensate for rising transportation costs. The former panel considered this development as rather likely, however, they highlighted that larger means of transport – especially trucks – would cause strong erosion of transport infrastructure leading to higher maintenance costs for transport infrastructure. Similarly, maintenance of infrastructure as a major hurdle emerged as a significant theme in Volume 2. Even more, finding sufficient means to invest in the maintenance of existing transport infrastructure is seen to be a greater challenge than the financing of new infrastructure projects in the future.



Overview of theses

EP = estimated probability; I= Impact; D= Desirability
Measures of C = consensus (interquartile range <= 25); dissent (interquartile range >= 25)

	No.	Theses for the year 2030	EP	C	I	D
Supply & demand	1	2030: There is no longer a shortage of transport infrastructure since sufficient investments have been made.	30%	20	4.1	4.2
	2	2030: Industrialised countries have lost their competitive advantage over emerging countries in terms of transport infrastructure.	41%	20	3.8	3.8
	3	2030: Transport infrastructure development strongly focuses on urban areas, while rural areas are neglected.	68%	20	3.7	2.9
	4	2030: Strong regulatory measures, such as road tolls and congestion charges, compensate for the increased need to invest in transport infrastructure.	60%	25	3.9	3.6
	5	2030: Infrastructure shortages (e.g. insufficient transport infrastructure) have forced the division of megacities into decentralised, autonomous “sub-cities”.	50%	30	3.6	3.0
Finance	6	2030: In emerging countries, there is more capital available to invest in transport infrastructure than in industrialised countries.	52%	30	3.7	3.1
	7	2030: Financing the maintenance of transport infrastructure is more difficult than attracting investments in new infrastructure.	66%	25	3.9	2.1
	8	2030: Financial pressure on governments has become so intense that almost all investment in transport infrastructure has been shifted to the private sector.	55%	30	3.9	2.7
	9	2030: Governments are no longer able to contribute to the funding of local transport infrastructure (e.g. main roads and subways), thus user-based financing structures are prevalent.	52%	30	3.7	2.4
	10	2030: International transport infrastructure (e.g. major ports and airports) is controlled by private investment funds, which are strategic drivers of large-scale transport infrastructure projects.	61%	25	3.8	3.0
Competitiveness	11	2030: Transport infrastructure is still a key element of the basic services of an economy, but is no longer a deciding factor in the competition between countries to attract investment.	42%	25	3.7	2.8
	12	2030: Digital infrastructure (ICT) has become a stronger driver of economic growth than transport infrastructure.	60%	20	3.8	3.4
	13	2030: The success of a logistics cluster (logistics region) depends on the close collaboration of industry, government and academia, in addition to advanced transport infrastructure.	78%	20	4.0	4.3
Sustainability	14	2030: A decrease in environmental awareness and regulation has accelerated the realisation of large-scale transport infrastructure projects, boosting economic growth.	29%	20	3.8	2.0
	15	2030: Transport infrastructure operators are obliged to participate in emission trading systems to obtain pollution permits.	69%	20	3.9	3.6
	16	2030: The environmental costs caused by infrastructure development (including emissions resulting from construction) have become a serious deterrent to investments for which there is otherwise a good economic case.	56%	20	3.9	2.6

Figure 14 Overview of theses

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