COMPETE

Analysis of the contribution of transport policies to the competitiveness of the EU economy and comparison with the United States

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Impacts of and responses to congestion

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COMPETE

Analysis of the contribution of transport policies to the competitiveness of the EU economy and comparison with the United States

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List of abbreviations

ARA	Amsterdam, Rotterdam and Antwerp
ATM	Air Traffic Management
bn	billion = 10^9 = 1,000,000,000
CMP	Copenhagen Malmö Port
EU	European Union
EUR	Euro
GDP	Gross Domestic Product
GPS	Global Positioning System
ICE	InterCity Express
IOT	Input-output-table
IRU	International Road Transport Union
IVEC	Index on vulnerability of the economy on congestion
JIS	just-in-sequence
JIT	just-in-time
km	kilometres
LCC	Low-cost carrier
LTO	Landing and take-off
m	million = 10^6 = 1,000,000
NEC	not elsewhere classified
p.a.	per annum = per year
pkm	passenger-kilometres
t	ton(s)
TEU	Twenty-foot-equivalent-unit: volume of a container that is 20 feet long, eight feet wide and 8,5 feet high
tkm	ton-kilometres
UBS	United Bank of Switzerland
UIC	International Union of Railways
UK	United Kingdom
US / USA	United States of America
vkm	vehicle-kilometres
VOT	value-of-time

1 Scope and research design

1.1 Approach and choice of economic sectors

The in-depth analysis is investigating economic consequences of congestion to different economic sectors. Since detailed analysis is lacking so far, we have chosen a pragmatic approach, which consists of the following elements:

- Choice of interesting economic sectors being differently affected by congestion
- Search for empirical studies and policy papers within these sectors
- Carrying out of interviews with experts and actors within the specific sectors.

The following sectors were chosen:

Table 1-1: Choice of economic sectors for in-depth analysis

Economic sector	Relevance for congestion: Thesis
Transport: Road Rail Air Waterborne	The transport sector is directly affected, by increased costs. Most interesting is the comparison of different modes and different countries, in order to make visible possible impacts on competitiveness of the sector
Auxiliary transport	This sector is directly affected by congestion and is a leading agent in changed logistic strategies and new models for freight transport organisation
Food and retail	Due to the character of goods (perishableness) and the delivery in urban areas, this sector might be very vulnerable to congestion
Automotive industry/Car manufacturing Chemistry/Electronics	The global production with just in time character within the value added chain and the delivery structure might lead to vulnerability with regard to congestion In addition the importance of these sectors is varying across countries.
Banking and insurance	Passenger transport with high time sensitivity plays an important role within this sector.

1.2 Guiding questions for the interviews

a) General questions

What role does transport play for your commercial business? Big – Medium - Small

- Input provision of goods
- Production of your products
- Output delivery of goods
- Passenger transport
- How is your transport organised:
- Do you have an own internal transport organisation?
- Do you have an own fleet?

What are the reasons for in- or outsourcing of transport organisation?

Which transport modes are most relevant? (Road, Rail, Waterbourne, Air)

What is the share of transport cost to your turnaround (very small, 1-3%, 3-5%, more than 5%)

b) Impacts of congestion

What is the relevance of congestion in your business? Big – Medium - Small

In which of your transport activities is congestion most relevant?

- Input provision of goods
- Output delivery of goods
- Internal freight transport
- Commercial passenger transport
- Commuter transport
- Which type of congestion is most relevant for you?
- Urban congestion
- Network bottlenecks
- Congestion in specific corridors (e.g. East-West, transalpine)

In which ways is congestion influencing your business?

- Higher input prices
- Reduced reliability
- Non optimal location
- Others

Do you think that your competitiveness is worsened due to congestion? Is there a difference between different countries in Europe or between Europe and the US?

c) Your reactions on congestion

Is tackling of congestion an explicit issue in your business strategy?

Are you able to shift increased transport cost to your product prices?

Which measures do you undertake to reduce impacts of traffic congestion to your business?

- Outsourcing of transport
- Increased fleet
- Change of production or delivery times
- Change of customers/clients

Is congestion an argument in your general decisions of locations/branches?

Have you undertaken any specific measures in the past to reduce transport cost? If yes, which ones?

d) Measures against congestion

Which measures are – according to your opinion – most successful for the reduction of congestion?

- Change in the spatial organisation
- Change in transport intensity
- Infrastructure capacity increasing
- Reduction of transport in peak hours (e.g. due to parking policy, road pricing)
- Modal shift

2 Review of selected studies

Full Title:	**Economic Implications of Congestion, NCHRP Report 463**
Author/Partners:	Weisbrod G., Vary D. and G. Treyz (2001)
Client/Sponsor:	American Association of State Highway and Transportation Officials and The Federal Highway Administration
Objectives:	This study examines how traffic congestion affects producers of economic goods and services in terms of business costs, productivity, and output, and how producers are variously sensitive to congestion. Past attempts to assess the economic implications of congestion have found that this is a difficult relationship to document. This study should be viewed as an incremental step toward a broader definition of the economic costs of congestion. The research shows the many facets of congestion impacts on businesses and local economies, by illustrating the types of data necessary to document those costs and demonstrating how analysis can be carried out and ultimately improved.
Main Results:	Statistical Relationships: The research team conducted extensive data assembly and statistical model analysis for the Chicago and Philadelphia metropolitan areas. The analysis models were developed to examine the degree of sensitivity of various types of business activity to the costs of transporting products and the costs of worker commuting. The estimation and application of these parameters are the subject of considerable discussion in this report. In general, the calibrated models for Chicago and Philadelphia yielded consistent results: • **Industry differences in congestion costs:** The results for both areas indicated that industries with broader worker requirements and higher levels of truck shipping absorb higher costs associated with congestion. They also benefit the most from reduced congestion. • **Industry sensitivity to congestion costs**: The production function models also indicated that firms with lower-skilled labor requirements or nonspecialized (commodity) input requirements tend to be hurt relatively less by congestion (and benefit relatively less from reduced congestion) than those with requirements for highly skilled labor or highly specialized material inputs. • **Effect on travel patterns**: The models confirmed that congestion does reduce the agglomeration benefits of urban areas by reducing access to specialized labor and delivery markets, whereas businesses adjust with shorter trip lengths. Conversely, congestion reduction can provide greater benefits

	to businesses associated with increased access to labor and delivery markets, although that is accomplished through some increases in vehicle-miles of travel. • **Economies of scale**: The models also illustrated how traffic congestion has the effect of nullifying some of the agglomeration benefits of operating businesses in larger urban areas. The labor cost model, for instance, indicated that doubling the effective labor market size leads to an average 6.5 percent increase in business productivity.

Full Title:	**Transportation, International Trade, and Economic Competitiveness**; NCHRP Project 20-24 (23) B, Symposium Summary.
Author/Partners:	METRANS, Transportation Research Center (2002)
Client/Sponsor:	American Association of State Highway and Transportaion Officials (AASHTO)
Objectives:	METRANS teamed with the American Association of State Highway and Transportation Officials (AASHTO) to host the National Symposium on *Transportation, International Trade and Economic Competitiveness* on October 25, 2002. The one-day conference, funded by the National Cooperative Highway Research Program, was one of four conferences being held around the U.S. to highlight various aspects of the U.S. transportation system and the significance of transportation in the national economy. The conference included the following topics: • Description of the scope and impact of trade on the national economy • Description of the state of the national goods movement transport system and projections for future goods movement demand • Discussion of major problems associated with the goods movement transport system • Reflections on problems from various stakeholder perspectives • Suggestions for solving these problems
Main Results:	Conference presenters included academics, industry representatives (port authorities, trucking, shipping, labor), public agency representatives (federal, state, local), and elected officials (federal and state). Conference attendees included faculty and graduate students as well as a wide range of industry stakeholders, both public and private. Conference presenters argued that the existing port and highway capacity is insufficient to meet present and future demands of intermodal goods movement. Large ports are nearly built out and have little or no land for further

	expansion. The national stock of transportation infrastructure (highways and railroads) is aging and requires significant capital investment for its maintenance, repair and construction of any additional capacity. The shortfall in funding to maintain and expand transportation infrastructure was a big concern at the conference. It was observed that the demands for homeland security make public funding for infrastructure improvement projects more difficult. The major problem areas discussed included congestion and reliability, financing and pricing, safety and security, and the lack of adequate data and modeling capability to monitor and forecast freight flows. Industry stakeholders also identified the impacts of goods movement on local populations and the environment, as well as the absence of a comprehensive "supply chain" perspective as significant problems. The conference discussed several ways to address the funding shortfall. Policy changes to encourage private participation and to make private and joint venture intermodal goods movement projects eligible for federal funding were proposed. AASHTO Executive Director John Horsely proposed broadening eligibility for the TIFIA program and establishing state infrastructure banks in all states. James Preusch suggested a new fee on all U.S. imports and exports, levied at the point of border crossing, which will be collected by customs. This fee would be based on goods' value and CPI adjusted every year. A "National Freight Security and Infrastructure Bank" would be set up with contributions from federal and state governments and U.S. customs fees, and would be dedicated to finance infrastructure projects. The conference also discussed causes of inefficiency and ways to improve productivity of intermodal transport. Trucking was critical of the time-consuming paperwork at the ports, and limited working hours of ports and warehouses, which forced truck trips during working hours when highways are already congested. Port authorities identified the challenge of assembling and clearing all necessary legal documents related to cargo clearance and cargo transfer. All agreed that the productivity of existing infrastructure could be significantly improved with advanced management techniques and use of modern technological tools like GPS, but overall physical freight capacity is a major challenge at key hubs and on key corridors. A coordinated effort by port authorities, trucking and warehousing to increase work hours would disperse freight traffic over time and reduce traffic congestion. Trucking would have the option of driving in low traffic hours. A moratorium on the maximum period a container could remain on port after being unloaded from ocean-carrier would increase productivity of limited port capacity. The issue of underutilization of railroads was also brought up at the conference. Railroads could present capacity options for carrying freight on long haul routes. Railroads are already in the process of integrating advanced

	communication technology, presently for security reasons, but there are opportunities for better coordination and scheduling with truck operators to provide more efficient freight transport. The symposium presentations were thought provoking discussions. However, recommendations presented were frequently politically contentious. While federal funding for essentially private infrastructure is attractive to port operators, for example, state highway operators see a threat to already scarce transportation dollars. The challenge is to develop consensus around a goods movement agenda that would both use existing resources as efficiently as possible and provide for the future infrastructure needs of a growing economy.

Full Title:	**Measuring the Economic Costs of Urban Traffic Congestion to Business**
Author/Partners:	Weisbord G., D. Vary and G. Treyz (2002)
Client/Sponsor:	-
Objectives:	This paper distills key findings from NCHRP Study 2-21, which examined how urban traffic congestion imposes economic costs within metropolitan areas. Specifically, the study applied data from Chicago and Philadelphia to examine how various producers of economic goods and services are sensitive to congestion, through its impacts on business costs, productivity and output levels. The data analysis showed that sensitivity to traffic congestion varies by industry sector, and is attributable to differences in each industry sector's mix of required inputs and hence its reliance on access to skilled labor, access to specialized inputs and access to a large, transportation-based market area. Statistical analysis models were applied with the local data to demonstrate how congestion effectively shrinks business market areas and reduces the "agglomeration economies" of businesses operating in large urban areas, thus raising production costs. Learning from the results of prior research, we examined the economic implications of: congestion not by surveying businesses, but rather by using an empirical analysis approach which examines the many aspects of congestion-related costs incurred by different types of business operations in different types of urban settings. We then used statistical analysis of existing business and travel patterns to infer the business productivity loss associated with congestion. Given the complexity of the problem and the limitations of available data, our study does not provide the final word on economic costs of congestion. Rather, it represents a starting point – showing the many facets of congestion impacts on businesses and local economies, illustrating the types of data necessary to document those costs, and demonstrating how analysis

	can be carried out and ultimately improved. The paper is organized into five parts: (a) background on the nature of the analysis problem, (b) general approach for analyzing congestion costs, (c) calibration of statistical analysis models, (d) application of scenarios to assess the nature of congestion impacts, and (e) conclusions.
Main Results:	Overall, this research illustrates how it is possible to estimate the economic implications of congestion, an approach that may in the future be applied for benefit-cost analysis of urban congestion reduction strategies or for development of congestion pricing strategies. The analysis also shows how congestion reduction strategies can induce additional traffic as a result of economic benefits. More Complete Measurement. The most important aspect of this study is that it attempts to achieve a more complete representation of the real monetary cost of congestion to local or regional economies than the mere accounting of traveler expense and time. This includes the incorporation of additional productivity costs associated with travel time variability, worker time availability, freight inventory and logistics/scheduling, just-in-time production processes, and economies of market access. Link to Productivity Studies. The study also incorporates a concept of production functions that attempt to recognize the ability of businesses to sometimes substitute among inputs (and workers) to some degree, as they adjust to the higher costs of travel. This effect is of particular note, for it helps to reconcile transportation impact analysis methods with more aggregate studies of the relationship between business productivity and transportation investment. While some of the specific numbers generated in this study are affected by model assumptions, the analysis does provide insight into the ways in which travel time reduction can induced traffic growth. Scale Economies. The economic analysis further demonstrates how congestion can effectively shrink business market areas and reduce the scale economies (agglomeration benefits) of operating in large urban areas. Application for Policy Testing. The product of this study is a demonstration of a general approach that can be applied for broader analysis of the economic costs of congestion around the country. The model results show that a congestion alleviation strategy that explicitly considers impacts to firms in terms of their costs of doing business can provide a fuller picture of the trade-offs among alternative investments than a traditional comparison based merely on traveler costs.

Full Title:	**The Cost of Congestion to the Economy of the Portland Region**
Author/Partners:	Economic Development Research Group (2005)
Client/Sponsor:	Portland Business Alliance, Metro, Port of Portland and Oregon Department of Transportation
Objectives:	This study is intended to provide useful information to the public, the business community and government decision-makers as they work to formulate transportation policy, projects and funding decisions. The study should be used as a springboard for future discussions about planning for and investing in the Portland metropolitan region's transportation system. As a first step to addressing the Portland region's rising congestion problem, public and private sector partners commissioned a study to provide base-line information about the relationship between investments in transportation and the economy. This report does not recommend a level of funding for transportation improvements, nor does it endorse a specific package of improvements. Instead, it is intended as a springboard for discussions about planning for and investing in the Portland metropolitan region's transportation system.
Main Results:	This report outlined a number of potential tools, such as road and transit capacity enhancement, system management, and pricing strategies that are being considered in other cities, and should also be considered here as we look at solutions. Local business and government leaders should immediately have a discussion about the impacts of congestion and solutions in order to protect and enhance the local economy and quality of life. Marine, highway and air connections to national and international destinations, projected growth in freight and general traffic cannot be accommodated on the current system. Increasing congestion -- even with currently planned improvements - will significantly impact the region's ability to maintain and grow business, as well as our quality of life. Action is needed to remain competitive with other regions that are planning large investments in their transportation infrastructure. This report finds that: • Being a trade hub, Portland's competitiveness is largely dependent on efficient transportation, and congestion threatens the region's economic vitality. • Businesses are reporting that traffic congestion is already costing them money. • Failure to invest adequately in transportation improvements will result in a potential loss valued at of $844 million annually by 2025 – that's

	$782 per household -- and 6,500 jobs. It equates to 118,000 hours of vehicle travel per day – that's 28 hours of travel time per household annually; • Additional Regional investment in transportation would generate a benefit of at least $2 for each dollar spent.

Full Title:	**Transport costs in relation to Europe's competitiveness on a global level – Final Report**
Author/Partners:	Transport Department: Bozuwa J., Van der Flier M., Tollenaar R. and L. Vocks (1999)
Client/Sponsor:	European Commission
Objectives:	The objective of this analysis is to estimate the effects of higher transport costs on intercontinental trade and the European economy.
Main Results:	The impact of increases in the integrated transport costs for the selected commodities is limited or even negligible. Past developments, as shown in the previous chapter, have illustrated this. Furthermore, the share of transport costs in the overall product costs are in general modest. If increases are limited to the inland transport costs only, effects are even smaller if not negligible. With respect to competitiveness, the ability of the European industries to be competitive in terms of production costs and product quality is far more important. In general one could say, that other conditions than transport costs are far more important in global trade (i.e local policy, subsidies, presence of natural sources/raw materials, presence of low cost labour et cetera).

Full Title:	**Transport Trends – 2005 Edition**
Author/Partners:	Department for Transport (2005)
Client/Sponsor:	-
Objectives:	This publication presents an overview and analysis of trends in transport and travel in GB over the past 25 years, and highlights some of the key issues. It is intended as a companion volume to Transport Statistics Great Britain, which contains reference tables of more detailed figures and some longer time trends. This is the eighth annual edition of Transport Trends, published to fulfil the commitment in the Government's 1998 Transport White Paper to publish these reports each year so that progress against key indicators can be monitored. This edition of Transport Trends broadly follows the structure of the

	previous publication, with some additional analyses incorporated. Transport Trends includes a wide range of indicators and statistical analysis to illustrate longer-term trends and to help put key policy targets and trends into a broader context. The report includes trends in relation to the Department's Public Service Agreement (PSA) targets (see Annex 2) and the government's sustainable development indicators which are most relevant to transport (see Annex 3).
Main Results:	The summary below highlights some of the key points in Transport Trends: •**Roads, vehicles and congestion**: Road traffic has grown by 81 per cent since 1980, although it has grown less during the 1990s than in the 1980s. Many factors have affected traffic levels, including an increase in car ownership and numbers of drivers, falls in car occupancy levels, fuel price changes and varying levels of capital and current expenditure on roads. Over a quarter of households now have access to two or more cars, more than the proportion of households without access to a car. Men are still more likely to have a driving licence but the proportion of women holding a licence has been increasing at a faster rate. Personal travel by mode Car use has continued to increase as disposable income has risen, against a backdrop of little change in the real cost of motoring and rising real costs of public transport fares. While the average time people spend travelling has hardly changed, at around one hour per day, increased car use has allowed them to travel further in the same time. •**Public transport**: The number of bus journeys has declined from the mid 1980s to the mid 1990s, but has shown some increase over the past 6 years, mainly because of increased bus use in London. Bus operators are now investing in newer vehicles, and passenger satisfaction is generally high although buses tend to have a poorer image among non-users and infrequent users. Rail travel has increased by over 40 per cent over the last 10 years despite the effects of the Hatfield crash in October 2000. Investment in national rail infrastructure has increased significantly since privatisation. The reliability of train services has been improving gradually since 2000, as has passenger satisfaction with journeys undertaken. Variation in personal travel and access to services The number of trips made and distance travelled increase with income. Adults in households with two or more cars travel on average over three times further than those in households without a car. On average, men travel a third further than women do. The proportion of people experiencing difficulty getting to medical and shopping facilities has decreased in recent years. • **Freight and logistics**: The weight of goods lifted in Britain has increased by 25 per cent since 1980 with most of that increase happening during the 1980s. This rise was largely due to increases in the amount of goods lifted by road. Another important freight measure is tonne kilometres moved (de-

	fined as tonnes carried multiplied by kilometres travelled). This too has increased, rising 44 per cent since 1980. • **Ports and airports**: UK residents made 64 million overseas visits in 2004 compared with 18 million in 1980, while the number of visits to the UK by overseas residents increased from 12 million in 1980 to 28 million in 2004. The growth in air travel accounts for the majority of these increases. • **Safety**: In terms of fatalities per passenger kilometre, air continues to be the safest mode of transport. The passenger fatality rate for cars, the mode of transport used most, has halved since 1980. Vehicle related thefts in England and Wales have halved since they peaked in the mid 1990s. • **Health and the environment:** Walking and cycling for travel purposes have both declined significantly over the past twenty years. The accompanying growth in motorised transport has resulted in a 47 per cent increase in carbon dioxide emissions from transport sources since 1980, which now account for 23 per cent of UK carbon dioxide emissions. Emissions of local air pollutants have declined with the advent of catalytic converters and cleaner fuels. Despite an improvement in vehicle fuel efficiency, the fuel consumed by transport has increased due to growth in road traffic and a substantial rise in international aviation. The prices of petrol and diesel are roughly the same in real terms as they were in 1980.

Full Title:	**Traffic Congestion and Reliability - Trends and Advanced Strategies for Congestion Mitigation – Final Report**
Author/Partners:	Cambridge Systematics, Inc. with Texas Transportation Institute (2005)
Client/Sponsor:	Federal Highway Administration
Objectives:	The report Traffic Congestion and Reliability: Trends and Advanced Strategies for Congestion Mitigation provides a snapshot of congestion in the United States by summarizing recent trends in congestion, highlighting the role of travel time reliability in the effects of congestion, and describing efforts to reduce the growth of congestion. This is the second in an annual series developed by the Federal Highway Administration's (FHWA) Office of Operations. Much of the report is devoted to communicating recent trends in congestion. The report pays particular attention to the concept of travel time reliability – how consistent travel conditions are from day-to-day – and strategies aimed at improving reliability. The variation in travel times is now understood as a separate component of the public's and business sector's frustration with congestion problems. Average travel times have increased and the report discusses ways to reduce them. But the day-to-day variations in travel conditions pose their own challenges and the problem requires a dif-

	ferent set of solution strategies. The topics covered in this year's report include: • Characteristics of congestion and travel reliability; • Significance of reliability to travellers; • Recent trends in congestion, especially reliability; • Strategies to address congestion problems; and • New tools and initiatives for dealing with congestion.
Main Results:	Examination of the available data on congestion and highway usage over the past decade leads to the conclusion that congestion is getting worse. Highway usage has been growing at roughly two percent per year and is expected to continue doing so. On highways that are already congested, any additional traffic leads to a disproportionately higher amount of congestion – once traffic flow has broken down to stop-and-go conditions, adding more vehicles makes recovery very difficult. Changes in reliability could be considered a fourth characteristic of congestion trends. The extra travel time and amount of the day and system affected by travel delays is not the same every day. It may not even be as it was predicted 10 minutes ago.

Full Title:	**Qualitative Assessment of Transport Policy Impacts in Accession Countries**
Author/Partners:	Cambridge Econometrics, UK (2004) with IWW Germany, ME&P UK, TRT Italy, TNO INRO Netherlands, NOBE Poland
Client/Sponsor:	European Communities
Objectives:	The main goal of this research work has been to give an insight into the impacts on macroeconomic performance of Central and East European economies up to 2030 exerted by influences of European transport policy on economic development. For this purpose the report is first analysing the potential economic development, second looking at current trends of the transport system and, third, presenting and analysing, quantitatively and qualitatively, the future plans and potential impacts of transport policy in the Eastern European accession countries. This report particularly focuses on the transport developments in Eastern Europe and finally discusses strategies for European transport policies. The report starts with a detailed analysis of future macroeconomic developments as economic growth defines an important driver for transport developments.

Main Results:	The results of this study clearly underline the importance of infrastructure investments particularly for the already over average performing agglomeration. The relatively optimistic projections for regions around Prague, Warsaw, Budapest, Bratislava and also Slovenia should not be seen as a signal to reduce the efforts for these regions. In contrary, these regions can be interpreted as germ cells for economic growth, which should be fostered in an intensive manner in the coming years, at least if intra- and inter regional infrastructure investments are considered. According to the study four main policy conclusions can be drawn: • The creation of a Western framework will result in Western transport conditions e.g. concerning car-ownership levels or freight modal-shares. • In general infrastructure investments can have a positive impact on macroeconomic performance. However, in some cases regions would benefit more, if investments would be shifted to other fields. • European visions and national interests are converging but are not congruent yet. • The timing of infrastructure improvements may play a significant role for the outcome in terms of modal-shares but also for economic developments.

Full Title:	**The Cost of Road Congestion in Great Britain,** A NERA Briefing Paper
Author/Partners:	Dodgson J. and B. Lane (1997)
Client/Sponsor:	Quentin Bell Associates on behalf of BT
Objectives:	This report provides estimates of the costs of road congestion to road users in Great Britain in 1996. There have been a number of previous estimates of the cost of congestion to individuals and businesses, but none are based on such a detailed analysis as the present one. Indeed, most of the previous estimates are simply rather unsatisfactory “back-of-the-envelope” calculations.
Main Results:	The costs of congestion estimated in this study are less than the figure of £15 billion which has been widely quoted in the past. However, this figure was never based on a detailed analysis of the condition of the British road network, and the traffic flows and patterns of travel on that network. Moreover, our figure of £7 billion represents a substantial cost to the British economy, and was equal to one per cent of Gross Domestic Product in 1996.4 It would never be either possible nor desirable to eliminate all congestion, since road users will always have to share the network with other

	users, and there will inevitably be some costs of delay imposed on each other. A situation where each of us has the network almost entirely to ourselves at any time of the day or in any part of the country is not a realistic possibility. However, from a practical and relevant policy perspective, reductions in traffic at the margin, perhaps through changed methods of the way we work, could contribute to the reduction of congestion where it is greatest, and where the marginal costs of congestion are highest.

Full Title:	**Estimation of Congestion Costs in the Netherlands**
Author/Partners:	Koopmans C. and E. Kroes (2004)
Client/Sponsor:	-
Objectives:	In this paper we have presented an economic theory based approach to quantifying congestions costs, which lead us to argue that the total costs of congestion include two components: observed costs and unobserved costs. The observed costs can be measured directly on the road network, the unobserved costs relate to travel behaviour that has been modified in reaction to the congestion. Such modified behaviour can be for instance changes in route, in mode of transport, in time of travel, in destination, etcetera. Most traditional methods used to estimate congestion costs only address the observed costs. Our theoretical analysis has suggested that in networks with substantial and persisting congestion, the unobserved costs can be quite important relative to the observed costs.
Main Results:	Using the Dutch National Model System we have quantified the year 2000 congestion costs, which we have defined as the costs associated with not traveling at free-flow speed. We have use two methods, a more traditional speedflow based approach, and a more comprehensive logsum based approach that included unobserved effects (choice of mode, destination, and timing of travel). The results have indicated that the second approach arrives at a total congestion costs estimate almost twice as high as the first approach. This can be seen as empirical support for the "unobserved costs" theory. Or in other words: indeed the total costs of congestion in The Netherlands are substantially higher than what is suggested by estimates based solely on observed congestion.

Full Title:	**The 2005 Urban Mobility Report**
Author/Partners:	Texas Transportation Institute: D. Schrank and T. Lomax (2005)
Client/Sponsor:	American Road & Transportation Builders Association – Transportation Development Foundation; American Public Transportation Association; Texas Transportation Institute

Objectives:	The 2005 Report shows that the current pace of transportation improvement, however, is not sufficient to keep pace with even a slow growth in travel demands in most major urban areas. The complete report, methodology, data, charts and tables can be found at: http://mobility.tamu.edu/ums
Main Results:	The problem can be stated simply – urban areas are not adding enough capacity, improving operations or managing demand well enough to keep congestion from growing larger. Over the most recent 3 years, the contribution of operations improvements has grown from 260 to 340 million hours of congestion relief, but delay has increased by 300 million hours over the same period. Congestion occurs during longer portions of the day and delays more travellers and goods than ever before. And if the current fuel prices are used, the congestion "invoice" climbs another $1.7 billion which would bring the total cost to about $65 billion. Some key changes for this year are: • Four urban areas moved into a new population group in 2003. All historical statistics were updated with these changes. Atlanta and Phoenix were moved into the "Very Large" group. Providence was moved into the "Large" group. Allentown-Bethlehem was moved into the "Medium" group. • The researchers have refined the numerous equations and calculations used to produce the Urban Mobility Report. Minor changes to the computer programs have been made and the historical trend data reflect the new information and procedures. Additional changes are anticipated at the conclusion of the study. • The calculation methodology has been changed to provide an improved estimate of fuel wasted during congested conditions. The new values show the amount of wasted fuel as approximately half of the previous total. The year-to-year trend is the same—increasing fuel consumption and fuel costs. • The operational treatment effects are included for 2000, 2001, 2002 and 2003 mobility estimates. The data provide a better picture of the travel conditions in those four years. Unfortunately, the long-term trend analysis for years before 2000, does not yet include this information.

Full Title:	**Mobility and the Costs of Congestion in New Jersey,** 2001 Update
Author/Partners:	New Jersey Institute of Technology (2000)
Client/Sponsor:	Foundation of the New Jersey Alliance for Action
Objectives:	-
Main Results:	• Congestion has a real and quantifiable cost to commuters in New Jersey.

	• People travelling longer time to and from their jobs experience higher levels of stress, and this, in turn, leads to decreased labor productivity, and a reduced quality of life. • Congestion leads to higher costs for truck freight and service operations, these increased costs are passed on to consumers and have negative impacts on the manufacturing industry and the service sector. • Much peak period travel throughout the state is affected by congestion. In many counties, there are more vehicles on the roads during peak periods than can be safely accommodated by the existing infrastructure. • Traffic volume in New Jersey will continue to grow in the future faster than both population and employment.

Full Title:	**Freight Industry Attitudes Towards Policies to Reduce Congestion**
Author/Partners:	Th. F. Golob and A. C. Regan (1999)
Client/Sponsor:	-
Objectives:	This paper presents an analysis of the perceptions held by for-hire and private trucking company logistics and operations managers about the impacts of congestion on their operations and the feasibility and effectiveness of actual and potential congestion mitigation policies.
Main Results:	The analysis presented in this paper identified six classes of congestion mitigation policies: • new dedicated truck facilities • improved operational efficiency • improved traffic management • enhanced truck urban arterial priority • increased road capacity •congestion tolls and matched support for these to trucking companies characteristics.

Full Title:	**Challenges to Growth, 2004 Report**
Author/Partners:	Eurocontrol (2004)
Client/Sponsor:	-
Objectives:	The study has been conducted to help clarify the future position of air

	transport in Europe via a network-wide analysis of: • The long-term evolution of traffic demand • The long-term potential for airport capacity enhancement • The long-term network effect of airport capacity constraints • Possibilities to mitigate these constraints • A qualitative analysis of environmental challenges Because the results of the study will also serve as an input to strategic planning in the context of the European ATM Master Plan, the focus of the analysis was on the interaction between traffic demand and airport capacity, without any a priori assumption of ATC capacity constraints.
Main Results:	**1. Future Traffic Demand:** To study the long-term evolution of traffic demand, the Agency, in collaboration with Stakeholders, has developed four forecasting scenarios which together were judged to capture a range of possible futures for the air traffic industry that was wide enough to support the formulation of strategy: • Scenario A — globalisation and rapid economic growth: flight demand (traffic without airport constraints) grows on average 4.3% p.a. By the year 2025, this scenario would result in a growth of 2.5 times the 2003 flight demand. • Scenario B — business as usual (moderate economic growth and no significant change from the status quo and current trends). Results in an annual growth rate of 3.6%, which equates to a growth factor of 2.2 by 2025. • Scenario C — strong economic growth with government regulation to address growing environmental issues: leads to 3.2% growth p.a. and a growth factor of 2.0. • Scenario D — regionalisation and weak economies (increased tensions between regions with high security costs and high oil prices), resulting in 2.5% growth p.a. and a growth factor of 1.7. In this study, most of the analysis is focused on scenario A, because its associated traffic demand forecast represents the highest challenges to growth. **2. Future Airport Capacity:** While it addresses all served airports, the focus of the study is on the first 133 European airports which together handle 90% of the IFR traffic. The findings are based on the replies to a EUROCONTROL-ACI questionnaire sent to these airports (response rate 52%) complemented by data obtained from

	non-responding airports on earlier occasions. It is estimated that the airport network has a long-term potential for 60% capacity growth, but only a small part of this extra capacity can be provided at the major airports and one third of it would in fact not be needed in 2025 due to insufficient demand at the concerned airports. The potential is partly due to the fact that 25% of airports reported a possibility for building new runways in the next 20 years. However most of this reported growth potential is to take place under the condition that all airports manage to apply best practices as soon as possible. Nevertheless, almost 80% of the airports indicate that without adding extra runways, they will be unable to achieve the same capacity as the best performing airport with comparable runway configuration. The most frequently cited reasons for this were physical site and infrastructure limits (two thirds of airports with constraints), followed by environmental issues (half of the airports), and physical constraints related to surrounding airspace and geography (one third). Today, most airports have some spare capacity. In fact, for the first 133 airports, nearly 30% of existing capacity remains unused at 2003 typical busy hour traffic levels. In the scenario with the highest traffic growth (scenario A), even with maximum achievable capacity enhancements, this situation is expected to gradually deteriorate into capacity imbalance, i.e. capacity shortage in parts of the network with a remaining capacity surplus in other parts. Already in 2010, more than twenty airports are expected to have a capacity shortage if the demand evolution follows the high growth scenario. Ultimately, in 2025, with all new investments taken into account, more than 60 airports will be unable to handle the typical busy hour demand without generating delays or unaccommodated demand. **3. Traffic Growth Potential:** With the highest growth scenario airports will severely constrain traffic growth in 2025. Annual demand will have increased to 21 million flights, a growth by a factor 2.5 compared to 2003. However, despite 60% potential capacity increase of the airport network, only twice the volume of 2003 traffic can be accommodated, and 17.6% of demand (i.e. 3.7 million flights per year) cannot take place. This is expected to have a significant impact on airport operations: more than 60 airports will be congested, and the top-20 airports will be saturated at least 8-10 hours per day. The progressive occurrence of unaccommodated flight demand will cause pressure to change the traffic distribution pattern: growth will be limited to parts of the airport network which are not yet congested, meaning that extra flights will only be possible at secondary airports, generally at less favourable times. There will also be a strong pressure to accelerate the switch-

	over to larger aircraft, in order to accommodate more passengers while keeping the number of flights constant. The study has analysed the potential of mitigating unaccommodated demand if aircraft operators would be willing to adapt their demand distribution patterns: • If unaccommodated flights would take place up to 3 hours earlier or later than desired, then the unaccommodated demand could be reduced from 17.6% to 11%, meaning that up to 1.6 million extra flights per year could be accommodated. • In addition, if unaccommodated flights could be transferred to secondary airports in the same region, the unaccommodated demand would be brought down to 5%. In other words, it is possible to find capacity for up to 2.6 of the 3.7 million unaccommodated flights by accepting less ideal times and places for that traffic. On the other hand, if the air transport market would require that demand distribution patterns need to remain as they are, and considering that the existing airports cannot expand as required, the only alternative way to handle the 3.7 million unaccommodated flights per year in 2025 would be the creation of reliever airports in the vicinity of their congested counterparts. The study concludes that there could be a market for up to 10 new major airports (capacity 70-140 mov/hr) and 15 medium sized airports (capacity 35-70 mov/hr).

Full Title:	**Influence of Capacity Constraints on Airline Fleet Mix**
Author/Partners:	Hansen M., Gosling G., Margulici J.-D. and W.-G. Wei (2001)
Client/Sponsor:	Los Angeles World Airports
Objectives:	This report documents the findings of research sponsored by the Los Angeles World Airports to examine the influence of airport capacity constraints on airline fleet mix and to explore the potential effects of policy options to influence airlines to use larger aircraft types and thereby accommodate growth in passenger or cargo demand without a corresponding increase in the number of aircraft operations. This issue is of growing importance at many major airports in the United States and indeed around the world, as a steadily increasing demand for air transportation has resulted in volumes of air traffic that are approaching the capacity of the existing airport infrastructure, resulting in the prospect of significantly greater levels of aircraft delay in the future. At the same time, environmental and other concerns are limiting the ability of airports to construct additional runways to increase their airside capacity.

Main Results:	It is clear from an analysis of traffic patterns at LAX over the past ten years that in spite of the significant growth in passenger traffic, there has been very little, if any, increase in average aircraft size by the large domestic and international airlines. There has been a significant increase in average aircraft size by the regional airlines, resulting largely from the replacement of aircraft with 19 or fewer seats by aircraft in the 30 to 35 seat range. However, the regional airlines currently serving LAX have not so far deployed larger aircraft than 35 seats in any of the markets, and it is unclear whether further growth in the regional airline markets will be served through an increase in frequency or the introduction of larger aircraft. While the growth in aircraft operations over the past ten years appears to have levelled out over the past three years, this is largely the result of shifts in traffic composition, and further growth in passenger traffic is likely to result in the resumption of the growth in aircraft operations. The analysis presented in this paper suggests that airline response to the resulting increase in delays that will inevitably occur appears likely to result in only modest increases in average aircraft size, if left to market forces. In any event, airlines cannot deploy aircraft that they do not have in their fleets, and therefore any significant increase in average aircraft size is likely to be a slow process. On balance, the prospects for a large enough increase in average aircraft size over the next decade at airports like LAX to accommodate the expected growth in traffic are not very encouraging. Delay costs alone do not appear sufficient to offset the competitive advantages of greater flight frequencies, particularly in short haul and low density markets. Without some intervention by the airport operator, it appears likely that traffic growth will lead to ever greater levels of delay at many airports, including LAX. Although there appears to be weak evidence that the airlines have increased the average aircraft size in many congested markets, this effect is much less pronounced than necessary to offset the growth in traffic. Therefore some form of policy intervention appears to be necessary to encourage the use of larger aircraft if significant future increases in delay levels are to be avoided. A number of approaches are possible, and careful assessment of the pros and cons of each, together with input from the airlines using the airport, will allow the design of appropriate measures that meet the airport objectives within the economic and operational constraints faced by the airlines.

3 Sectoral results of qualitative analysis

3.1 Road Transport sector

The following in-depth analysis of the impact of congestion in the road transport sector is based on several interviews (with road transport companies and officials of road organisations) and a literature analysis[1].

3.1.1 Relevance of congestion

In the road transport sector congestion is an issue of major relevance. All companies interviewed attach great importance to congestion. Due to dynamic changes in the transport and logistics sector and as consequence of liberalisation within the transport markets, there is a widespread range of actors in the road transport sectors. The different sub-sectors of road transport are affected by congestion in different ways:

- - Long-range hauliers: They are often integrated (at least partly) in bigger logistic supplier companies which combine different modes of transport. Thus, these companies are able to provide a broader range of transport and logistic services covering several steps of the transport chain and different transport modes (besides road often rail and sometimes water transport).
- - Short-range hauliers: They usually concentrate on their core business, which is road freight transports from A to B. They do generally only provide one step in the transport chain. Short-range hauliers are at the end of the transport chain. Competition with other transport modes (e.g. train) is less important than for long-range hauliers.
- - Delivery vans: The delivery of goods by vans is generally the last step in the transport chain. Delivery by vans is especially frequent in urban areas.
- - Specialised transport: This covers a lot of different types of road transport sub-sectors, such as construction transport, terminal haulage, etc., but also passenger transport (e.g. bus and coach operators).

In the last years competition in the road haulage sector has increased especially in Europe. Above all the road hauliers from Eastern Europe which have significantly lower operation costs are an increasingly strong competition to those in Western Europe. This growing competition in the road haulage sector, together with other effects of liberalisation, leads to efficiency gains and price reductions. An evidence for this tendency is the fact that the average size of road haulage companies has increased by 50% in the last ten years. This change of size of the compa-

[1] Interviews have been conducted with Jens Hügel from the International Road Transport Union (IRU), Francis Babé from the FNTR (Fédération Nationale des transporteurs routiers, France), Christian Rose from the UNOSTRA (Union Nationale des Orgnanisations Syndicales des Transporteurs Routiers Automobiles, France) and officials from the following haulier companies: Galliker Transport, Wespe Transport, Planzer Transport, Markoma Spedition, CSAD Tisnov.
The following literature has been analysed for this chapter: AECOM (2001); Bozuwa et al. (1999); Cambrigde Systematics (2005); Dodgson, Lane (1997); ESRC Transport Studies Unit (2004); Golob, Regan (2000); Hamer et al. (2005); IRU (1998a); IRU (1998b); Kouwenhoven et al. (2005); Laksmanan, Anderson (2002); McKinnon (2003); McKinnon (2004a); McKinnon (2004b); METRANS (2002); NEI (2001); Pastori (2006); Regan, Golob (1999); Vickermann (2005); Washington Research Council (2001).

nies is an effect of liberalisation and shows clearly the relevance of economies of scale and scope. The whole development of ongoing liberalisation and increased competition has led to a reduction in margins in the road haulage sector and, as a consequence, to a higher vulnerability to congestion of the whole road transport sector. The lower the margins of the road haulage companies, the bigger the problems they face if unexpected increases in their operating costs (e.g. due to congestion) occur.

Although congestion is undoubtedly a very important issue for the road transport sector, it has to be borne in mind that there are different reasons for road congestions. In general, restricted infrastructure capacity is often seen as the only reason of delays and road congestions. However, only parts of all congestions are capacity related, as a study commissioned by the International Road Transport Union (IRU 1998a, IRU 1998b) points out. Besides capacitiy related congestion a whole set of other barriers to road transport exist: delays at border crossings, strikes and blockades, traffic bans, construction sites, speed limit constraints, etc. In UK and Italy, infrastructure capacity is the most important cause for time losses: Between 60-70% of the time losses can be attributed to capacity related congestion. Other important factors for time losses are traffic bans and strikes/blockades. In Eastern Europe, about 40-50% of the time losses are caused by capacity related congestion. Border delays are the second reason for delays (20-30% of the time losses). In other countries, however, capacity constraints are only a minor source of time losses. In France, for example, the share of capacity related congestion is much smaller (only 5-10%). The main causes of time losses in France are strikes and blockades.

Besides the different reasons for congestions and delays, the relative importance of time delays compared to the total transport time differs a lot between different countries. The share of congestion of the total transport time ranges from 5-10% (UK, Italy) up to 17-22% (France, Czech Republic, Poland).

For road freight transport all types of congestion are relevant: congestions in urban areas, on motorways and on certain corridors (e.g. in France Paris-Lille or the Rhone Valley, in Switzerland, Austria and Italy the trans-alpine corridors, etc.). However, congestion in urban areas is easier to handle since it can be better foreseen (avoiding peak times). The biggest problems arise from unexpected congestions.

3.1.2 Congestion impact analysis

The most relevant problems of congestion are the time losses and the related delays, which again lead to a decrease in reliability and service quality. Organisation of transport is getting more difficult if congestions occur more often. The more frequent non-recurring congestions occur, the higher gets the risk of low reliability. All interviewees have emphasised that the effect of reduced reliability and service quality is the most important problem related to congestion. This problem is getting worse since clients set an increasingly high value on deadlines and reliability. Sometimes, clients even claim their money lost due to delays. Additionally, transport chains are nowadays planned tighter than in the past, which again makes it more difficult to react on congestion. In the United States of America a survey amongst road hauliers (Golob, Regan 2000) indicates that nearly 90% of the respondents sometimes miss schedules because of congestion. For 25% of the interviewees, this happens often or very often. Since competition in the road freight transport sector is very high, the risk of losing clients and business due to a decrease in reliability is significant. Road hauliers highlight that these risks related to congestion and decreased

service quality are significantly higher than the direct costs in form of increased personnel and energy costs.

Besides the problems of decreased reliability, most road transport companies state that congestion further leads to increased personnel costs. However, these costs are seen as less relevant than the reliability issue.

The companies interviewed stated that they would not be able to quantify the costs related to congestion. Some studies, however, have estimated the costs of congestion and other impediments. The Hague Consulting Group, for instance, has quantified these costs for a set of countries in a study for the International Road Transport Union (IRU 1998b). The following tables summarises the costs of impediments in selected European countries. The data are differentiated between the losses of travel time (direct time costs) and the total losses including lost business opportunities due to congestions/impediments.

The study concludes (although based on a rather small sample) that the total costs of impediments or congestions (including missed opportunity costs) are about 2.2 times higher than the cost estimates that only include the direct time costs based on value-of-time (VOT) calculations. Therefore, the missed opportunity costs are about 1.2 times higher than the time losses.

Table 3-1: Cost of impediments in selected countries (road freight and busses/coaches)

	UK	France	Italy	Czech Republic	Poland
Road Freight:					
Loss of travel time: - in % of road expenditures - in % of GDP	 3.2% 0.16%	 2.3% 0.14%	 1.3% 0.09%	 8.3% 1.27%	 28.8% 2.6%
Total loss including lost business opportunities: - in % of road expenditures - in % of GDP	 7.1% 0.35%	 5.0% 0.32%	 2.8% 0.19%	 - 	 -
Busses and Coaches:					
Loss of travel time: - in % of road expenditures	 0.4%	 16.3%	 6.2%	 3.3%	 3%
Total loss including lost business opportunities: - in % of road expenditures	 1.2%	 45.6%	 17.3%	 9%	 9.1%

Source: IRU 1998b

The interviews conducted within this study support the thesis that simple value-of-time calculations underestimate the total costs of congestion or delays. The ratio of the IRU study (IRU 1998b) between the reliability costs (indirect costs due to lost opportunities) and the direct time costs of congestion is quite high (1.2) compared to other studies. Weisbrod et al. (2003) quantified this ratio on less than 0.5 (e.g. 0.44 for the manufacturing industry or 0.28 for the agricultural sector). Another study carried out in the Netherlands (Bozuwa et al. 1999) has estimated the indirect costs of congestion ('reliability costs') on about 8-11% of direct costs. A study from

Leeds University (Nash et al. 1999) has estimated a willingness-to-pay of 85 pence per minute to increase reliability of transport, which is an even lower share compared to the direct time costs.

Within cost benefit analysis, another approach to quantify reliability is used, the so-called *reliability ratio*. This concept is similar to the above-mentioned ratio: The reliability ratio is the ratio between the value of one minute of additional standard deviation (i.e. the value of reliability) and the value of one minute of average travel time. Table 3-2 summarises the different reliability ratios for different transport modes and different journey purposes. These ratios are recommended for cost benefit analyses. The ratios indicated in Table 3-2 are quite conservative and thus compatible with the scientific studies and show that reliability is not as costly as the IRU study points out. In this regard, the IRU study can be seen as an upper bound (maximal risk).

Table 3-2: Reliability ratio for different journey purposes

Journey purpose	Mode	Reliability ratio
Commuting (passenger traffic)	Car	0.8
Business (passenger traffic)	Car	0.8
Other (passenger traffic)	Car	0.8
All (passenger traffic)	Train	1.4
All (passenger traffic)	Bus/tram/metro	1.4
Commercial Goods Traffic	Road	1.2

Source: Hamer et al. (2005), Kouwenhoven et al. (2005)

Concerning possible competitive disadvantages related to congestion, the interviewed companies denied such effect. They think that all companies are affected more or less the same. However, the freight transport companies think that there are differences between the transport modes: rail freight transport has certain advantages compared to road transport, since there are fewer congestion problems on the rail than on the road. In this respect, railway transport is more efficient and reliable.

Situation in different regions

Comparing the congestion situation in different regions, the road freight companies state that the problems are most severe in the most densely populated urban agglomerations in Western Europe, such as in the Netherlands, Germany, Belgium, the UK, etc. In general, congestion situation is clearly better in the countries of Eastern Europe than in the EU15. Additionally, the road hauliers underline that they could handle congestion problems more easily in countries with a liberal transport policy, for example in countries without strict night or weekend driving bans for heavy duty vehicles.

3.1.3 Reaction patterns to congestion

a) Short term reactions

According to the interviews with the road freight companies, congestion leads to certain reactions within the companies. However, these reactions are only moderate. The possibility to shift additional costs of congestion to transport prices is very limited since clients will not accept higher prices and low reliability at the same time. Price increases are only possible in very exceptional situations, for example if certain corridors (e.g. a tunnel in the Alps, etc.) are completely

closed. Therefore, the largest part of the financial risk (additional working time of drivers, etc.) has to be borne by the transport companies and not by their clients.

In order to omit congestion, the road hauliers industry has developed several strategies. The most important strategy is a better organisation of deliveries (transport management), such as the temporal shift of transport (bundling, unbundling, long range haul, avoiding urban areas during peak times) to off peak situation. The additional costs due to driving round congested areas are accepted in order to be able to keep up reliability and punctuality. Additional costs of other strategies to avoid congestion, such as driving through the night, can be seen as long term evasion costs of congestion.

Some road freight companies have introduced new technologies in their transport fleet: They equipped all vehicles with on-board positioning system (based on GPS), so that the tucks can be followed anywhere by the control centre. In this way, the control centre is closer to the vehicles and always informed about possible incidents (e.g. due to congestion), which helps them to plan the journey better and update the clients about possible delays. If clients can be informed exactly and quickly, this helps that they understand better the situation.

Although congestion causes additional time costs for the road hauliers, all companies interviewed stated that congestion has not led to an increase in personnel or vehicle fleet until now. Some companies, however, said that this could become an issue in the future if congestion problems are getting worse.

Another strategy, at least for big road freight companies, is the inclusion of other transport modes into their service portfolio. For specific corridors, railways have become an alternative to road freight transport. Most important in this respect is trans-alpine transport, where specific measures (such as tolls, night bans etc.) lead to a strong shift towards combined transport road-rail. Some road freight companies have therefore begun to provide combined transport and rail services as an alternative to their traditional road business. In fact, many road hauliers are slowly becoming logistics companies when broadening their services. Overall, congestion on roads reduces the competitiveness of road transport compared to rail transport.

Another development is the insourcing of transportation services by companies of certain sectors. Above all sectors which are especially vulnerable to congestion (e.g. just-in-time production, food and retail, etc.) tend to insource the transport services in order to have a better overview on and better control of the transport chain.

b) Reaction patterns long term

Congestion has no significant influence on the location of a company site. First of all, a transport haulier has no influence on the client's routes and the goods flows and therefore the location of the company only plays a minor role. Secondly, for the site selection the accessibility of the company is the more important factor (e.g. location in the middle of the country, close to a highway, close to a port, close to a railway terminal, etc.). However, congestion situation around the company site has of course a certain influence on its accessibility and therefore plays a minor role for the site selection for road transport companies.

3.1.4 Ideas and strategies to overcome congestion

The companies interviewed see two measures as most effective to overcome congestion problems. First of all, they regard infrastructure enlargement and general improvement of the road network as the most important countermeasure against congestion. As a second measure, the companies think that a modal shift from road to rail could – in some cases – help to reduce congestion problems on the road. However, road hauliers emphasise that rail transport is not always an alternative to road. Above all in short-range transport, trucks and vans can not be replaced by rail. Whereas road transport companies consider modal shift as a possible strategy to overcome congestion problems and sometimes already offer rail transport services, road transport organisations do not agree about this point.

Road transport organisations such as the International Road Transport Union (IRU) have developed a general policy approach to overcome congestion. This policy consists of several elements. Like the road hauliers their main aim is the increase in infrastructure. Additionally, modern traffic management and information systems in order to anticipate recurrent and non-recurring congestions are seen as helpful for reducing congestion problems. Moreover, road transport organisations still see some scope for efficiency increases, for example by an increase of weight limits or the increased use of off-peak times. For the increased use of off-peak times the suspension of night and weekend driving bans could be very helpful. Also the road hauliers see the loosening of driving ban as a good measure for them to overcome congestion. The IRU calls its whole campaign against negative impacts of congestion the '3I strategy' (Infrastructure, Innovation, Incentives). Besides the already mentioned general infrastructure improvements, important elements of the 3I strategy are own lanes for trucks to overcome passenger car related congestion as well as delay penalties for construction site managers (infrastructure maintenance). However, the demand for doing infrastructure maintenance mainly during the night hours (in order not to harm passenger transport) could again lead to barriers for freight transport, above all if road hauliers increase driving during nighttime. Another possible measure against congestion, the introduction of bonus-malus or quality systems for the road freight transport sector, is however not yet common.

Generally speaking, road freight companies think that politics play a very important role in the congestion issue. They wish that politics would play a more active role in tackling the congestion problems.

3.2 Rail Transport sector[2]

3.2.1 Relevance of congestion

The panorama of congestion has shown that punctuality reporting is common. Congestion has three elements:

- Delays of trains due to several endogenous and exogenous reasons: Directly relevant for the client.
- Risk of missing connection trains at major directly relevant for the client.
- Opportunity (Scarcity) costs due to limited infrastructure capacity.

Most vulnerable is passenger transport (esp. long distance transport) and freight transport (esp. combined transport). Both face strong competition to other modes (aviation, road) and represent the segments which are most dynamic. The main problems of rail transport are:

- low quality of infrastructure due to infrastructure deficits
- interoperability problems (e.g. track width/gauge, electrification, communication systems, etc.)
- availablilty of rolling stock (this reason is diminishing due to dynamic international rolling stock markets
- low levels of competition (only partly liberalised, depending on the country)
- weak transport chain management

Generally speaking, the situation is better in Western Europe than in Eastern Europe since rail infrastructure quality is lower in Eastern Europe, which makes the congestion situation more difficult. Compared to that, the situation in the US is less critical. Some local problems are visible in regional passenger transport to access bigger cities (e.g. Chicago).

Interoperability problems are getting smaller nowadays. Still, at the border of different countries, interoperability is often the main cause for delays. There are several neighbouring countries with different track widths: whereas in France they have standard gauge, in Spain the common system is broad gauge. Concerning the level of liberalisation, rail transport has not reached the same level of liberalisation as most other transport means (e.g. air, water transport). However, liberalisation processes in Europe have progressed a lot in the last years. The situation differs very much between the different European countries. In some countries (e.g. UK, Sweden) liberalisation process in rail transport is advanced whereas the liberalisation is only at the beginning in other European countries (e.g. Greece, Spain).

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[2] Information on the rail transport sector are based on telephone interviews with the following four persons: Arnold Berndt, Swiss Ministry of Transport, Section trans-alpine freight transport; Stefan Gasser, SBB Infrastruktur, Petra König; Michel Erhard, Deutsche Bahn AG, passenger transport; Snejana Markovic and Gerard Dalton, of the International Union of Railways (UIC); Edward Calthrop, Community of European Railway and Infrastructure Companies (CER).

3.2.2 Congestion impact analysis

Congestion and delays is an increasingly important quality indicator in rail transport, both for road and rail. Delays themselves are relevant if reliability (of the transport chain) is affected. The importance of congestion differs a lot between the different rail transport segments: urban rail, interurban and border-crossing high speed rail (passenger transport) and freight transport.

Passenger transport

High speed passenger transport is the most important and most critical segment. A high quality is a central competition factor compared to short distance air transport. Since connections between different high speed trains (intercity or international) are very relevant and often rather tight at big train stations, passenger transport is quite sensitive to congestion. If an incoming train is too late, transfer passengers will miss their connecting trains. Additionally, time valuation of passengers in high speed trains is rather high. In some countries (such as US, Spain, Germany, Austria), delay statistics and penalties (e.g. reimbursement to passenger in cases of delay) are common, in order to compensate passengers for time losses. Yet, the problems are generally much less bad than in air transport since most train systems operate with synchronised timetables where the same connections operate once or twice an hour or at least every other hour. Moreover, rail passenger transport is generally privileged compared to rail freight transport, which means that passenger transport is prioritized if there are infrastructure constraints on the rail system. Therefore, in reality the delay situation in passenger rail transport is very good, above all compared to other transport modes (road, air). It can even be stated that rail is generally profiting from congestion on road (especially in urban areas and specific corridors, e.g. transalpine) and air transport.

Compared to that urban rail transport is less vulnerable by delays mainly in big nods due to increased capacity problems. This is mainly true in countries using hub system for railway stations. Since punctuality for High speed rail is however a central issue. Rail operators tend to privilege high speed rail against urban rail leading to connectivity problems: Whereas high speed rail is punctual, urban rail is suffering from delays and missing connections between high speed and urban rail.

The costs of delays can be separated in the following categories:

- Costs for the passenger transport company: Reorganisation of schedules, additional trains. Due to the high share of fixed costs, the additional costs are not very relevant in the short run. In the longer run – due to the high relevance of quality reputation of a provider – loss of passenger and revenue reduction is possible.
- Costs for the infrastructure operator: Reorganisation costs in the short run are not very relevant. In the long run, repair costs and managing costs (software, hardware) and are more relevant.
- Costs for passenger due to reduced reliability: Compared to the costs above, this part is most relevant, especially in long high speed and intercity transport, due to the high share of time sensitive business transport.

Freight transport

In freight transport, delays due to interoperability problems are a major issue, especially in transnational transport. For the time being, the reliability problem is bigger than in passenger transport. The sensitivity of rail freight transport to congestion differs between the different types of freight transport. Wagon load freight is usually not very time sensitive. Therefore, the vulnerability of this traditional rail segment is rather low. Combined transport with hub and spoke terminal and gateway systems, however, has a considerably higher vulnerability to congestion since rail and road transport chains have to fit together. Still, the biggest problems do not arise because of infrastructure scarcity but because of delays at the borders: Cross-boarder activities are significantly harming the competitiveness of rail freight transport. Sometimes problems at the border can be very basic, such as the absence of a locomotive.

In Switzerland, there exists a quality indicator to measure delays of combined transport trains, which is used by the Swiss transport policy. This delay indicator helps to monitoring the punctuality situation in rail freight transport. For combined transport in Switzerland, the indicator reveals clear deficiencies. Although Switzerland is promoting combined transport heavily and is also permanently improving infrastructure quality, only about 55% of the trains are 'on time' (which means have a delay of less than 30 minutes to schedule). 10% of the trains even face delays of six hours and more. There are mainly two reasons for these delays. Firstly, the lack of border organisation leads to many severe delays. Secondly, the lack of infrastructure on certain routes leads to scarcity problems. These problems are particularly pronounced when passenger rail is given priority compared to rail freight.

In the United States freight rail industry is a lot more competitive than in Europe since the productivity is considerably higher. As a consequence, delay problems are more important in the US because of the highly competed market. However, interoperability problems are obviously smaller in the US, mainly because there are fewer nations than on the European continent.

Similar to passenger transport, the costs of delays are mainly passed to the client, freight forwarder or shipper. In combined transport with its intermodal transport chain, late arrivals of trains cause waiting costs for pre- and endhaul road services. These costs cannot passed cannot hardly be passed to the customer.

Infrastructure

It is important to state that todays quality problems are one issue. Even more important is the problem of opportunity costs for the railway infrastructure operator and industry to be prepared to supply expected growth. Limited capacities of tracks, delay risks and long realisation periods are important obstacles to a high flexibility which would be important to increase the competitiveness to other modes. The high density of network and the age and level of service (esp. in Eastern Europe) are – in the medium and long run – much more important for the competitiveness of the railways since todays railways schedules do represent already a reaction to scarcity and cannot show the whole potential. Thus scarcity costs and delay costs must be considered always together in order to evaluate the congestion problem of the railways.

3.2.3 Reaction patterns to congestion and strategies to overcome congestion

Most of the railway companies state the overcoming of congestion and delay problems as a major issue for their corporate strategy. Most important are improvements in the railway network, potentials to separate high speed passenger rail from long distance freight transport and

We can distinguish three levels of action:

- Improved monitoring systems: Measuring of delays is common for railway companies and is usually involving different actors such as infrastructure operator, passenger and freight traction services and freight operators (such as combined transport). The monitoring is however restricted to the punctuality of train lines. Costs of missing connections ore reduced reliability of passenger or freight services are not measured.
- Infrastructure improvement: Overcoming capacity problems and improving railway quality is a main agenda point of most of the European countries, the UIC and the European Commission. In recent years, policy in Europe has intensified its attempts to overcome the quality problems in rail freight transport (above all in the combined traffic). At the moment, there are ongoing efforts to strengthen the role of the EU railway packages aiming at increased infrastructure capacity, interoperability and competition. Another promising step would be the separation of passenger and freight networks. On the one hand, this is a very effective measure against the congestion and delay problems in rail transport. On the other hand, it is very expensive to built and operate two separate networks. Until now, the idea of two separate rail networks has only been implemented on very few routes.
- Track allocation systems considering quality: In addition, there are also ideas about introducing quality indicators and related bonus-malus systems in the rail freight sector. The most recent German track pricing system represents a major attempt in this direction, where quality and delay risks become part of track pricing policy.

3.3 Air transport sector[3]

3.3.1 Relevance of congestion

Air transport and airports are very sensitive on congestion. Especially on airports where the home carrier or another important airline follows a hub strategy the functioning of the network is very important since connections flights are an important element of the strategy. Here the problem of congestion is on the feeder side (flights carrying passengers to a hub airport in order to fill an intercontinental flight e.g.) as well as on the de-feeder side (flights taking passengers after an intercontinental flight to their final destinations to non-hub airports). The functioning of a hub system bases on feeder flights arriving in time, in order to guarantee quick transfer times and a

[3] Information on the air transport sector stem from interviews by phone with the following persons: Katrin Müller, Unique Zurich airport, planning and engineering; Alexander Holzrichter/Nils Braun, Lufthansa; Andrew Sentence British Airways, Rolf Dieter Rolshausen, Frankfurt airport. The studies are directly summarised in the text.

start in time of the connecting flight. The same holds true for the landing flight and the transfer to the de-feeding flights. Therefore especially big hub systems like airport London, Paris, Frankfurt and Amsterdam are vulnerable to delays but as well sub-hubs like Zurich or Munich.

Air transport had a considerable change in the last 10-15 years due to increased liberalisation and competition accompanied by arising of new business models like low cost carries (LCC), regional carriers and quite big growth rates of the transport volumes. The causes of delays in air transport are mostly not capacity constraints of the runways. Delays arise mainly due to late incoming flights (causes elsewhere than on the airport itself), bad weather, late arriving passengers and limited terminal capacity.

The following feedback from the interviews and review of study can be summarised:

Europe:

- The report challenges to Growth Study 2004 (EUROCONTROL 2004) states that most airports have some spare capacity. The most important 133 airports have about 30% existing capacity at typical busy hour traffic times. Facing the expected quite intense growth of air transport in the future this reserve will be used quite quickly. The strong growing markets are especially Asia (and there mainly China and India). Eurocontrol says that remaining capacity in the sky is quite limited and a growth of more than 17% cannot be satisfied within the actual structure of the sky. This congestion problem is not at the spots of the airport but during the flights on the flight path.
- According to the interviews, airports like Frankfurt, Munich, London Heathrow, Madrid, Barcelona, Milano, Tokio, Bangkok and Singapur are critical. In the US problems arise in the Eastern part (New York).
- Looking at the top-133 **airports, the following can be observed**: Current airport capacity ranges from less than 10 mov/hr to more than 110 mov/hr. The top-35 airports represent 50% of the total available hourly capacity. Only 20 airports have a capacity greater or equal to 59 mov/hr. The top-10 has a capacity better than 75 mov/hr (European Commission 2005).
- 70% of the 50 largest EU airports having already or almost reached **saturation** point in terms of **ground capacity and severe capacity constraints** being forecast for the year 2025 (European Commission 2005).
- A survey of EUROCONTROL shows the following:

Reasons for not being able to reach the maximum theoretical capacity	Nbr of airports answering 'yes'	Percentage answering 'yes'
Physical site & infrastructure limits	38 out of 58	66%
Environmental issues	29 out of 58	50%
Surrounding airspace & geography	18 out of 58	31%
Other constraints	5 out of 58	9%

Table 3 Nature of airport constraints

With regards to the construction of new runways, airports reported the following:

Question	Nbr of airports answering 'yes'
Are there new runways planned or under construction which are anticipated to be operational by the year 2010?	9
Do you believe additional runways will be constructed between 2011 and 2015?	11
Are there any long term runway possibilities for the period 2016-2025?	13

Table 4 Projected new runways

Source: Eurocontrol (2004)

United States:

- In general the US worry more about safety than capacity constraints: The Federal Aviation Administration (FAA) does not give high priority to grants for growth alone. Its priority is safety standards and finding a solution to the problem of airspace congestion (AirportsGate 2001).
- Congestion and capacity constraints are threatening the East Coast's top cargo airports (e.g. Miami, New York, Newark, Atlanta): limited space to expand and located in traffic-clogged areas (Karp 2005).
- Monopoly situation of many airports as mayor problem. New York-Newark is 60% more expensive as Chicago O'Hare. Politics not business is deriving the airports management. (Bisignani 2006).
- Key hubs like Atlanta, Chicago and Las Vegas are facing operational constraints in term of runway, airspace facilities and gates (AirlinesGate 2001).
- FAA sees problem of airspace congestion as important as capacity congestions at airports and delays (AirlinesGate 2001).
- Airlines can to a certain degree adapt by different fleet mix: Big cargo aircrafts are more vulnerable to congestion than small and flexible aircrafts. / Small regional airlines occupy too many runaways (e.g. LAX: 30% of aircraft movements account for 5% of passengers) (Hansen et al. 2001).
- United States tremendous challenge is that their air traffic control system is old and has to be replaced by new technologies. Countries like UK, Germany, France and Australia have taken steps to modernize their air traffic control system. ATA sees solution in Smart Skies Campaign. (May 2006)

3.3.2 Congestion impact analysis

The impacts of congestion on **passenger air transport** is today more important that on the air cargo side. In competition with other transport modes air transport wants to be quicker, more reliable and competitive in the costs. When congestion increases the transport chains in air transport are endangered. Passengers have to wait, connecting flights or connecting trains are missed and reliability and credit of air transport is diminishing. The strategies of today's actors show the high time sensitivity of the passengers and the air transport system itself: Low cost

carriers use other airports with less congestion to avoid waiting times and high charges (e.g. Stansted in London or Hahn in Frankfurt). Another possibility to avoid delays from the point of view of the passengers is the business aviation, where professional pilots with business jets operate independent from a hub network strategy, no incoming flights have to be waited for, small airports can be approached and all regional destinations are reachable directly also in alternative time slots.

In the short run most congestion costs in air transport are passed to the passengers in form of time losses. The most important monetary consequences on the airline side concern reimbursements for cancelled flights or hotel costs for stranded passengers. But there are also increased operating costs for the airlines, like rescheduling, higher standing cost when waiting at crowded airports and waiting time costs of lower utilisation (less rotation and airplane costs are highest when standing on the ground). Generally US industry is more vulnerable to congestion in air transport because air transport has a higher relevance and importance in the economy than in the EU.

The other transport modes in the transport chain before or after a flight are not identified as sources of delays in air transport. Transport by rail is mostly very efficient in high punctuality and for cars the parking capacity is the element that could cause passenger coming too late. But mostly parking capacity is big enough at the airports.

The competitiveness of the air transport industry is weakened especially for hub carriers which are depending on reliable connections. In Europe the competition between air transport and high speed rail is visible and also appropriate. Especially for regional relations with flying time below 3 hours train is often with the better cost-benefit ratio.

The impact of congestion on **freight air transport** (air cargo) is also important, since air cargo usually consist of perishable goods or (valuable) goods very high demand on reliability. Air cargo being transport as belly freight is facing similar problems than passenger transport. Besides, air cargo is often using off-peak slots to organize their worldwide traffic or air cargo is on board of passenger flights as belly-freight. Most parts of the goods transported are not as time sensitive as passenger transport because air transport is internationally anyway the fastest way to deliver time critical goods. Cargo hub systems are mainly used during the night, causing considerable noise at sensitive times for residentials. In Frankfurt e.g. more than 100 cargo planes are leaving the airport after midnight. As soon as bans are discussed to protect densely populated areas, there are increased risks of additional costs for the air cargo industry. The air cargo industry has partly already reacted (especially in Europe) by using road alternatives (and combined rail alternatives) for feeder transports with short distances to big hub airports (e.g. from Switzerland to Frankfurt).

A publication of IATA (2006) is providing an overview on airline network benefits which are vulnerable to congestion and delays. It points out the increasing importance of hub and network activities for firms, based on a survey done by IATA. The survey also shows the importance of reducing delays: Reduced delays are – in the viewpoint of passengers - the most important topic for improvements customer services of air transport.

The following table provides a summary of the economic burden of airline delays to different actors. It comes out clearly that today's costs and relevance in the short run does not reflect the increased relevance in the longer run.

Table 3-3: Costs of air congestion/delay for different actors in the short and in the long run

Actor	Type of costs	Relevance of costs	Relevance for competitiveness
Short run			
Airport	Managing, reduced terminal flexibility, passenger care	Not very relevant	Medium relevant
Airline	Managing/Rescheduling, reimbursements of missed flights/connections, passenger care	Medium Relevant	Relevant
ATM	Managing cost	Not very relevant	Not relevant
Customer	Time costs, reduced reliability for passenger and freight transport	Relevant (business passenger) Relevant (tourist passenger) Relevant (air belly freight) Relevant (air cargo planes)	Medium relevant Not very relevant Medium relevant Relevant
Long run			
Airport	Image and competitiveness (in connection with home carrier), increased scarcity costs vs. runway and terminal enlargement	Very relevant	Very relevant
Airline	Image and competitiveness (in connection with home base),	Very relevant	Very relevant
ATM	Technological improvement costs	Relevant	
Customer	Time costs, reduced reliability for passenger and freight transport	Relevant (business passenger) Relevant (tourist passenger) Relevant (air belly freight) Relevant (air cargo planes)	Relevant Medium relevant Relevant Relevant

Scale: Not relevant, Not very relevant, Medium relevant, Relevant, Very relevant
(Source: Own estimation based on interviews and review of studies/papers)

3.3.3 Reaction patterns and strategies to reduce congestion

In the long term, delays might increase, if predicted growth rates will continue and no hardware (terminal, runways, etc.) are being built.

The air transport industry in the EU and US has recognized the congestion problems a while ago. The open sky agreements and the strategies to improve Air Traffic Management (ATM) are important corner stones. Modern systems might reduce delays at airports in the LTO cycle by up to

10%, leading also to considerable fuel savings. Peak load pricing and improved slot allocation systems at hub airports might flatten daily frequencies and the allocation between primary and secondary airports. Bigger plane capacities are another part of the strategy.

The survey of studies/papers in Europe and US has shown the following additional issues:

Europe:

- Most important is the increase of airport capacity, intermodality approaches and improved slot allocation. The EC paper on Airport capacity, efficiency and safety in Europe has provided an overview on possible strategies.
- The AEA comments on the Commission staff working document Airport capacity and Safety in Europa (AEA 2005) states that capacity constraints are an increasingly problems and points out the complexity of the aviation network. A coordinated capacity programme is therefore useful. The main focus is on increasing airport capacity, in addition the single sky approach should increase ATM capacity. An intermodal approach (shift to rail) and a pricing strategy will – according to the comments – not be appropriate instruments.
- The IATA comments on the same paper focus on slot allocation mechanisms and increased efficiency. It points out that the effects of slot trading mechanisms are underestimated by the Commission and does not consider the complexity of air schedules and mutual effects of slot allocation for different destinations.
- **Secondary airports** are as well showing their potential, as they are growing more rapidly than the largest airports. The economies of scope resulting from feeding air traffic through major connecting points has created a situation whereby some of the hub airports are facing saturation whereas some secondary airports have spare capacity and seek for opportunities for attracting more operation (ACI Europe 2005).
- Typical for EU is the high concentration of traffic on a small **number of airport pairs** but also the high number of airport pairs for which there is little traffic. Any eventual limitation on daily flight frequency will therefore impact only a fraction of the totality of airport pairs. The aim of this analysis (Eurocontrol 2004) has therefore been to explore whether a constraint imposed on certain airport pairs may liberate sufficient slots in order to have an impact on overall levels of unaccommodated demand.

United States:

- At least 9 projects for new runways at major US airports, namely in Atlanta, Chicago, Houston, Seattle, Boston, Charlotte, Washington, St. Louis and Norfork (ACI North America 2004).
- There are some pockets where full growth potential remains untapped: Philadelphia, Houston, Los Angeles ad in lesser extent New York, Newark. Other key hubs like Atlanta, Chicago and Las Vegas are facing operational constraints in term of runway, airspace facilities and gates. (AirlinesGate 2001).
- U.S. Department of Transportation: Study on 'National Strategy to Reduce Congestion on America's Transportation Network' (Mineta 2006). → Accelerate major aviation capacity projects and provide a future funding framework.

- An important issue are technological developments (ATM): New CNC/ATM Systems for management of air traffic in all phases of flight. Improving the flow and reducing the delays. North America has been among the earliest adopters of digital air-ground communications, satellite navigation based on global positioning systems (GPS) and ADS-B. Such initiatives will derive revenues (Frost 2006).
- A Study about changing dynamics of the airline industry of the US Department of Transportation points out the following strategies: Implementation of TRACONS (terminal radar approach control facilities) to increase capacity with new technologies. New digital radar system called STARS (standard terminal automation replacement system) for better air traffic management (Mineta 2004).
- High-tech logistics and ever-faster expedited trucking operations mean that international cargo can be flown into a variety of airports throughout the US and still get to the end destination quickly. Export distribution chains also are increasingly directed beyond the traditional gateways along the Atlantic coast. Congestion in the East's major airports leaves smaller airports in the region with increased opportunities (Karp 2005).
- Airlines can extend their services to secondary airports, diverting traffic off the initial price-sensitive connecting links and time-sensitive non-stop traffic from the busiest airports. In US, the boom in regional jets sweeping the country is leading many small airports to plans for runway extensions (AirlinesGate 2001).
- 'Influence of Capacity Constraints on Airline Fleet Mix' (Hansen et al. 2001): At Los Angeles World Airport a significant proportion of runway capacity is utilized by regional airlines. Thus a large proportion of operations handle a relatively small proportion of the passenger traffic (30% of aircraft movements account for 5% of passengers) → accommodate traffic growth through the use of larger aircraft rather than adding more flights.

3.3.4 Comparison EU and US

Capacity constraints in the aviation sector (airports, airspace) are an important issue for both regions. However, the US still seems to have more possibilities to tackle the problem. For them safety issues seems to be nearly more important than capacity constraints. New airport capacity is easier provided and for some important airports growth potential remains untapped. At least 9 projects for new runways at major US airports are in place.

The European Union generally seems to be more vulnerable. 70% of the 50 largest EU airports have already or almost reached saturation point in terms of ground capacity and severe capacity constraints being forecast for the year 2025. Further environmental reasons are an issue in the EU for not being able to reach the maximum theoretical capacity of the airports.

Both regions invert heavily in new ATM technologies for management of air traffic in all phases of flight. The joint seminar on ATM R&D held in June 2005 shows that there is some cooperation between Eurocontrol and FAA. Additionally smaller secondary airports are becoming more important in the US as well as in the EU. Another alternative for improving capacity is the composition of the fleet mix. Airlines use bigger aircraft types and therefore accommodate growth in passenger or cargo demand without a corresponding increase in the number of aircraft operations. Still

smaller aircraft to open new routes can reduce costs even more than moving to larger aircrafts. The EU improves the airports relationship with other modes of transport and encourage the shift towards rail alternatives. This is an option which is not available in the US, at least for passenger transport.

3.4 Ports

For the analysis of the congestion problems in European ports, the country example of Denmark was analysed. For this purpose five interviews were conducted with

- Port of Copenhagen/Malmö
- Port of Århus
- DFDS Torline (Specialist in Roll-on Roll Off)
- Unifeeder (Specialist in container feeder transport)
- Wallenius Wilhelmsen, Malmö (Specialist in Car Shipping)

3.4.1 Interlinkages of sector activity and transport

All activities described in this section belong to the maritime transport sector.

3.4.2 Congestion impact analysis

Maritime Transport in Europe has experienced a tremendous boom in the last decades, which is mainly due to the strong performance of the Asian Economies. Table 3-4 shows that last year's total growth of goods transhipped through four selected ports amounted to 5.7%. General freight increased by 8.3 and containers transport by 11.3%. Hamburg experienced the strongest growth in containers reaching 15.5%. The latter growth rate implies that the number of containers handled doubles every 5 years!

Table 3-4: Transshipment in selected North European Harbours

Port	Total Transshipment		Bulk Goods		General Freight		Container		Container	
	1.000 t	Growth p.a. %	1.000 t	Growth p.a. %	1.000 t	Growth p.a. %	1.000 t	Growth p.a. %	TEU	Growth
Hamburg	125.743	+9,8	39.972	+5,8	85.771	+11,8	83.046	+12,2	8.087.545	+15,5
Bremen	54.342	+3,9	9.638	-7,1	44.704	+ 6,7	36.993	+ 5,6	3.735.574	+ 7,7
Rotterdam	369.200	+4,8	259.500	+3,7	109.700	+ 7,4	91.150	+10,6	9.300.000	+12,3
Antwerp	160.054	+5,1	63.961	+2,2	96.094	+ 7,1	74.593	+ 9,2	6.488.029	+ 7,0
Total	**709.339**	**+5,7**	**373.071**	**+3,3**	**336.269**	**+ 8,3**	**285.782**	**+10,0**	**27.611.148**	**+11,3**

Another engine of the proliferation of maritime transport is the economic development of Russia and other East European countries. Especially the port of St. Petersburg experienced an enormous expansion, which amounted up to 25% annually.

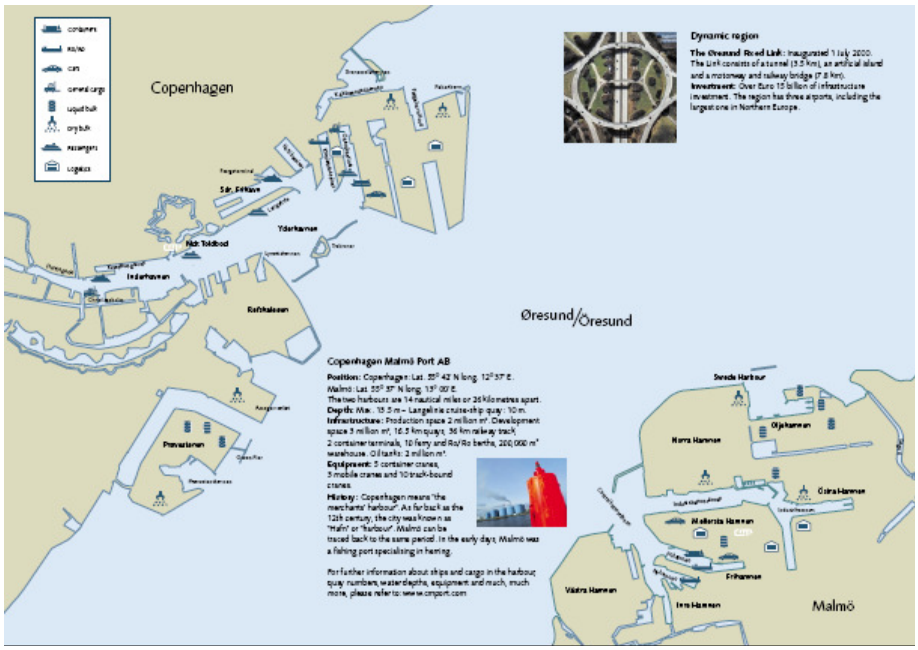


Figure 3-1: The port of Copenhagen- Malmö

Even though the ports in Denmark are much smaller, they experience similar growth rates. In Copenhagen the two ports on both side of the Öresund Copenhagen and Malmö joined to one port named the Port of CPM. In 2000 the turnover amounted to 15 m tons and 150,000 containers.

Table 3-5: Port of CMP – cargo turnover:

	2001	2002	2005
Total cargo turnover in millions of tons	13.3	13.4	15
Floating bulk in millions of tons	5.5	5.4	6
Dry bulk in millions of tons	2.9	3.	1 4
Containers in thousands of TEU	126	130	150
Ro/Ro in thousands of units	210	210	250
Cruise ships	215	179	300
New cars in thousands	26	39	175

The port of Århus is Denmark's largest container port handling 63% of the country's container transhipments. In 2005 it transshipped 11 m tons of freight and 800,000 containers. The port's cargo turnover in the first quarter of 2006 was 10 per cent higher than same period in previous year. The container turnover is still increasing. In the first quarter the number of units rose by 13.1 per cent, which was 13.7 per cent in January, status quo in February, and 25.5 per cent in March.

Table 3-6: Turnover in the port of Århus

in 1'000 tonnes	2004	2005
Liners	2,771	3,151
Ferries and ro-ro	3,220	3,313
General Cargo	133	248
Bulk Traffic	2,776	2,846
Tankers	1,600	1,729
Total	10,500	11,287

The impacts of the congestion problems in other European ports are well experience in Denmark, not only by the shipping companies interviewed, but as well by the port authorities.

a) Reaction patterns

It obvious, that the transport explosion in European ports entails capacity constraints. Unanimously, the interviewees named the capacities for loading and unloading of ships as the main bottlenecks: These are quays to berth, limited storage facilities and not enough space, shortage of warehouses, crane capacities, other loading equipment and manpower.

Major bottlenecks were mentioned in the ports of Bremerhaven, Gent and Antwerp. St. Petersburg was named by all shipping companies as the port with the biggest capacity constraints in Europe. The Danish ports interviewed are presently not experiencing severe constraints, but problems might occur in the future. Århus, CPM and Hamburg were able to provide enough expansion capacities and increase planning and construction speed in order to keep up with the exploding demand.

Capacity constraints were experienced most severely in field of container handling and in car transport, where presently an unprecedented growth takes place. For both the capacity limits are determined mainly by the space available in the ports. In the port of Copenhagen-Malmö the number of cars increased from 26,000 in 2001 to 350,000 cars in 2005. The there the distribution is done by feeder ships over the whole Baltic Sea. Since cars cannot be stored above each other, these quantities of cars need large space for storage. The strong growth in this sector caused capacity constraints in CMP in the past. The loading and unloading of cars is a very time sensitive issue. For example the unloading of 3600 cars is delayed by only 1 second per car, the whole delay amounts to 1 hour delay of the ship. Thus, it is mainly a problem of adequate organisation and design of the operations, which are determined by the facilities available.

The capacity problems are most severe in ports, where the shipping companies do not own port facilities, such as warehouses and storage space. In these ports companies cannot make their proper planning and have to rely on the provision of facilities through the port. Delays in despatching of previous ships may cause chain reactions, which cannot be included in the planning of the affected shipping companies. More often than not, this is an information problem.

The two Danish ports did not mention any capacity constraints regarding land access and egress by of road and rail. Delays due to urban congestion are regarded as minimal and additionally, the port terminals function as buffers. Both ports claim fast access to the motorways (e.g. Århus 5-7 min) and good rail access. Goods are not delivered just in time, since unpredictability during

longer journey (e.g. from Asia) is too high. Sometimes clients prefer to keep their goods in the ports before they pick them up. Only in Hamburg the extremely strong growth will cause capacity constraints regarding road and rail access and major investments (e.g. bridge over the Köhlbrand) are demanded by the haulage industry.

b) Congestion impact analysis

The capacity constraints in Bremerhaven were described by a Danish shipping company as specially severe. There is often not enough storage space available and berths are more often than not occupied by other ships. An extreme example for ship delay during a peak period was given by a container feeder for the week after Whitsun (June 6 to 11). The company had 10 ships putting into Bremerhaven during this period. The average delay amounted to 11.4 hours per ship, totalling in 114 hours with a maximum of 36 hours per ship.

Again no quantification for the costs of the above delays was given by the interviewees. However, it was emphasised more often than not, that other constraints such as unfavourable weather conditions have stronger impacts on time schedules and reliability than capacity constraints or congestion in the harbours.

A delay in one of the ARA ports or in Bremerhaven and Hamburg has repercussions on the whole transport chain in the Baltic Sea. Time schedules cannot be kept for deliveries. Since Bremerhaven is the turnaround point, loading of cargo might be delayed as well.

Thus, port usage is often unpredictable and causing time delays, especially if no proper facilities are owned. A rescheduling or relocation of ships entails higher costs, not only capital cost, but as well labour costs due to work in night shifts. However, a quantification could not be given by the interviewees.

Another constraint is the long waiting time of containers, especially in the ARA-Ports, which amount 5-7 days. Especially for container and car transporters, congestion is cause due to the long storage times of containers. Interviewees explained the causes with organisational problems and administrative delays (e.g. customs).

3.4.3 Reaction patterns to congestion

a) Short term reactions

It has to be emphasized that capacity constraints are regarded as a natural consequence of the present boom in maritime transport and all the interviewees had full comprehension of the problems port authorities are facing. The general attitude was more how to tackle the problems until capacity constraints are removed. This might be the reason, why even though the impacts of congestion are well perceived, they cannot be quantified in monetary terms.

Before capacities expansion projects are entirely implemented, a number of measures are undertaken in order to increase capacities of ports. A 24 hour crane service and moving of containers is often organised. This implies night shifts and increases the costs correspondingly.

For container feeder companies, an improved planning is possible, if the information would be available in time, i.e. 2-3 days in advance. In this case a rescheduling of ships would be possible, which implies that cargos have to loaded differently. In practice this is restricted by the fact that the information is not available in time. Delays of an ocean going vessel might be caused in

other ports or due to weather conditions. The delay information is often not given on in to the next port or the feeder company. A delay of the ocean going vessel is not anticipated by the feeder, who has to wait and, additionally, a berth might not be available when it is needed.

A medium term solution to capacity constraints is to change the port from a congested port to another port with less congestion. However, this decision will not be taken by the shipping company. It depends on their skills to persuade to relocate their distribution system to a better port. Thus, in this decision process other aspects than only capacity constraints become relevant.

b) Reaction patterns long term

The tremendous growth in transport was exceeding all predicted plans. Thus ports had to bring forward their plans and increase the speed of investments into expansion projects. Some ports, such as Hamburg have managed provide in a long term planning process for expansion space (Walterhof, Burchardskai, Moorfleet). Due to this long term planning and due to fast investments, Hamburg is presently experiencing no major bottlenecks in port capacities and is able to reap the fruits by tremendously increasing its turnover in the past years.



Figure 3-2: Expansion area of the port of Copenhagen-Malmö

Copenhagen and Malmö have reacted by merging the ports into CMP in 2001. While in Copenhagen port expansion projects are restricted by residential land use, the constraints in Malmö smaller. Additionally, the advantage of CMP is the fact that the Baltic is quite shallow (10m) and land reclamation though silting up of new land is possible and financially feasible. CPM invests half a billon Danish Kroner (70 m Euro) into a new ferry terminal (2004), a car terminal (2003) and the expansion of the bulk terminal. The expansion plans for car space are enormous: It is planned to expand from presently 100,000 m2 to 800,000 m2.



Figure 3-3: Strategic location of Århus

The port of Århus is planning as well expansion projects through land reclamation from the Baltic Sea. The plan is, to develop the port as a new container hub in the Baltic and thus reliever Copenhagen, as well as Hamburg and Bremerhaven.

Figure 3-3 depicts the plans of Århus to attract Ocean going vessels to the port and thus establish a new hub system in the Baltic Sea. Presently one ocean going vessel is calling per week. It is assumed that 3-5 major vessels per week would be enough to achieve the critical mass to start a new hub.

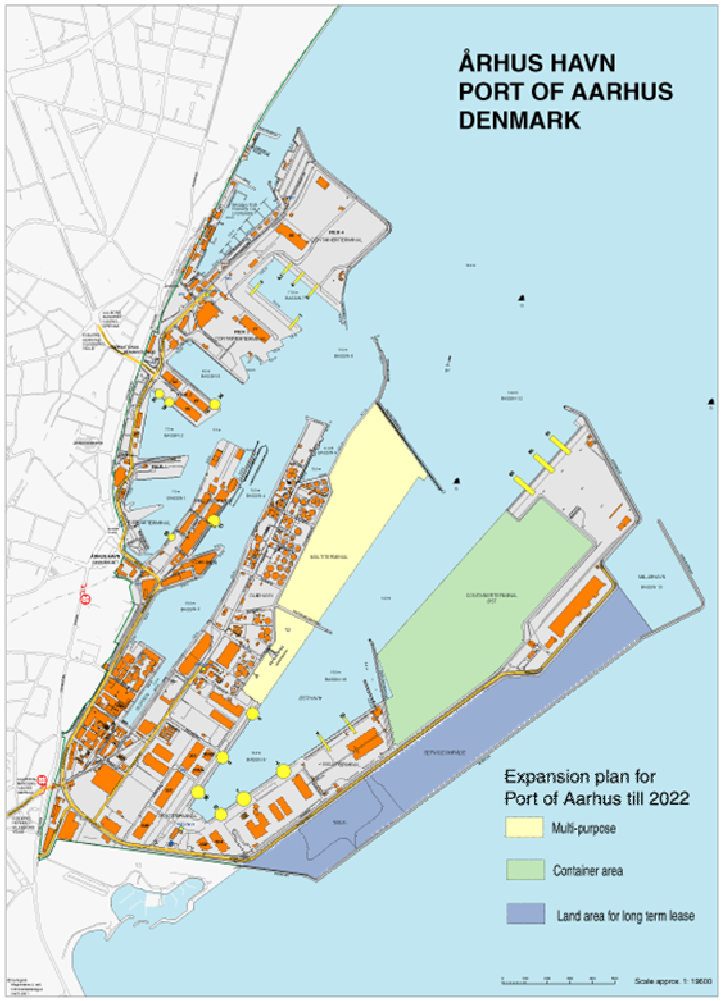


Figure 3-4: Expansion plans of the port of Århus

Shipping companies are investing as well in terminals, not only in Denmark but also overseas. DFDS Torline just opened a new Ro-Ro terminal constructed in Immingham (UK) in July 2006 with a capacity of 800,000 TEU p.a.

Another issue to be mentioned in this context is the dredging of rivers and access canals. These works are necessary to give access for large ocean going vessel, which are expected to further increase in its size. Environmental problems caused by dredging are known, but hardly assessed.

3.4.4 Ideas and strategies to overcome congestion

In this context it has to be mentioned, that maritime transport is an appropriate solution for congestion on roads and rail. DFDS Torline offers scheduled services in the North Sea and the Baltic with 164 weekly departures. Transports on the motorways of the Sea are undertaken with a comparable speed, they are reliable and environmentally preferable. The company has just invested in six new ships running at a speed of 23 knots per hour (43 km/h).



Figure 3-5: Scheduled services by DFDS Torline

Predictions of the future development in the Baltic Sea show, that the demand from East Europe will further increase, especially in the car sector. It is expected that the present strain on the ports in Finland and St. Petersburg will further augment and cause repercussions on other European ports. Possible solutions could be the development of ports in the Black Sea.

3.4.5 Comparison with the USA

The main difference between Europe and the USA is the fact that intra-European trade is done by maritime transport, while in the United States this trade is done by road and rail. Therefore, USA has distribution centres in the hinterland, while in Europe ports function as distribution centres as well. Even though European ports serve several functions, they seem to be organised more efficient than ports in the US. This not only shown by the cost comparison provided in the previous chapters, but as well by the assessment of BMW, who perceives major bottlenecks in ports serving their production plant in South Carolina.

3.5 Auxiliary transport (logistics)

For the analysis of the impacts on the logistic transport industry, interviews with two haulage companies, three associations and one consulting company were conducted:

- Kühne & Nagel, Switzerland
- Kommitee Deutscher Seehafenspediteure, Germany
- Bundesverband Güterverkehr und Logistik (BGL), Germany
- Deutscher Speditions- und Logistikverband, Germany
- Deutsche GVZ Gesellschaft, Germany
- Locom, Consultant, Germany

3.5.1 Interlinkages of sector activity and transport

Logistics industry is a large economic sector in Europe. In 2004 total spending on logistics services is estimated at 730 bn Euro, which amounts to roughly 7% of GDP. If this figure is compared to USA, the share on GDP is considerably higher (8.6% according to Wilson 2005) in America. This may be explained by the different spatial structures, e.g. longer distances and the inefficiencies in the logistic market commented further on in this text.

Figure 3-6 gives an overview on the European market of logistics as listed in Top 100 of Logistics (Klaus and Kille 2006).

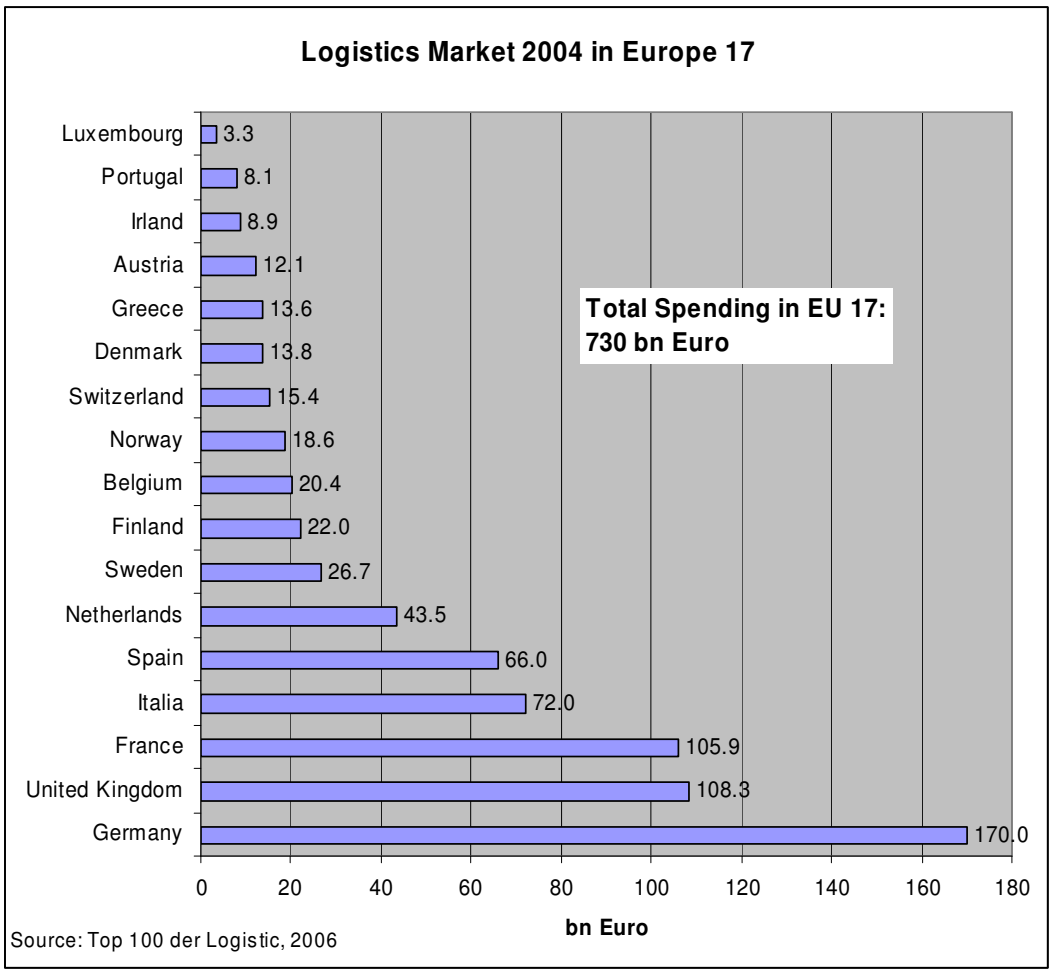


Figure 3-6: Spendings 2004 for logistics in Europe 17 (EU15 plus Norway and Switzerland)

Germany is the biggest logistics market in Europe with an estimated turnover of 170 bn Euro in 2004, which amounts to 7.7% of German GDP. The share of logistic costs on production is estimated at 6.5% with, 5.1% for the automobile industry and 8.0% for food industries.

Figure 3-7 shows the distribution of the logistic market on the economic sectors in Germany 2003. The most important sectors are Iron/Steel/Metal with 13.3% of turnover, Car Manufacturers with 9.5%, and Food Industry with 17.9%.

Top 100 of Logistics (Klaus and Kille 2006) in Germany 2.5 m people are working in transport logistics, receiving incomes of in the order of 67,3 bn Euro in 2004. The average gross income per employed persons amounts to 31,000 Euros p.a.

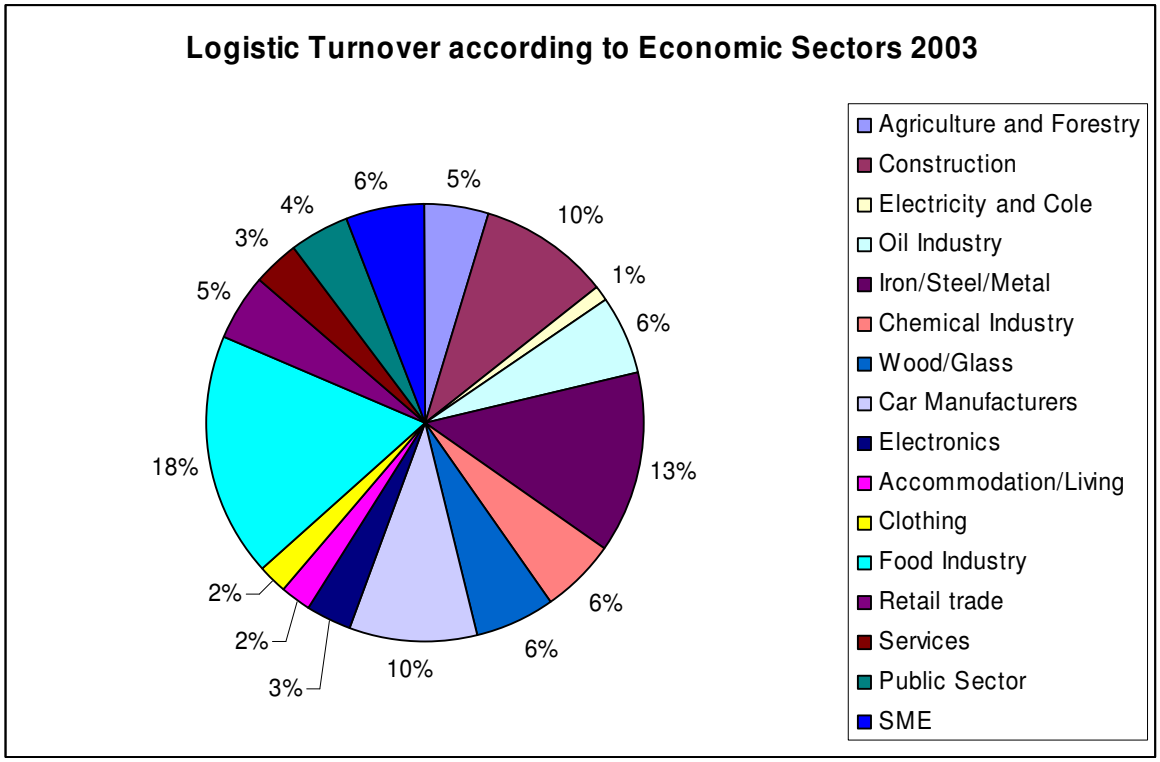


Figure 3-7: Logistic turnover in Germany 2003 (economic sectors)

Figure 3-8 shows the importance of the various sectors, which form the logistics market according to the Top 100 in Logistics publication. The most important ones are Terminal and Storage Services with a market share of 11.2%, Industrial Contract Logistics with 26.8% and Consumer Goods Distribution12.6%.

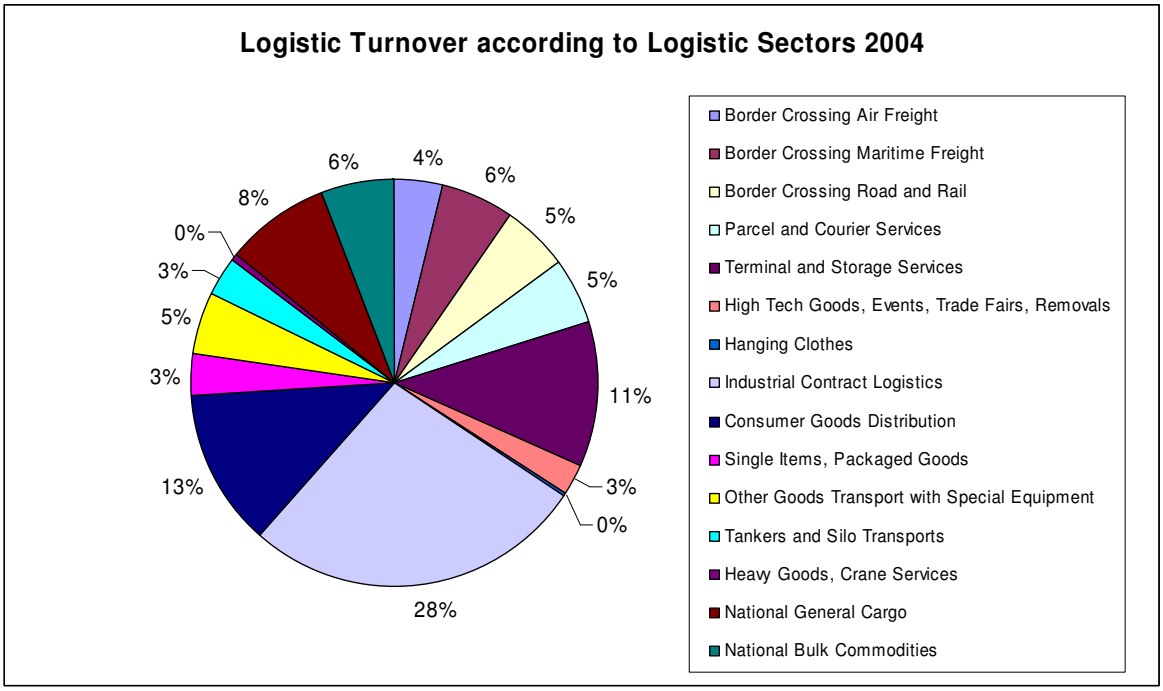


Figure 3-8: Logistic turnover in Germany 2003 (logistic sectors)

In Germany 1.9 million vehicles are operating in the field of logistics, of which 430,000 (23%) belong to commercial carriers and the remaining 1,460,000 are used for intra-company transports. Even though the share of vehicles of commercial carriers is much lower, their share on transport related turnover amounts to 58%. This can be explained by the annual load transported, which amounts to 3,600 tons per commercial vehicle compared to 922 tons per company vehicle.

In Germany logistic services amounting to 79 bn Euro have been sourced out, which is 47% of the logistics market. If only transport services are observed, the share increases to roughly 70% outsourced services. If transshipment and storage services are taken into account, the share is at 40%, for planning and dispatching 23%.

3.5.2 Congestion impact analysis

a) Reaction patterns

The overall statement of the interviewees on the magnitude of effect that congestion has on their business was partly contradictive. The relevance of congestion was assessed as average to big. Nevertheless, the German Logistics Association estimates that long distance road transport has a punctuality of 90-95%, which is mainly due to transport over night. In contrast to roads, the punctuality of railways only comprises 75-85% (delays >30 Min). Additionally, railways have the disadvantage, that their average speed of goods transport amounts to only 25-28 km/h (including complete trains loads) while trucks are considerably faster (50-60 km/h), even on long distances.

Congestion in urban areas is not felt strongly by the companies, since the times of delivery are off-peak. More important than congestion are temporal or general access restrictions to the cities imposed by communities.

As problematic long distance corridors are often mentioned the Trans-Alpine Corridor and the Ruhr Area. While the latter has capacity constraints due to congestion, the constraints on the Alpine Corridors are mainly due to restrictions imposed by governments in order to protect its sensitive natural environment.

The relatively small importance that congestion and transport bottlenecks play is corroborated by the fact, that delays due to congestion play practically no role for planning processes of logistic companies. Other processes such as the duration for loading and unloading (3 hours per trip) are much more important than delays due to traffic congestion.

During the interviews it was perceived, that the interviewees put much more concern on the capacity constraints in the rail mode, than in road transport. A night leap from Munich to Hamburg is not possible. Instead the travel time amounts to 13-14 hours. A car transport leaving Wackersdorf (Bavaria) at 15.00h arrives in Bremerhaven one day later at 22.00 h and is only at the quay the next morning (+2 days). Low reliability and capacity constraints are regarded as the main reasons why modal shifts from road to rail are difficult. The constraints are caused by old infrastructures and the priorities which passenger trains receive. A solution might be the establishment of a network of dedicated goods rail tracks.

b) Congestion impact analysis

During the interviews the following effects of congestion on transport costs were mentioned by logistic companies:

- The shift of transport activities away from peak hours to night times causes higher labour costs, which range in the order of +10%.
- The delays cause by traffic jams may entail much larger effects, since the required driving brakes have to be taken into account as well. A quantification how often this is the case and on the costs was not given be the interviewees.
- Delays cause by congestion might as well entail longer waiting times for loading or unloading, since the planned time slots have expired.
- The costs for one hour delay in road transport are estimated at 50-60 Euro/vehicle.

The costs of congestion are mainly bared by the carrier, not the haulage companies. These costs comprise vehicle operating costs and higher labour costs. However, in a competitive market these costs are internalised on the long run thought the contracts. However, no distortion of competition can be expected, because all competitors face the same kind of problems.

There is a serious lack of data on the effects of congestion. The interviewees gave little or no indication on the total costs of congestion. There are practically no data collected on this issue. The reason is that carriers often have not the means and the time for data collection and analysis, since they are often small or medium enterprises. But even large haulage companies with own vehicle fleets are not undertaking this type of assessment.

Just in Time deliveries are the most time sensitive transports, where one hour delay is regarded as considerable. Regarding the punctuality, the question of liabilities arises. Generally, haulage companies include time agreements in their contracts. These payments embrace the costs for extra transports, which have to be undertaken. However, penalties for non-performance are rarely issued neither for haulage companies nor for carriers. Haulage companies are not liable for production losses.

The little importance congestion has for haulage companies is corroborated by the fact that it is not part of the planning procedures and not part of cost calculations.

3.5.3 Reaction patterns to congestion

a) Short term reactions

Haulage companies, carriers and especially the drivers know well the “hot spots of congestion”, anticipate the risks and react accordingly. The most common reaction is the shift of the transport activities to less congested times of the day (night) and the avoidance of hot spots. However, little financial leeway remains for carriers due to very stiff competition in Europe.

Since the clients are carrying the costs of large scale losses, in these cases additional transports are organised in order to avoid a standstill of production. Often the reason for these “special transports” is not congestion, but production problems of the supplier. In theses rare cases (twice p.a. per large haulage company) transport of missing parts might be even organised by plane. In this case the costs are bared by the clients and not the haulage company.

b) Reaction patterns long term

German carriers face a very stiff competition with foreign companies, especially from Eastern Europe, that are 30-40% cheaper. Since the market is mainly dominated by the clients, prices are extremely low for German carriers and more often than not the small and medium enterprises operate at the verge of profitability. This is verified by the large number of insolvencies of German carriers in the past years. Taking the stiff competition amongst carriers into account, the above assessment might underestimate the effects of congestion. Congestion might contribute just the small additional effect, which causes a company to fail economically.

A possible reaction pattern might be the choice of the location of the company. However, the distance to the main clients is the most important criterion for the location of the company's site. Goods distribution centres locate their facilities according to 60-70 different criteria. Only roughly 20% of these criteria are related to accessibility issues, including congestion.

3.5.4 Comparison with the USA

The main difference between USA and Europe are the special geographic conditions in America: settlement patterns, longer distances, lower population densities. Transport networks are less dense and the European Logistic industry considers the quality of the roads as worse compared to Europe.

One of the main differences is concerning transport services for passengers and goods. Especially the market for high quality haulage services is not well developed in the USA. Mainly parcels are transported and the frequency is low combined with high prices. Therefore in the USA many companies use their own vehicle fleets for supply, deliveries and intra-company transports. Often the loads carried are not sufficient to fill the trucks and thus load factors are considerably lower than in Europe, entailing higher transport costs.

This statement was contradicted by a car manufacturer, who claimed that generally the costs for road transport are 25% cheaper in the USA and in Japan compared to Europe.

The share of spending on Logistics on GDP amounts to 8.6% in the USA (Wilson 2005) compared to 7% in EU16 and 7.7% in Germany. Only the Netherlands, Sweden, Luxembourg and Finland have a higher share than USA.

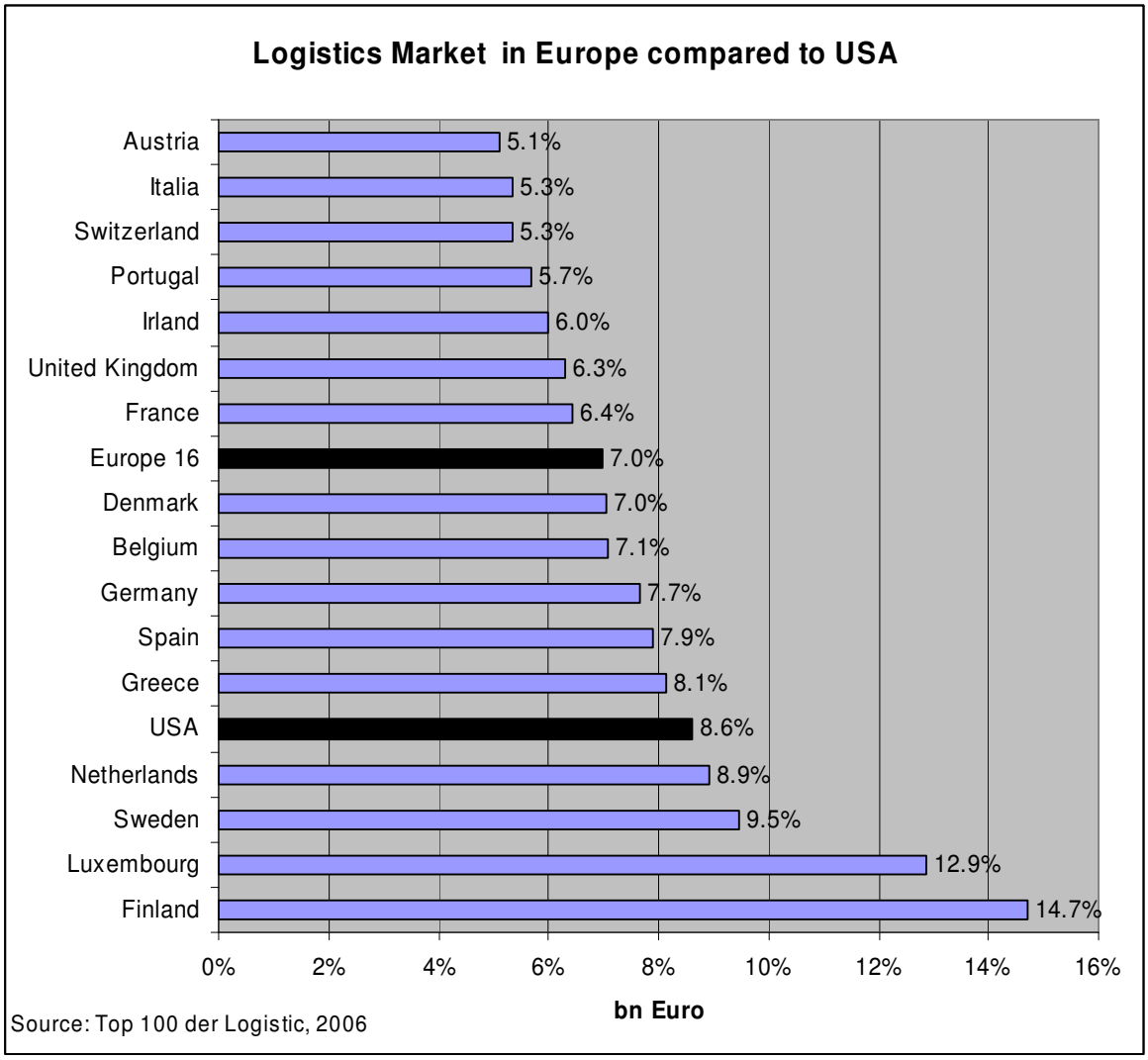


Figure 3-9: Share of logistic market in relation to total GDP 2004

3.6 Food and retail

For the in-depth analysis of the impact of congestion on the food retail sector interviews with representatives of (food) retail companies have been carried out. The interviewees were persons from the strategic level of the company and responsible for the transport and logistics within the enterprise. The following companies have been interviewed for this in-depth analysis: Carrefour, Wal-Mart, Coop and Migros. Other companies contacted – Aldi Süd, Aldi Suisse and Lidl – were not willing to participate in this survey.

Besides the interviews, the following analysis also includes the results of a literature analysis about the impact of congestion on the food and retail sector.

3.6.1 Interlinkages of sector activity and transport

The transport intensity of the food retail sector is one of the highest of all economic sectors. According to the input-output-tables the sector "wholesale and retail trade and repairs" – of which the food retail sector is part – the transport intensity varies very much between the different countries (see Table 3-7 below). On average, transport expenditures make up 7% of all expenditures for intermediates. The whole sector "wholesale and retail trade and repairs" is one of the most important economic sectors with a contribution of 11% to the total GDP.

In the following in-depth analysis the focus lies on the food retail sector, as a sub-sector of the total wholesale and retail sector[4].

Table 3-7: General transport intensity of the sector "wholesale and retail trade, repair"

Country	**Transport intensity** (transport expenditures/total intermediates)	**Economic importance of sector** (in % of GDP)
France	12%	8%
Germany	3%	10%
Denmark	26%	11%
Netherlands	10%	11%
Spain	5%	6%
Finland	15%	8%
UK	23%	11%
Poland	17%	15%
Hungary	14%	9%
Czech Republic	11%	9%
US	3%	12%
Average (weighted)	**7%**	**11%**

Data source: Input-output tables of the different countries, see also chapter 4 of this annex.

Whereas the share of transport expenditures in relation to the *total intermediates* makes up 11% (according to the input-output tables) in the wholesale and retail sector, the transport expendi-

[4] Mainly based on the following literature: DEFRA (2005), Barnes, McVittie (2005), Winsor-Cundell (2003), TfL (2005), Ernst & Young (2006), GLA (2005), Edinburgh City Centre Management Company (2004), Bell et al. (2004), Quddus et al. (2005), Vickermann (2005), Wharton (2005).

tures account for about 1-3% of the *total turnover* of companies in the food retail sector (according to company interviews). The overall incidence of transport costs on the *final prices of goods* is on average in the range of 5-10% for processed food. Compared to other sectors transport is of high relevance to the retail sector.

The following figure shows the structure of the food retail sector within the value added chain. Additionally, all relevant transport chains (upstream, within the sector and downstream) can be seen.

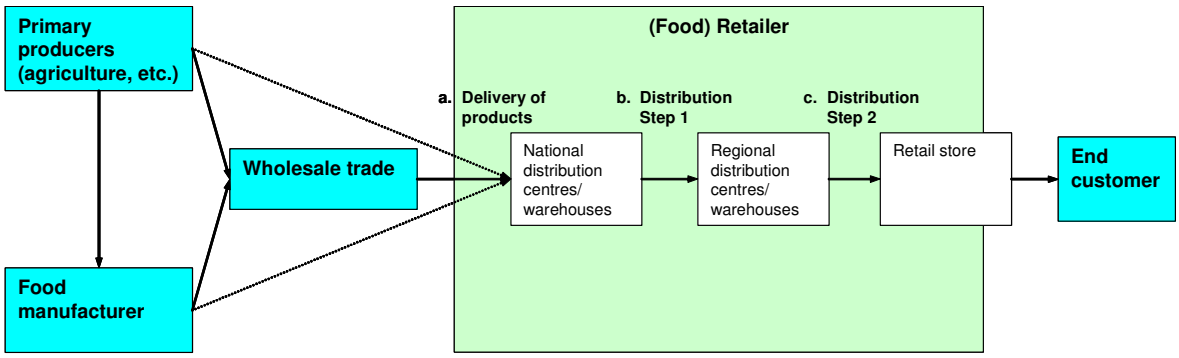


Figure 3-10: Production structure and transport chains in the food retail sector

In the past, the importance of transport has considerably increased. Earlier, most of the primary food was produced and further processed in the same area. Nowadays, more and more food is being imported and raw or semi-manufactured food products are transported over longer and longer distances. Briefly, transport distances and volumes have grown a lot. Furthermore, transport within the retail sector itself has increased since the companies got bigger and smaller retail shops have become rarer. The retail channel structure for food in Spain, for example, consists of 81% modern distribution (hypermarkets, supermarkets) and 19% traditional or specialised (increased share of modern). Therefore, most of the big (food) retailers began to operate at least part of the internal transport chain by themselves ("insourcing" of the transport).

In the retail sector, transport is especially relevant in two areas: a. delivery of goods from food manufacturers and primary producers; b. internal distribution of the products to and from distribution centres and to the stores. At the end of the chain, the transport of the product from the store to the home of the customers has a certain importance, too. This transport, however, is not professional but belongs to the category of individual transport. In the food retail sector, freight transport is of high relevance whereas passenger transport (e.g. business travel) only plays a minor role.

Organisation of the transport differs in the companies interviewed. Generally speaking, the delivery of goods from the suppliers as well as the first distribution step of the goods within the retail company is carried out by external transport enterprises. Detailed distribution of goods from (regional) warehouses to the retail stores is often done by the retail company itself with its own transport fleet. Above all bigger retail companies tend to control their sensitive transport chains by themselves because they are very time-critical and particularly vulnerable to congestion. A minority of the retail companies interviewed has outsourced all transport services to an external transport enterprise.

Within the food retail sector road transport is most important (above all for the last distribution step), followed by rail, which has become more relevant in the last years. Air and water transport only plays a minor role for the import of goods.

3.6.2 Congestion impact analysis

a) Reaction patterns; relevance of congestion

For most companies, congestion is a topic of great importance in all of the three important steps of the transport chain (a.-c. in Figure 3-10): both for the delivery of goods and for the distribution within the retail company congestion is a major problem. Because of its high transport intensity the retail sector is highly affected by congestion. The retail companies, which have outsourced their transport services do not consider congestion such a big problem as the other retail enterprises with own transport fleets. The reason for this is the fact that retail companies with outsourced transport services have also handed over part of the responsibility (e.g. for punctuality) to the transport enterprise. Basically, congestion is of higher relevance for retail companies with stores situated in the city centres than for the retailers with stores outside of densely populated urban areas.

Congestion only plays a role for freight transport. Passenger transport (business transport, transport of customers) is less important in the food retail sector and therefore congestion in passenger transport does not have great relevance. It only plays a role when it comes to accessibility of retail stores for customers. In this respect, congestion is one factor that influences the level of accessibility of a site.

b) Congestion impact analysis

The main impacts of congestion for the food retail sector can be summarized as follows:

A. *Delay* in delivery and distribution of goods: Delays may lead to severe loss of reliability if certain products are not in the stores in time. Sometimes, certain products can even not be sold because of late delivery due to congestion. Most critical are the transport of perishable goods (e.g. fruit, vegetable, meat) and the delivery of products of sales promotions that have to be in the shops on time.

B. *Costs* due to increased time and personnel expenditures: Most companies affirm that they have to bear additional costs due to congestion. However, they are not able to quantify the direct costs related to the additional efforts due to congestion. Additionally, most companies consider the costs to be the minor problem compared to the delays and the related problems (decreased reliability, indirect costs, etc.). Companies with outsourced transport services even state that they would not have to bear any additional direct costs because of congestion since those costs have to be paid by the transport enterprise.

Besides the transport of perishable goods, the delivery for retailers in urban areas is most critical. Whereas long distance trips are usually carried out by night road haul or rail transport, the delivery to urban areas uses early morning slots with delivery vans or small trucks. Late delivery means significant production losses, a critical issue in a very dynamic market with a high level of competition and low margins. The higher the number of logistical processes in the transport chain, the higher the risk of congestion, as the transport survey in UK has shown (UK KPI survey

2002, McKinnon 2004a). Since delivery in the food retail sector has to use several transport legs compared to other sectors, it is specifically vulnerable to congestion.

The interviews, however, showed that there is no directly measurable and explicit cost increase of congestion which could be shifted to consumers. The interviewees stated that within the hard-fought retail market price increases due to specific congestion costs could never be implemented. However, some companies admitted that in the end, all their expenses had to be covered, which means that a slow, hidden price rise would be probable.

Most of the interviewees stated as well that the whole retail sector would be affected in the same way and there was no difference between different actors. One company, however, even thinks they would have an advantage compared to their business rivals since they would have a more sophisticated transport chain which is less vulnerable to congestion (e.g. because of a higher share of rail transport in long distance transport) and have better countermeasures.

Neither of the interviewed companies is able to estimate the costs of congestion. Yet, the retail sector is the only economic sector (besides the transport sector itself) which has carried out own studies analysing the economic impacts of congestion. The AEA food miles study (DEFRA 2005) has estimated congestion costs for food transport in the UK of nearly 5 billion British Pounds. Over 77% of these total costs are caused by congestion in urban areas, 14% by congestions in rural areas and only 8% by motorways. Furthermore, 48% of the total congestion costs can be attributed to professional freight delivery, whereas 52% of the costs are generated by passenger cars of individual shopping transport. From the freight transport related costs, 44% is generated by light duty vehicles, the rest by heavy duty vehicles. Compared to the interviews carried out, these figures of the total congestion costs of food transport in UK seem rather high, but the tendency and the structure can be supported.

London Congestion Charge and its impact on the retail sector

Another interesting evidence is the impact of the London Congestion Scheme to the retail sector. The introduction of the London Congestion Charge (LCC) in 2003 initiated a long and controversial discussion about the pros and cons of the system for the London retail sector. On the one hand, the congestion charge increases the price for driving into the London's city centre which might keep some of the clients from entering the zone and shopping in the stores there. On the other hand, the congestion charge led to a drastic decrease in transport volumes and, as a consequence, to less congestion and shorter travel times in the London's city centre. This again could be seen as an advantage for retailers since clients as well as suppliers get quicker and more easily to the shops. According to the results of an econometric model (Bell et al. 2004), the introduction of the LCC led to a drop in sales of about 5.5% (results of). In addition, a study of the London Chamber of Commerce and Industry (Winsor-Cundell 2003) with a survey among the retailers within the charging zone states that over 80% of the retailers say that their number of customers have fallen. In this study, however, other effect which probably had negative effects on the retailers situation (such as the Iraq War, the state of the economy, etc.) have not been taken into account, in contrast to the study of Bell et al. Still, a third of the respondents of the survey supported the congestion charge shorty after the introduction (Winsor-Cundell 2003). And 21% of the retailers said the congestion charge had improved their productivity through quicker journey times. London's retail sector notwithstanding claims losses due to the charge. In its third annual report of the London Congestion Charge Transport for London concluded that the scheme

had a broadly neutral impact on London's economy (TfL 2005). In a detailed study based on an econometric model, Quddus et al. (2005) found out that the LCC had no statistically significant effect on the whole retail sector within the zone. However, the charge can have a negative impact on certain shops: the model shows a significant negative effect of the congestion charge for the John Lewis store in Oxford Street (Quddus et al. 2005). A plausible hypothesis for this might be that John Lewis at Oxford Street is particularly likely to be affected by the charge because a relatively large proportion of its sales come from customers who use a car for shopping. Data of different studies support this hypothesis: Whereas almost 10% of the John Lewis' customers use private cars, in general in central London only 3-6% of the customers use a car for shopping (Quddus et al. 2005, Bell et al. 2004). All in all, it can be concluded that the LCC has no major impact on the retail sector. This conclusion has also been supported by a recent study of an independent consulting company (Ernst & Young 2006). The additional cost of the congestion charge are therefore outweighed by the advantage of having less congestion in peak hours, making shopping in the central London area more attractive.

Situation in different regions

Comparing the congestion situation in different regions, one can state that the problem of congestion is more severe in Europe than in the US, since urban patterns are denser in Europe and big retailers (such as Wal-Mart) are more often located in suburbs in the United States of America. Retail companies emphasise that the situation is most severe in the most densely populated urban agglomerations in Western Europe, such as in the Netherlands, Germany, the UK, etc. One company further states that congestion situation in Europe is still manageable compared to the situation in certain Asian countries (e.g. Japan). The companies underline that they can handle congestion problems more easily in countries with a liberal transport policy, for example in countries without a strict ban on driving during the night for heavy duty vehicles.

3.6.3 Reaction patterns to congestion

a) Short term reactions

According to the interviews with the persons in charge with transport in the retail sector, there only very few short term reactions on congestion. Of course, an improved transport planning (e.g. avoiding predictable congestions, temporal and local shifts of transports, etc.) is for all companies the first measure to avoid congestion. A better transport planning is particularly promising during peak hours in urban agglomerations since this kind of congestions can often be avoided by means of temporal shift of transports (e.g. to the early morning). According to the interviewees congestion costs do not lead to an increase in product prices in the retail sector. Competition is too hard to shift these costs to the clients.

In addition, companies do not increase their personnel or transport fleet just because of congestion. Some companies however have – as mentioned before – outsourced their transport services to external transport enterprises. But it has to be stated that congestion has no influence on their decision to outsource the transport services. There are other driving factors for this decision (such as cost savings, etc.).

Another important strategy to react on congestion is the modal shift from road to rail transport. Although rail cannot substitute all transports on the road, the shift from road to rail transport

can be helpful for avoiding congestion for certain types of transport because rail transport has a higher reliability than road transport. In the last years, rail transport has been pushed above all in the trans-alpine freight transport and long-distance transport in general, where road transport is particularly vulnerable to congestion. However, while being more reliable than road transport, rail transport has certain deficiencies in flexibility compared to road transport. Additionally, rail transport is often more expensive than road transport. Interestingly, modal shift of transport is less important for retail companies which see congestion as a smaller problem.

b) Reaction patterns long term

For retail companies, congestion is a problem with only limited strategic importance. However, retail companies expect that the strategic relevance of congestion will increase in the future.

Congestion has only a minor influence on the choice of the location of company sites. Companies state that for the location of retail stores, congestion does not play any role. Rather, a high transport volume is seen as desirable since the companies want to have as many clients as possible. However, some retailers use outlet stores outside of densely urban areas with high congestion risk (e.g. Carrefour, Wal-Mart, Lidl, etc.). A good example is Wal-Mart which – in contrast to other actors – does not state congestion as a major problem. The suburban location outside of cities shift congestion costs to the consumer in form of higher transport costs, due to longer distances. Therefore, the choice of the location outside the urban areas cannot be seen as an isolated strategy to avoid congestion. There are other factors that are more important for choosing such locations, for example cheap land prices for large areas and good accessibility by road.

For the location of distribution centres congestion can be a factor of certain importance. The most important point, however, is accessibility as a whole. In this respect, congestion is one of the factors influencing accessibility and therefore has a certain importance for the site selection for distribution centres.

3.6.4 Ideas and strategies to overcome congestion

Most companies are sceptical about measures to overcome congestion. They think that there are no simple measures. Some even state that congestion could not be avoided and the companies simply had to live with it and handle it as good as possible. Others do have suggestions how they think the congestion situation could be improved:

- - Infrastructure enlargement: investments into traffic nodes which are overloaded with traffic
- - Modal shift from road transport to other transport modes (above all to rail)
- - Give freight transport a higher importance: above all in rail transport, freight transport should get a higher priority compared to today's situation.
- - Introduction of road pricing for controlling the traffic inflow into cities: This could be an instrument for the future. However, the benefits have to outweigh the costs, above all for the economy.
- - Less strict night and weekend bans for heavy duty vehicles would improve the flexibility of the retail companies and make it easier for them to overcome congestion.

3.7 Car manufacturing

For the analysis of the impacts on the automobile industry, interviews with three manufacturers and two suppliers in Germany were conducted:

- Daimler-Chrysler, Stuttgart
- BMW, Munich
- Volkswagen Logistics, Wolfsburg
- Mann und Hummel, Production of car filter systems, Ludwigsburg
- Bosch, Production of car electronics, Stuttgart

3.7.1 Interlinkages of sector activity and transport

Transport has a moderate share on the manufacturer's turnover. A calculation revealed 2% for the car producers and 1-2% for the suppliers. One guestimate was significantly higher.

But this does not describe the whole dependency on transport and especially on congestion, since the car manufacturing is a complex process which requires a large number of different primary products, which are outsourced to suppliers. In order to organise car production in Europe efficiently, a global logistics chain is essential. An example for a logistic chain in Spain is given in

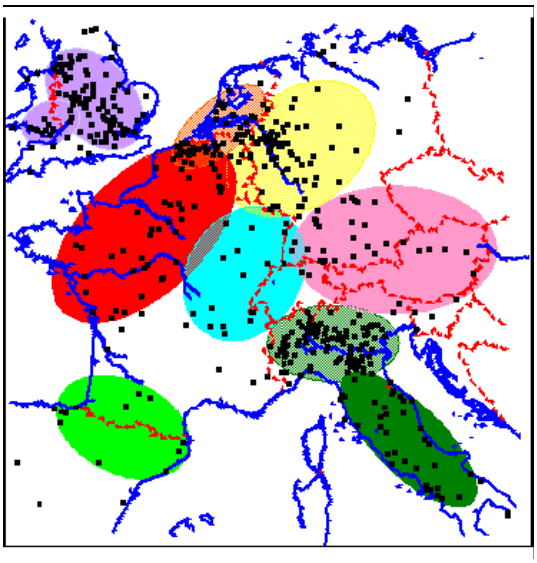
Table 3-8. Less than one third of the supply stem from Spain the remaining 69% are imported from other European countries.

Table 3-8: Supplies of the IVECO-Stralis supply chain

Country	Percentage of Supplies
Italy	31%
Germany	31%
Spain	24%
France	4%
Others	10%
Source: ECOTRA 2006, p. 111	

The complexity of the supply chain can be assessed if the outcome of the ECOTRA case study is taken into account. The manufacturer surveyed had about 200 direct suppliers, producing 3000 parts, which were assembled within three hours for the car (ECOTRA 2006, p.113). Every direct supplier in Europe deals with an average of 100 sub suppliers. Source: ECOTRA, 2006, p. 112

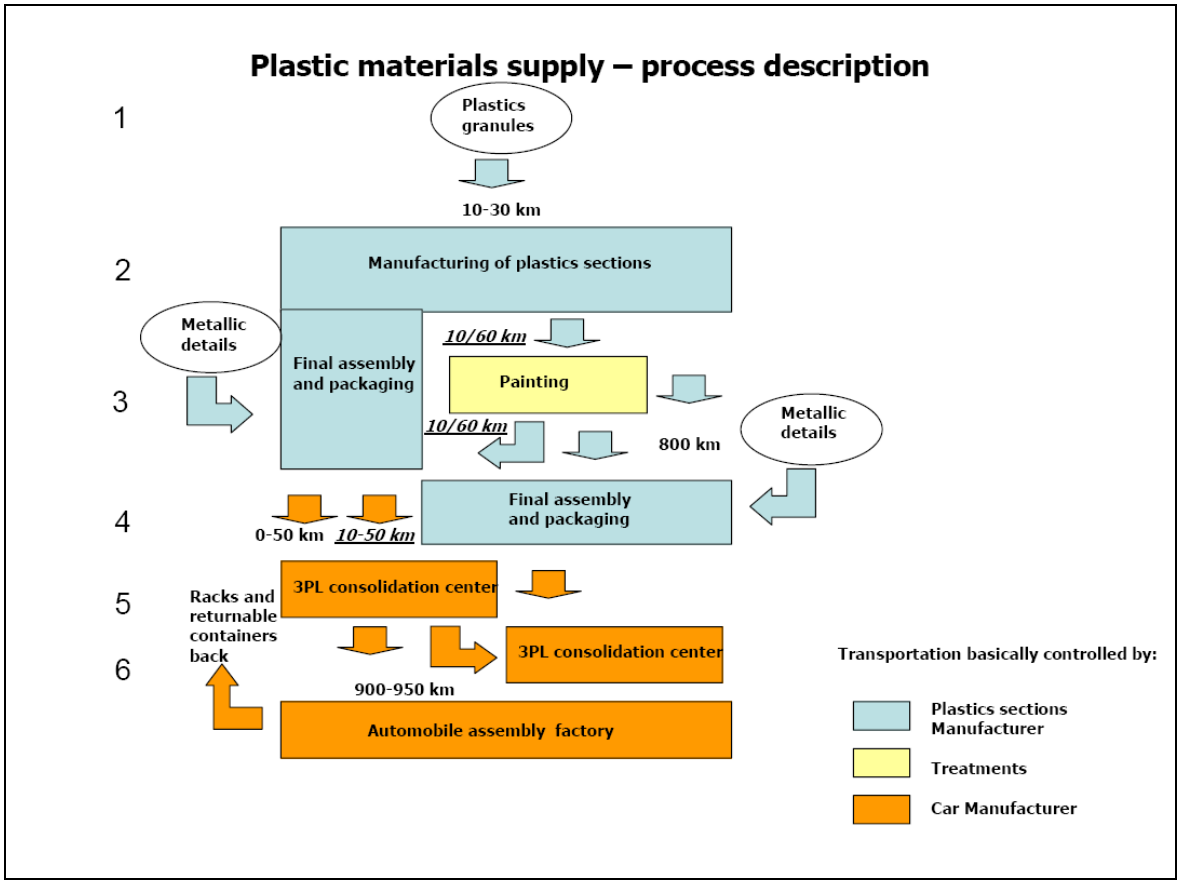
Figure 3-11 shows the location of these suppliers in Europe.



Source: ECOTRA, 2006, p. 112

Figure 3-11: Analysis of supplier network for an automotive group (assembly of final product and systems)

Figure 3-13 gives an example of a supply chain of plastic parts analysed in the ECOTRA case study. In step 1 granulates are supplied. In steps 2-4 the manufacturing unit provides a wide range of components after a thermoplastic process. Parts which require painting are sent to an external factory. After painting, the parts are returned for final assembly and packaging. During the following steps 5-6 the supply has to be just in time or with limited stock over a distance of 900 km. That implies different frequencies and quantities for individual replenishments.



Source: ECOTRA, 2006, p. 212

Figure 3-12: Example for a supply process of plastic parts

Transportation logistics has the task to reliably connect highly productive and very complex manufacturing plants with one another over long distances. These production plants are today partly optimized down to the range of seconds. In order to design the production process as efficient as possible it is imperative to deliver the supplies just in time (JIT) and just in sequence (JIS). Since generally most of the suppliers are not located on the premises, reliable transport is essential for the functioning of a modern production process. Some of the products are transported through Europe over long distances. Therefore, even with a low share of transport on turnover, the transport dependency of the car manufacturers is remarkable.

As an example of an automobile producing company the Mercedes Car Group belonging to Daimler-Chrysler Group will be presented:

The Mercedes Car Group has three assembly plants in Germany to produce passenger vehicles at Sindelfingen, Bremen and Rastatt. At further 15 locations aggregates are manufactured (e.g. in Hamburg, Berlin, Kölleda and Stuttgart). The German plants are linked with one another in a close production network. Between Sindelfingen and Bremen daily four trainloads operate and between Stuttgart and Bremen one trainload is moved per day. Export vehicles are transported from Sindelfingen via Bremerhaven with three trains per day. 4,500 containers per year with engines, transmissions and axles are shipped from Stuttgart port via Neckar and Rhine to the overseas plants (return of 2,000 loaded containers annually), with strongly rising tendency. Daily 1500 trucks call at the production unit in Sindelfingen and 700 trucks in Neckartal (Stuttgart).

Between Neckar Valley and Sindelfingen approx. 1,000 trucks are driving daily as intra-company transport.

Mercedes has a share of rail transport amounting to 25% (tonnage). Mercedes organises all in and outgoing transports of its plants. Thus the supplier's responsibility ends at the exit gate of their production unit. Mercedes outsourced its transport logistics to haulage companies, organised in so call regional concepts. The concepts are designed in a manner, that allow for a high usage of capacities, which amounts to nearly 90%.

Table 3-9: Goods transport patterns of Daimler-Chrysler's production unit in the Neckar Valley

Goods Transport	Trucks/day	Tons/day	Share
Supply delivery by truck	160	2200	28%
Distribution by truck	290	2300	29%
Intra-company transport by truck	140	2000	26%
Combined loads	50	800	10%
Import and export by rail		200	3%
Import and export by barge		300	4%
Total	**640**	**7800**	

Table 3-9 gives an overview on the goods transport patterns in Daimler Chrysler's traditional production unit in the Neckar Valley. Daily 7800 tons are transported to and from the unit using 640 trucks per day. The modal split for trucks is more than 80%.

Table 3-10: Passenger transport patterns of Daimler-Chrysler's production units in the Neckar Valley and Sindelfingen

Passenger Transport 2004	Cars	Company buses and public transport	Motor Cycle	Bicycle	Pedestrians
Neckar Valley	24,000 (64%)	10,300 (26%)	1,900 (5%)	1,100 (3%)	900 (2%)
Sindelfingen	30,000 (68%)	8,500 (20%)	ca, 500 (2%)	2,000 (4%)	2,000 (6%)

Table 3-10 gives an overview on the passenger transport patterns in Daimler Chrysler's production units in the Neckar Valley and in Sindelfingen. Daily 38,000 passengers travel the factory in Neckartal and 42,500 in Sindelfingen. 70 % of the passengers come there by car or motorcycle and only 20-26% by public transport or company buses. 5-10% of the employees live so close that they can reach their employer by non motorised transport.

3.7.2 Congestion impact analysis

a) Reaction patterns

The vulnerability of car manufacturers by road congestion depends mostly on the location of their production plants. For example the main factory of Volkswagen is located in a small town Wolfsburg, which hardly experiences any traffic jams. Thus road congestion is not regarded as a major problem. Other production units in Mosel and Kassel have only minor problems. Additionally, just in time and just in sequence is mainly intra-company transport on the premises.

BMW states that the company has minor problems with congestion. 97% of the company's deliveries are performing without major delays. Negative impacts relating to production oriented transport is felt between Wackersdorf and Regenburg, where just in time deliveries are frequently delayed during peak hour congestions on the A93 motorway. BMW did not assess the costs for this congestion.

In contrast to the other manufacturers Daimler-Chrysler states that severe congestion problems occur due to the historic location of the main production unit in the Neckar Valley in Stuttgart. Since the space of the premises is limited, supplies have to be delivered from other units and thus most of the intra-company-transports are done via motorway between Neckatal and Sindelfingen. Frequent congestion on the motorways around Stuttgart (Airport, Junctions) caused by high transport volumes and construction sites have their impact on Daimler's supply transports.

According to Mercedes, even with a distance of less than 100 km between the supplier and the production unit, delays of two hours and more are frequent. Since such delays cannot be anticipated, Daimler claims that buffers which may amount to several hours are to be included in transport planning, in order to assure the reliability of the input delivery. That entails a suboptimal use of resources (personnel, equipment and money).

Delays due to congestion do not cause a standstill of production, but rework expenses have to be calculated. These are mainly additional labour costs of night shifts. Neither the rework costs, nor the additional transport cost or the total delays due to congestion could be quantified by Daimler-Chrysler.

Automobile manufacturers are the industry with the largest share of just in time and just in sequence delivery. Remarkably the share of JIT deliveries differs between new production units where it amounts to 70% and old units where only 30% of total transports are JIT. The interviewed suppliers have to produce JIT, but their inputs are only 20% JIT deliveries. Thus, JIS is not common for the supply industries, but will increase in the future. The critical issue with JIT is not the speed of delivery, but the reliability of the transport. The major impact of congestion is the increased risk for delays in JIT deliveries during peak hour periods. Reduced reliability makes the planning of the production process more difficult and increases costs. Since the time sensitivity of JIT deliveries differs from input to input and varies between ½ hour (e.g. seats) and ½ day, no general rule can be deducted about the time sensitivity of JIT deliveries.

Production processes are very much related to the wishes of the clients. Generally, the clients are able to modify their orders up to 4 days before production starts. The reason for this short time period is, that generally more exclusive equipments are ordered, which has a significant impact

on turn over. Therefore, car manufacturers are planning to reduce this period in the future. Again this will imply further efficiency improvements in the supply chain.

The time sensitivity regarding deliveries is much smaller. Mercedes reports, that one third of all new cars are collected by the owners on the premises. For deliveries in Germany no major problems were reported by the interviewee. However, exports to overseas destinations are as well time sensitive. BMW reports that ½ day delay of rail transport to the port of export might imply that the ship to USA is missed and the export vehicles have to wait one week for the next boat to come.

b) Congestion impact analysis

Even though some interviewees judged congestion as a problem for their company, none of them could give an indication on the magnitude of the impacts of congestion, be it in time or in monetary terms. The fact, how little effort is made to quantify the impacts of congestion seems to be an indication for its relevance.

None of the interviewed manufacturers or suppliers reported a stop of production due to delays in delivery caused by traffic congestion. A number of other factors seem to influence the JIT and JIS deliveries, such as production problems of the supplier, strike of worker and employees, road blocks during protest actions, etc.

30-70% (according to the age of the factory) of all supplies for the automobile industry are not JIT deliveries. If the deliveries to the suppliers are regarded, this share amounts to roughly 80%. For all these incoming transports storage facilities are supplied, which constitute a buffer that compensates for delivery delays caused by congestion. Thus, it can be assumed, that no additional costs occur, except for the ones directly related to transport, i.e. increased vehicle operating and driver costs.

Surprisingly, during the interviews most of the interviewees emphasised more the problems they experience with railways rather than with complaining about the delays in road transport. Generally industry prefers complete train loads compared to single wagon loads. The first show little delays since trains run over night according to schedule and are often reliable, even when connecting East European countries. Wagon loads are generally more unreliable, slower and are thus not preferred. However, the problem which smaller companies face is that they do not have sufficient quantities of load complete trains.

All manufacturers reported major problems with rail transport through France to Spain. The transport was regarded as unreliable, frequently delays occur (1 day within 6-7 day travel time), tracking of wagons is not possible and even complete train loads are split into wagon loads. Due to these constraints Daimler Chrysler was not able to organise rail transport between Stuttgart and Vitoria (Pais Vasco, Spain). Instead of using complete train loads, goods are transported by truck over a distance of more than 1,000 km, entailing major environmental impacts.

3.7.3 Reaction patterns to congestion

a) Short term reactions

The JIT concept is quite rigid and little leeway is available for reactions to congestion. BMW claims that, a reorganisation of the deliveries is not possible, since all deliveries would have to be rescheduled due to congestion during a few peak hours. The establishment of buffer storage facilities would "contradict the whole concept of just in time".

Volkswagen used to transport supplies from Czech Republic by rail to its production units in Germany. However, the low speed and the unreliability of wagon loads caused Volkswagen to shift mode from rail to road, where little problems occur, but larger environmental effects are caused.

Constraints in the European ports, as already reported above (see section 1.5), are as well perceived by the automobile industry. Interviewees reported about a "hunt for shipping space". However, the constraints are regarded as a world wide phenomenon, with little possibilities for short term reactions. Companies reported about new shipping concepts, which are aimed at reducing transport risks through a different choice of harbours, more contracted shipping companies, and higher frequencies of transport. The capacity expansion in existing ports and the construction of the new Jade-Weser Port is highly welcomed by the industry.

b) Reaction patterns long term

As stated above, the share of JIT and JIS deliveries depends on the age of the production facilities. Old units are more often than not constrained by their location and the availability of space. New units have the advantage of providing enough space for the design of production process, which integrates the suppliers into the production process. New factories, such as SMART in Hambach, locate their suppliers on the premises in a manner that they are able to deliver their products directly onto the assembly line. JIT transport is either not necessary or only occurring on the premises. In this way new production units have a lower share of JIT transports, even if they have a high share of JIT and JIS inputs. The optimisation of the production process is achieved by avoiding transport. It is likely, that the optimisation has entailed a reduction of the overall transport volume. However, only research can verify this assumption.

Space for logistic facilities is scarce and costly on the premises. Thus BMW has established parking facilities outside the premises in Munich and introduced a truck guidance system for optimal allocation of loads at the ramps.

Mercedes is planning a similar project in Stuttgart. By agreeing on time slots for delivery with the haulage companies peak traffic and thus congestion will be avoided. Additionally, an intelligent truck control system that minimizes truck traffic is in the test phase. Smartphones (mobile phone of the new generation) will register incoming trucks and guide them to their destinations.



Figure 3-13: Daimler-Chrysler's ECOCombi test vehicle

Presently several German automobile manufacturers are testing with larger road vehicles called Gigaliner or ECOCombi. The main idea is to increase capacities of vehicles and thus use the existing transport infrastructures more efficiently. The trucks are able to load a volume of 150m³ and carry a one a total weight of 60t. The vehicles have a maximum length of 25,25m. While such vehicles are already introduced successfully in Scandinavia for years and in the Netherlands a test project is conducted since 2004, in Germany a similar project is missing. Daimler-Chrysler proposes to test their vehicles between the Neckar Valley and Sindelfingen. The aim is to achieve a clear reduction of costs by the reduction of trips and to lower emissions for the same transport volume.

As mentioned above, the location of Daimler-Chrysler in the valley of Neckar entails special constraints regarding congestion. Therefore, the company demands a number of capacity expansion projects: additional lanes on motorways and tunnels, new construction of a tangential motorway, extension of locks in order to allow for bigger ships, additional rail tracks, introduction of a traffic management system and faster planning procedures.

3.7.4 Comparison with the USA

The spatial distribution of population and the densities are the biggest differences between USA and Europe. From the perspective of the car manufacturing industries in Europe, congestion problems only occur in some major agglomerations (e.g. Detroit). The new formed Daimler-Chrysler Group closed down some former Chrysler production units in the US and built new ones in remote areas (e.g. Alabama). These production units had all the above described advantages regarding JIT and JIS. Suppliers were imported from Germany and located right on the premises.

3.8 Electronics

The electronics industry is quite wide and comprises electronics and electro techniques such as household appliances and media appliances. The relevance of transport therefore varies quite significantly. The interviews focussed on end products, because just in time delivery related congestion is an important issue.

For the in-depth analysis of the electronic sector qualitatively orientated interviews were made with persons responsible for transport and logistics. The following companies and associations were interviewed: Sony, BSH Bosch and Siemens Hausgeräte GmbH, Association of the electronic industry in Germany (ZVEI).

3.8.1 Interlinkages of sector activity and transport

The general transport intensity of the electrical machinery and apparatus sector – which is a big part of the whole electronic sector– ranges from 1.2% – 4.0% in the different countries (see table 1 below). Compared to other sectors, the average (weighted) transport intensity of 2.3% is medium to high. With a contribution of 0.9% to the GDP the electrical machinery and apparatus sector has reached low to medium importance for the economy of the countries listed below.

Table 3-11: General transport intensity of the sector "Electrical Machinery and Apparatus"

Country	**Transport intensity** (transport expenditures/total intermediates)	**Economic importance of sector** (in % of GDP)
France	2.0%	1.1%
Germany	1.2%	2.0%
Denmark	2.5%	1.3%
Netherlands	1.5%	0.4%
Spain	1.6%	1.4%
Finland	2.4%	1.1%
UK	4.0%	0.8%
Poland	3.3%	1.0%
Hungary	1.3%	2.8%
Czech Republic	2.3%	1.9%
US	2.9%	0.6%
Average (weighted)	**2.3%**	**0.9%**

Data source: Input-output tables of the different countries, see also chapter 4 of this annex.

The interviewees' best guess of the transport expenditures amounts to 3–5% share of the total turnover – compared to 2.3% share of total intermediates (table above).

The electronic industry – especially end products – is highly organised with JIT production structures. The interviews have shown that therefore transport plays a big role in the electronic sector. Most relevant to the electronic sector are the following three transport types:

1) supply transport (transports from production sites to clients)

2) delivery transport (transport of components to production sites)

3) delivery transport of spare parts

According to one interviewee, the output delivery of goods has a 2–3 times higher transport intensity than input delivery of components. Besides supply transports and delivery to end consumers, the delivery of spare parts is also rather important as time sensitivity is quite high. Personal transport such as business travels and commuter traffic play a smaller role in the electronic sector. The interviews however showed that the importance of commuter traffic grows with the size of the company.

Transport in the electronic sector in most cases is outsourced to professional providers. The reasons stated for outsourcing transport are:

1) costs (most relevant)

2) professional handling

3) higher efficiency of professional providers

4) higher flexibility of professional providers

According to the association of the electronic industry in Germany, big global companies are not able to handle the organisation of transport and logistics by themselves, as this requires highly specified knowledge and experiences (p.e. organisation of a take over at a ramp in China). Outsourcing the transport organisation was reinforced by the liberalisation of the logistic and transport sector which has led to a speed-up of transports in the last 20 years.

Spare part deliveries became an own big market. As spare parts have to be delivered all over the market places within small time periods, they have to be stored in many different places. Therefore different manufacturers often cooperate and run spare part stores together.

Within Europe road transport happens to be the main transport mode. One company stated that the intensity of rail transport of electronic goods within Europe amounts to 20–30%.

3.8.2 Congestion impact analysis

a) Impact patterns, relevance of congestion

The general impact of congestion is rated as medium to high. Companies with higher customisation tend to value the impact of congestion higher. The influence of congestion on just-in-time supplies of production sites is equally rated as high by the interviewed companies.

b) Congestion impact analysis

The interviews showed that the most important impacts of congestion on the value added chain are the risk of late delivery (image loss) in the first place and higher production cost (due to higher time costs) in the second place. Yet the interviews stated that the increase of production costs related to congestion is marginal and not shifted to product prices.

The following figure illustrates impact patterns of congestion in the electronic sector:

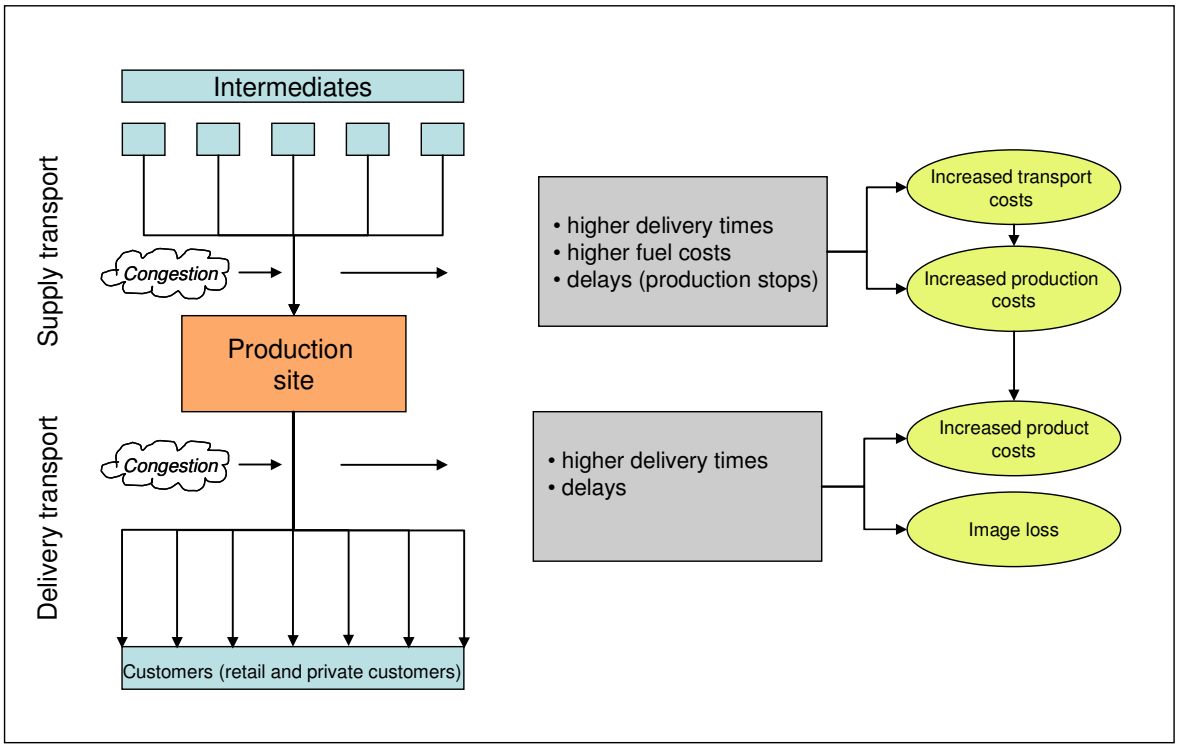


Figure 3-14: Impact patterns of congestion in the electronic sector

The main impacts can be summarized as follows:

- Impact on production costs: The interviewed companies affirm that higher delivery times of intermediates have a (minor) effect on the production costs. Companies which outsource their transport organisation carry those cost as much as companies with an own transport organisation. According to two interviewees higher personnel and fuel costs are part of the freight prices of transport providers and hence shifted to the company. While it was mentioned that delays can lead to production stops, it turned out that production stops hardly ever occur. Since consequences of a stop of production are rather cost intensive, companies have developed countermeasures in order to avoid delays in the delivery of intermediates (see reaction patterns).
- Impact on reliability (image loss): According to the interviews delays due to congestion occur sometimes and are an issue especially for companies with a high service quality orientation (e.g. delivery within 24 hours, Siemens household appliances). The interviews stated that customers do not appreciate delays in deliveries under any circumstances.

Summarizing the specific impact patterns of congestion in the electronic sector it can be stated that companies are more sensitive to congestion

a) the more intensively they are organised by JIT production and

b) the more service quality towards clients (short delivery times) is emphasized.

None of the interviewed companies was able to quantify the costs of congestion because the costs mainly consist of less reliability and transport costs which the transport providers have to bear. A direct measurable rise of freight prices due to congestion could not be confirmed by the interviewed companies. The electronic association, however, estimates the direct costs of congestion (transport costs) as below 0.1% of the total costs.

Within Europe road transport is the most important means of transport to the electronic industry (end products). One company reported a capacity scarcity of the railway for most parts of Europe. Yet according to the interviewee, on long distances combined traffic is the preferred transport mode because of sinking marginal costs. On distances longer than 500 km rail becomes less expensive than road. However road transport is regarded as the more reliable transport mode.. Two reasons to underline that were mentioned. First of all rail – especially in France and Spain – is noticeably affected by strikes. Furthermore, whenever a technical defect occurs the whole route system is affected. Compared to that road transport always offers opportunities to avoid congestion or to handle a critical situation differently.

According to one interviewee, road transport costs decreased with the liberalisation of the transport sector respectively with the withdrawal of regulations. Contrary to that nowadays companies have to face higher transport costs due to increased gasoline prices and motorway tolls. Over all in the last 15 years transport costs have levelled off which implicates that transport costs haven't influenced transport modes.

All interviewees stated that the whole electronic sector would be equally affected.

3.8.3 Reaction patterns to congestion

a) Short term reactions

All interviewees stressed that congestion mostly is not predictable. Thus in the very short run companies are hardly able to react to congestion at short notice. In sectors with a strong service orientation respectively with short delivery times, companies are not able to carry out deliveries during off-peak times in order to overcome congestion.

In order to avoid delays in production or production stops companies have built up intermediate stores located close to the production sites. When JIG production came up, intermediate stores were reduced by establishing lead times for the delivery of intermediates. As a short term reaction to congestion lead times have been lengthened in the electronic sector. An evidence to avoid rural traffic is that production sites and delivery gates are located in peripheral areas close to motorway connections. Finally, companies make use of possible measures in planning transport like avoiding predictable congestion by local shifts and time shifts of transport.

Companies which fully outsourced transport management to professional providers mentioned that they did not react to congestion at all because due to outsourcing transport congestion was no longer an issue for the company. None of the interviewees confirmed that congestion was a relevant factor for outsourcing transport organisation.

According to the interviews congestion is not taken into account when it comes to decisions regarding transport modes, distribution channels or input patterns.

b) Reaction patterns long term

According to the interviews transport aspects have an influence on long term strategic patterns like spatial decisions. Companies often locate production sites close to economic growth markets. Yet, one interviewee stated that additional transport costs are vastly outweighed by the economies of outsourcing production to cheaper locations. Congestion as a minor cost factor of transport, however, does not have an influence on spatial decisions of the companies.

When it comes to market orientations of products congestion, according to the persons interviewed, is not taken into consideration.

3.8.4 Ideas and strategies to overcome congestion

All interview partners agreed on the opinion that an increase of infrastructure capacity would be the most effective strategy to overcome congestion. One interviewee stressed that an increase of rail resources would be of main interest.

3.9 Banking and insurance

This service sector is quite different from the other sectors because JIT production and freight transport are of no relevance. Therefore, general transport intensity is quite low. Transport mainly consists of business travels to clients and of travelling between business partners to different locations/segments of the company.

For the in-depth analysis in the banking sector several interviews were made with persons in charge of human resources management, travel management and environmental management. The following global working companies contributed to the study: Dresdner Bank, Deutsche Bank, UBS, Zurich Financial, Swiss RE and Credit Suisse.

3.9.1 Interlinkages of sector activity and transport

The globalisation has led to major changes in the banking and insurance sector. Due to the increased global interlinking of the financial markets, the competition between the companies has highly intensified. In order to adapt to the changes on the market, companies revised their strategic orientations. The main results of this development are:

- fusions and acquisitions,
- restructured and consolidated business segments,
- opening up and intensifying globally orientated business segments (such as Global Wealth Management, Investment Banking, etc.),
- higher geographic coverage (new domiciles on international markets such as China, etc.).

The interviewees stated that changes on the financial market provoked a significant increase of travel needs not only between business partners within the company but most importantly with their customers who are more and more widespread over the world. The following figure shows the increase of total business and air travel between the years 2000 and 2004. The graph shows that the increase of travel activities is only partially explained by the increase of the revenue. According to the interviewees the noticeable growth in the year 2004 (516 to 721 Mio km per year) can be explained by an expansion of the strongly client orientated and global orientated business segments Wealth Management and Investment Banking.



Data source: Business report 2004 UBS Group (UBS 2004)

Figure 3-15: Development of business and air travel within the UBS Group

On average, according to the interviews, travel costs amount to 1-2% of the total costs. As can be seen in the graph, air transport is the most important one.

Most global companies in the finance and insurance sector outsource their business travel organisation to professional companies. The main reason for outsourcing is a higher professionalism of those agencies and economies of scope. According to the interview partners external travel agencies negotiate better contracts with airlines.

3.9.2 Congestion impact analysis

a) Reaction patterns, relevance of congestion

The interviews have shown that congestion in general is of no issue to the financial sector. Yet it turned out that there is a certain vulnerability to the service sector because of increasing capacity constraints and delays which occur in personnel transport – especially in the aviation sector. The interviewed travel managers stated that the relevance of delays and capacity constraints is quite high. This will become increasingly important in future since global service patterns of banking and insurance have increased travel activities significantly. The international travel activities of UBS (Switzerland) for instance have increased by 80% within the last 5 years. According to the interviewees, more compact flight schedules could be observed in the past 2–3 years and therefore delays in business travels occurred more frequently.

Commuter related congestion (of staff) is not directly relevant to companies in the banking sector. No claims for higher wages due to congestion problems have occurred so far. According to the human resources managements, congestion is regarded as a problem which is left to the employees. Delays of employees due to congestion would be hard to measure because of flexible working hours.

According to one interviewee congestion only indirectly affects the financial sector apart from business travels as congestion is considered a cost factor in the branch rating processes.

b) Congestion impact analysis

The impact analysis focuses on business travels as a very time sensitive segment of the financial sector. As stated above business travels are the only remarkable impacts of congestion that could be identified in this segment.

The interviewees underlined the difference between predictable and non predictable congestion. Predictable congestion would mean:

- rescheduled and cancelled flights announced by the airlines,
- well known recurring congestions on roads,
- early announced congestions on roads due to accidents, road works, etc or
- announced delays or cancelled trains due to technical defects, etc.

Whereas non predictable delays lead to longer travel times or missed meetings, also predictable delays cause certain costs for the company. The specific impacts of congestion on the financial sector can be summarized as follows:

a) increasing personnel costs due to longer travel times or unnecessary journeys (e.g. to the airport and back to the company)

b) higher administrative costs due to reorganising meetings and rebooking travels

c) image losses due to (repeatedly) missed meetings and delays at meetings with clients

It is obvious that companies are not able to quantify the sustained images losses which can be referred to delays and cancelled meetings with clients. Yet the image losses are rated as medium to little since the staff is usually able to explain delays or avoid delays by foresighted planning. Neither are the companies able to measure the (more relevant) costs of delays/capacity constraints (air and rail) and congestions (road) in terms of lost working times. According to the interviewees time keeping systems do not evaluate this type of working time. One interviewee pointed out that most kinds of congestion costs were indirect costs for the companies since direct costs such as the price of rebooked flights are carried by the airlines.

According to the interviews two types of business travels need to be differentiated: Client-facing business travels and business travels between business partners and segments. Since image losses can only be caused in client-facing business travels, congestion sensitivity varies over the different market segments. Furthermore client-intensive market segments such as Investment Banking or Private Banking show significantly higher travel intensity than other segments and are therefore even more affected by congestion.

The interviewees reported that the impact of congestion on the company has increased with the global expansion of the companies in the past 10 to 15 years. Apart from expanding geographically, the cause of longer business travels, the companies have also expanded their business fields and created new global orientated market segments (global asset management, global wealth management, etc.). This development created new headquarters in financial centres all over the world (mainly New York, Chicago, London, Singapore, Hong Kong). Only one company consolidated its market segments and thus has a lower volume of non client-facing business flights between business partners.

Summarizing the statements of the companies, one can state that the impact of congestion increases with:

a) the global orientation of the company,

b) the diversification of market segments of the company and

c) the share of client orientated business segments of the company

Regarding different transport modes the impact of congestion on business travels depends on the infrastructure of the different countries. According to the Swiss companies delays of the railways are of no consequence. Contrary to that road congestion frequently occurs.

Comparing different regions in Europe and the US, one can state that the major problems related to delays are located at the most important hubs, which are at the same time also important headquarters for the banking and insurance sector (such as London, Frankfurt and New York). However, according to one interviewee air travels is more frequent in the United States. Also, because there are less borders to cross there is less handling time for the domestic flights (1/2 hour instead of 1 hour). Therefore customs are also irrelevant.

3.9.3 Reaction patterns to congestion

a) Short term reactions

According to the interviews with persons in charge of travel management, short term reactions to congestions are rather limited. Despite the high relevance of delays in business travels out of the companies view there are in practice few possible measures to counteract congestion. The companies therefore leave it to the employees to handle delays by themselves. Hence employees nowadays tend to allow more extra time when planning business travels. Some employees for instance react to delays in aviation by booking earlier flights. Working on notebooks during waiting times in the airports or railway stations are other common reaction to delays.

Another visible strategy is the use of business jets within the high key and very time sensitive management segments of the sector.

Congestion has a partial influence on modal split of road – transport. Domestic business travelling in Switzerland is mainly done by rail due to its reliability and availability. In other countries modal split depends on infrastructure. In Germany, business travels will either be made by airplane, depending on the route (between two far away locations, i.e. Frankfurt – Berlin), by rail (finished ICE-routes) and partially by car (from the city to rural areas). The decisive factor is how fast the connection is. Congestion influences decisions regarding choice of transport insofar as congestion can be predicted.

To avoid congestion during commuter traffic bigger organisations offer incentives for the use of public transport. The reasons are mainly motivation and environmental aspects. One big company even built its own bus line and a train stop because of congestion problems during peak times.

b) Reaction patterns long term

The service sector has –due to increased costs in central urban areas – shifted several business units into suburban areas, such as less client intensive data processing and controlling activities. This is primarily an answer to increased land costs and not directly related to traffic congestion either. This indicates that urban sprawl can be, but must not be one of the causes of congestion.

According to environmental management congestion is not a selection criterion used for the choice of the location of branch offices. Online-banking reduced walk-in customers drastically. If locations are being closed, the periphery of the location is an issue, but congestion has only little if at all influence.

The interviews showed that the companies in the past 5 years have come up with several strategies to decrease transport intensity in general. Those strategies are

- Travel policies containing regulations regarding flight classes, travel modes, etc.
- Pre approval-systems where bosses can decide upon the necessity of business travels beforehand.
- Limited travel budgets.
- Video conferencing and conference calls.
- Bundling activities in foreign countries.

According to the interviews, these strategies are not directly related to congestion. More relevant are environmental aspects and especially costs.

3.9.4 Ideas and strategies to overcome congestion

The companies interviewed were quite pessimistic about measures to counteract congestion-especially in air traffic. The suggestions stated were infrastructure enlargements at the main hubs and on a national level a shift from road travels to rail travels. The latter suggestion would implicate an infrastructure enlargement and more time efficient railway organisation in some countries.

4 Index on vulnerability of the economy on congestion (IVEC)[5]

4.1 Aim of IVEC

Different economic sectors have different production functions, different transport intensities and different modal splits of the transport services needed. For some goods and services congestion has a more negative influence than for others. Because different countries have different sectoral structures the vulnerability of the economy on congestion could differ according to the sectoral structure. A second possibility is, that vulnerability on congestion differs as well for the same sector between countries, e.g. because efficiency of the organisation of the transport processes is different. The Index on vulnerability of the economy on congestion (IVEC) shall answer which reasons are how important and give an aggregate measure for the vulnerability of a country overall.

4.2 Methodology for calculating IVEC

The main idea of the IVEC is first to identify how vulnerable the different sectors of an economy are generally on congestion. After that this general judgement of sectoral vulnerability is applied for all counties considered. Because every country has different sectoral structures, a weighted measure of the vulnerabilites of all sectors in a country with the importance of this sector within the economy of a country will show the differences in vulnerability on congestion between different countries.

The IVEC analysis is based on the Input-Output-Tables of EU-25 and the US with the base year 2000. For calculating IVEC the following information is needed (the bullets below show as well the work steps needed):

- Transport intensities of different sectors for each of the countries (cost for transport in relation to total costs of intermediates within the production function of a sector)
- Qualitative evaluation of the vulnerability of the sectors to congestion (details in the following)
- Weighting the vulnerability with the economic importance of the specific sector per country.
- Development and calculation of an Index showing vulnerability to congestion of each sector per country and for a country overall.
- International comparison of an "Index on vulnerability of the economy to congestion" (IVEC) for some countries of the EU-25 und the US.

The "Index on vulnerability of the economy to congestion" (IVEC), which was developed particularly for this purpose, is defined as follows:

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5 Additional literature (not cited elsewhere) used for this chapter: Bremmer et al. (2004), Head et al. (1995), Koopmans, Kroes (2004), Hartwig (2005), NCHRP (2001), Schade et al. (2004), Spozavic (2001), US Department of Transportation (2005), Vanhove, De Ceuster (2003), Economic Development Research Group (2005), Washington Research Council (2001).

$\mathrm{Rat}_i = \mathrm{Rating\ of\ sensibility\ of\ sector}_i \mathrm{\ to\ congestion}$

$\mathrm{Rat}_M = \mathrm{Medium\ (3)\ rating\ on\ sensibility\ to\ congestion}$

$\mathrm{TI}_{i,j} = \mathrm{Transport\ intensity\ of\ sector}_i \mathrm{\ in\ country}_j$

$\mathrm{TI}_{i,AV} = \mathrm{Average\ transport\ intensity\ of\ sector}_i \mathrm{\ of\ all\ countries\ in\ comparison}$

$\mathrm{EcS}_{i,j} = \mathrm{Share\ of\ total\ output\ of\ sector}_i \mathrm{\ of\ country}_j \mathrm{\ on\ total\ output\ of\ country}_j$

$\mathrm{IVEC}_j = \mathrm{IVEC\ of\ country\ j}$

$$IVEC_j = \sum_i \left(\frac{Rat_M}{\sum_i Rat_i} * \frac{TI_{i,j}}{TI_{i,AV}} * EcS_{i,j} \right)$$

The IVEC of all countries in comparison allows a ranking and grouping of the countries according to their vulnerability on congestion.

4.3 Working steps for calculating IVEC

4.3.1 Selection of countries

The sample of countries in comparison shall contain countries from EU-15, countries from EU enlargement EU-10 and the US. The following 11 countries have been chosen to analyze and compare vulnerability on congestion:

- EU-15: Germany, France, Netherlands, Spain, United Kingdom, Finland, Denmark
- EU-10: Poland, Czech Republic, Hungary
- United States

For all these countries an Input-output-table for the year 2000 at basic prices was available from the OECD. The sectoral structure was not the same for all countries. The input-output-information has been converted consistently into a 36-sector raster for all countries (see following chapter).

4.3.2 Sectoral transport intensities per country

For calculating the IVEC, two main pieces of sectoral information are needed per country:

- Transport intensity per sector, calculated as cost for transport in the production function on total costs for intermediates per sector.
- Economic importance of each sector of a country on total output of a country

For all countries considered an IOT based 2000 (level total at basis prices) was available. We analysed them after converting all values to Euros. First of all we calculated the transport intensities for all countries as share of transport intermediate input in the production process as share of total intermediate input per sector. The following two tables show the results exemplarily for Poland, once as relative measure transport intensity per sector and once as total expenses for transport per sector.

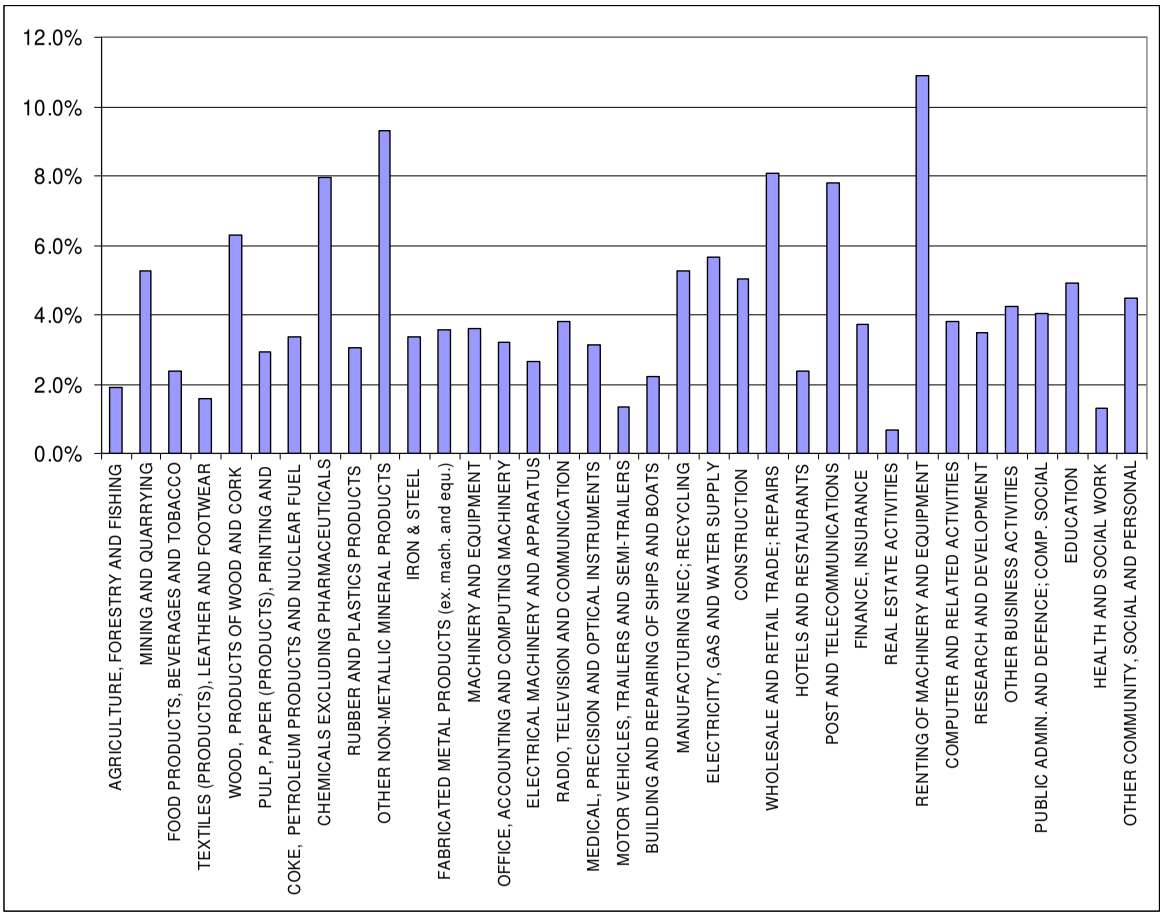


Figure 4-1: Transport intensity (e.g. transport costs in percent of GDP) of the economic sectors (Example of Poland 1995)

Renting of machinery and equipment has the highest transport intensity, followed by other non metallic mineral products and Chemicals, wholesale and retail trade and post and telecommunications.

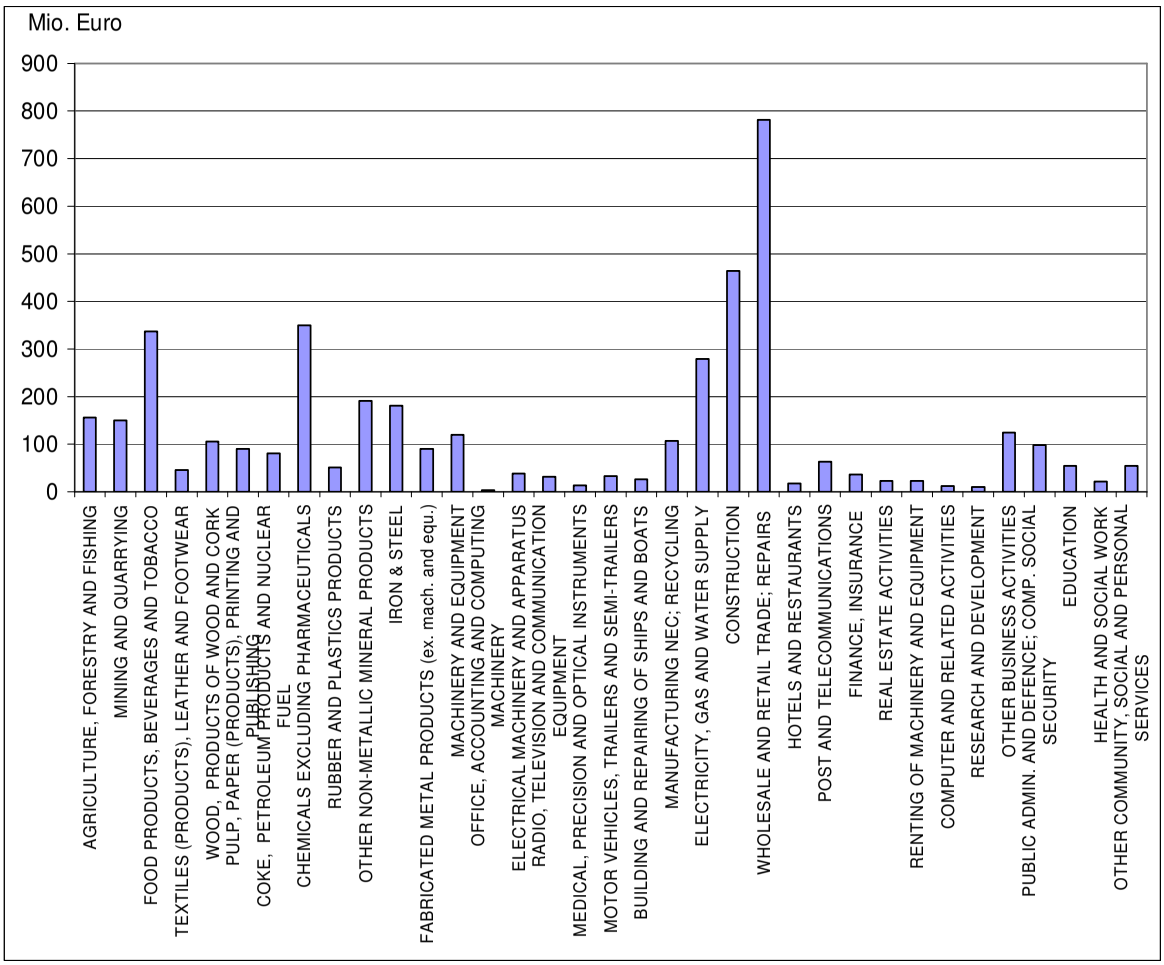


Figure 4-2: Transport expenses per sector (Example of Poland 1995)

In absolute figures transport expenses are highest in the sector wholesale and retail trade, followed by construction and chemicals, food products and manufacturing and recycling.

The following figure shows the comparison of the transport intensity per sector exemplarily for three countries of the analysis.

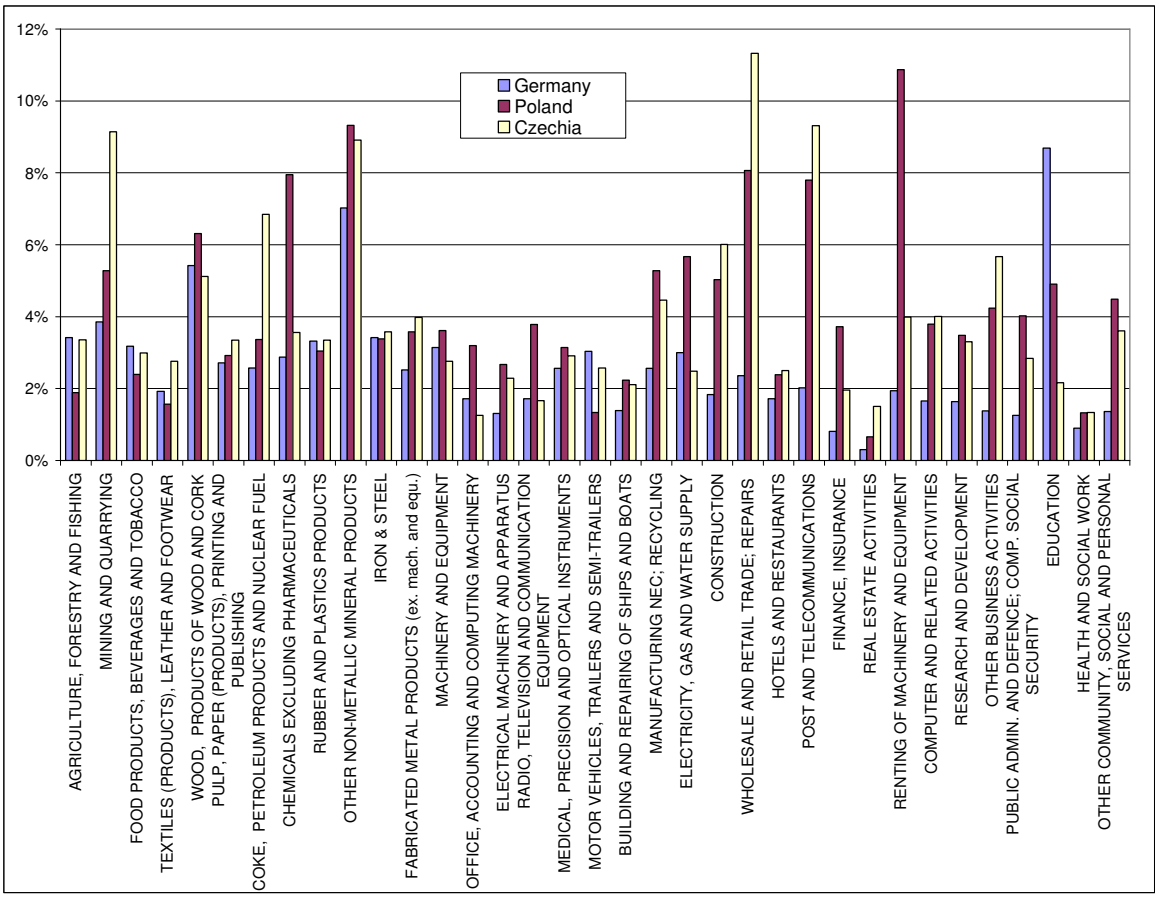


Figure 4-3: Transport intensities in comparison (Example Germany, Poland, Czechia)6

In Poland, Czechia and Germany the transport intensities are quite similar for a big part of the manufacturing sectors. But in the service sectors the transport intensity of Poland and Czechia is significantly higher apart from education. This might be a sign of the earlier shift to the third sector in Germany and therefore a longer time of improving and efficiency-increasing processes. The comparison between Czechia and Poland shows a quite homogeneous picture. Significant different transport intensities occur in the sectors Mining, Coke, Wholesale and post and communication where Poland has higher transport intensities. In renting of machinery and equipment Czechia has higher values.

6 The sector „Manufacturing NEC; RECYCLING“ contains the manufacturing “not elsewhere classified”, this means the sum of the sectors “production of furniture”, “jewellery”, “musical instruments”, “toys” and all “secondary raw materials”. The reason why this sector has a low transport intensity in Germany has to be analyzed further.

The following two tables show the needed input data from the input-output-tables for calculating the IVEC.

Table 4-1: Transport intensity for the 11 countries selected; cost for transport per sector on total cost of intermediates.

Transport Intensity		France	Germany	Denmark	Netherlands	Spain	Finland	United Kingdom	Poland	Hungary	Czechia	United States
1	AGRICULTURE, HUNTING, FORESTRY AND FISHING	3%	3%	1%	3%	5%	2%	1%	2%	2%	2%	5%
2	MINING AND QUARRYING	5%	3%	20%	2%	14%	20%	10%	10%	12%	14%	5%
3	FOOD PRODUCTS, BEVERAGES AND TOBACCO	3%	5%	3%	1%	2%	6%	5%	3%	2%	3%	5%
4	TEXTILES, TEXTILE PRODUCTS, LEATHER AND FOOTWEAR	2%	3%	3%	1%	3%	6%	4%	2%	1%	2%	5%
5	WOOD AND PRODUCTS OF WOOD AND CORK	4%	7%	3%	2%	2%	11%	4%	10%	3%	4%	7%
6	PULP, PAPER, PAPER PRODUCTS, PRINTING AND PUBLISHING	8%	3%	4%	5%	4%	10%	6%	4%	2%	3%	5%
7	COKE, REFINED PETROLEUM PRODUCTS AND NUCLEAR FUEL	2%	1%	1%	0%	3%	2%	1%	5%	4%	3%	4%
8/9	CHEMICALS INCL. PHARMACEUTICALS	3%	3%	6%	1%	5%	8%	5%	6%	3%	3%	5%
10	RUBBER AND PLASTICS PRODUCTS	1%	4%	4%	1%	4%	6%	5%	4%	2%	3%	7%
11	OTHER NON-METALLIC MINERAL PRODUCTS	10%	8%	9%	2%	8%	11%	15%	10%	8%	8%	14%
12/13	IRON & STEEL AND NON FERROUS STEEL	3%	4%	1%	1%	10%	5%	5%	6%	2%	2%	7%
14	FABRICATED METAL PRODUCTS, except machinery and equipment	2%	3%	3%	1%	4%	4%	4%	4%	2%	3%	4%
15	MACHINERY AND EQUIPMENT, N.E.C.	2%	4%	2%	1%	1%	3%	3%	4%	2%	2%	3%
16	OFFICE, ACCOUNTING AND COMPUTING MACHINERY	4%	3%	2%	1%	1%	2%	1%	6%	1%	0%	2%
17	ELECTRICAL MACHINERY AND APPARATUS, NEC	2%	1%	3%	2%	2%	2%	4%	3%	1%	1%	4%
18	RADIO, TELEVISION AND COMMUNICATION EQUIPMENT	1%	2%	1%	1%	1%	2%	3%	3%	1%	1%	4%
19	MEDICAL, PRECISION AND OPTICAL INSTRUMENTS	2%	4%	2%	2%	1%	2%	3%	5%	2%	0%	4%
20	MOTOR VEHICLES, TRAILERS AND SEMI-TRAILERS	1%	4%	2%	1%	2%	5%	3%	5%	1%	2%	3%
21/22/23	BUILDING AND REPAIRING OF SHIPS AND BOATS, AIRCRAFT, SPACECRAFT, RAILROA	1%	1%	1%	2%	1%	2%	2%	3%	2%	0%	3%
24	MANUFACTURING NEC; RECYCLING	3%	3%	6%	2%	10%	5%	4%	5%	4%	2%	5%
25	ELECTRICITY, GAS AND WATER SUPPLY	1%	2%	1%	1%	20%	10%	0%	5%	5%	1%	18%
26	CONSTRUCTION	2%	2%	2%	2%	1%	4%	1%	4%	5%	3%	4%
27	WHOLESALE AND RETAIL TRADE; REPAIRS	12%	3%	26%	10%	5%	15%	23%	17%	14%	6%	5%
28	HOTELS AND RESTAURANTS	4%	2%	0%	5%	4%	5%	4%	1%	2%	0%	3%
29	TRANSPORT AND STORAGE	59%	53%	66%	28%	40%	34%	38%	30%	15%	50%	24%
30	POST AND TELECOMMUNICATIONS	1%	1%	9%	35%	2%	9%	8%	2%	2%	2%	2%
31	FINANCE, INSURANCE	1%	1%	2%	21%	3%	7%	7%	1%	1%	1%	3%
32	REAL ESTATE ACTIVITIES	3%	0%	1%	6%	0%	2%	2%	2%	2%	1%	2%
33	RENTING OF MACHINERY AND EQUIPMENT	3%	0%	6%	3%	3%	4%	11%	3%	3%	4%	6%
34	COMPUTER AND RELATED ACTIVITIES	4%	1%	4%	7%	5%	7%	2%	5%	1%	1%	3%
35	RESEARCH AND DEVELOPMENT	3%	2%	5%	3%	3%	8%	2%	4%	3%	2%	4%
36	OTHER BUSINESS ACTIVITIES	6%	2%	3%	5%	4%	5%	5%	3%	2%	1%	2%
37	PUBLIC ADMIN. AND DEFENCE; COMPULSORY SOCIAL SECURITY	5%	6%	11%	7%	11%	7%	3%	4%	2%	0%	5%
38	EDUCATION	7%	15%	10%	4%	11%	7%	8%	4%	3%	2%	3%
39	HEALTH AND SOCIAL WORK	3%	1%	9%	6%	4%	8%	3%	1%	1%	1%	3%
40	OTHER COMMUNITY, SOCIAL AND PERSONAL SERVICES	3%	2%	5%	8%	4%	7%	3%	3%	4%	1%	5%

Source: own calculations based on input-output-tables

Table 4-2: Economic importance of the sectors on total output per country

	Economic Importance of the sectors on total output	France	Germany	Denmark	Netherlands	Spain	Finland	United Kingdom	Poland	Hungary	Czechia	United States
1	AGRICULTURE, HUNTING, FORESTRY AND FISHING	3%	1%	3%	3%	4%	3%	1%	4%	5%	3%	1%
2	MINING AND QUARRYING	0%	0%	2%	2%	0%	0%	2%	2%	0%	1%	1%
3	FOOD PRODUCTS, BEVERAGES AND TOBACCO	5%	4%	5%	6%	11%	3%	3%	7%	6%	5%	3%
4	TEXTILES, TEXTILE PRODUCTS, LEATHER AND FOOTWEAR	1%	1%	1%	1%	3%	1%	1%	2%	3%	2%	1%
5	WOOD AND PRODUCTS OF WOOD AND CORK	0%	1%	1%	0%	1%	2%	0%	1%	1%	1%	1%
6	PULP, PAPER, PAPER PRODUCTS, PRINTING AND PUBLISHING	2%	2%	2%	2%	3%	8%	3%	2%	2%	2%	3%
7	COKE, REFINED PETROLEUM PRODUCTS AND NUCLEAR FUEL	2%	1%	1%	2%	2%	2%	1%	2%	2%	1%	1%
8/9	CHEMICALS INCL. PHARMACEUTICALS	3%	3%	2%	5%	4%	2%	2%	2%	3%	2%	2%
10	RUBBER AND PLASTICS PRODUCTS	1%	1%	1%	1%	2%	1%	1%	1%	1%	2%	1%
11	OTHER NON-METALLIC MINERAL PRODUCTS	1%	1%	1%	1%	2%	1%	1%	2%	1%	2%	1%
12/13	IRON & STEEL AND NON FERROUS STEEL	1%	2%	0%	1%	3%	3%	1%	2%	2%	2%	1%
14	FABRICATED METAL PRODUCTS, except machinery and equipment	2%	2%	2%	2%	3%	2%	1%	2%	2%	3%	1%
15	MACHINERY AND EQUIPMENT, N.E.C.	2%	4%	3%	2%	2%	4%	2%	2%	2%	3%	2%
16	OFFICE, ACCOUNTING AND COMPUTING MACHINERY	0%	0%	0%	0%	0%	0%	1%	0%	4%	1%	3%
17	ELECTRICAL MACHINERY AND APPARATUS, NEC	1%	2%	1%	0%	1%	1%	1%	1%	3%	3%	1%
18	RADIO, TELEVISION AND COMMUNICATION EQUIPMENT	1%	1%	1%	1%	1%	8%	1%	1%	4%	1%	0%
19	MEDICAL, PRECISION AND OPTICAL INSTRUMENTS	1%	1%	1%	0%	0%	1%	1%	0%	0%	1%	0%
20	MOTOR VEHICLES, TRAILERS AND SEMI-TRAILERS	4%	5%	0%	1%	7%	0%	2%	2%	6%	5%	3%
21/22/23	BUILDING AND REPAIRING OF SHIPS AND BOATS, AIRCRAFT, SPACECRAFT, RAILROA	2%	1%	0%	1%	1%	1%	1%	1%	0%	0%	1%
24	MANUFACTURING NEC; RECYCLING	1%	1%	1%	1%	2%	1%	1%	1%	1%	2%	0%
25	ELECTRICITY, GAS AND WATER SUPPLY	2%	2%	2%	2%	2%	2%	3%	3%	3%	5%	2%
26	CONSTRUCTION	6%	6%	7%	8%	12%	7%	7%	9%	5%	9%	5%
27	WHOLESALE AND RETAIL TRADE; REPAIRS	8%	10%	11%	11%	6%	8%	11%	15%	9%	8%	10%
28	HOTELS AND RESTAURANTS	3%	2%	2%	2%	6%	2%	3%	1%	2%	2%	3%
29	TRANSPORT AND STORAGE	5%	4%	9%	5%	4%	6%	6%	5%	4%	6%	3%
30	POST AND TELECOMMUNICATIONS	2%	2%	2%	2%	2%	2%	3%	2%	2%	2%	4%
31	FINANCE, INSURANCE	5%	5%	4%	5%	2%	3%	7%	3%	3%	3%	8%
32	REAL ESTATE ACTIVITIES	7%	9%	7%	5%	2%	7%	6%	5%	5%	4%	8%
33	RENTING OF MACHINERY AND EQUIPMENT	1%	2%	0%	1%	0%	0%	1%	1%	0%	1%	1%
34	COMPUTER AND RELATED ACTIVITIES	2%	1%	2%	2%	0%	1%	2%	1%	1%	1%	1%
35	RESEARCH AND DEVELOPMENT	1%	1%	0%	0%	0%	0%	0%	0%	0%	0%	4%
36	OTHER BUSINESS ACTIVITIES	8%	7%	5%	7%	4%	3%	8%	5%	5%	5%	6%
37	PUBLIC ADMIN. AND DEFENCE; COMPULSORY SOCIAL SECURITY	5%	4%	5%	6%	2%	4%	5%	4%	4%	3%	10%
38	EDUCATION	3%	3%	4%	2%	1%	3%	4%	3%	2%	2%	1%
39	HEALTH AND SOCIAL WORK	5%	5%	7%	5%	2%	5%	5%	3%	3%	2%	5%
40	OTHER COMMUNITY, SOCIAL AND PERSONAL SERVICES	3%	4%	4%	4%	2%	3%	4%	3%	3%	3%	3%

Source: own calculations based on input-output-tables

4.3.3 Qualitative evaluation of the vulnerability of the sectors to congestion

The analysis in the main report of COMPETE has shown clearly the most relevant elements in the context congestion and economic consequences, such as the transport intensity, the relevance of "Just in Time" production patterns, the involvement in transport chain issues, the perishableness of goods, the relevance on the demand side e.g. for delivery to clients in urban areas and the quality of infrastructure.

The next working step was the valuation of the qualitative sensitiveness of the single sectors on congestion. The following four criteria are most important to valuate the sector in this field:

- Perishableness of the products: The higher the degree of perishable goods, the higher the importance of transport time and reliability and the vulnerability of a sector to congestion.
- Importance of quick transport for further value added chain: The more time sensitive end users or next sectors in the value chain, the higher the vulnerability of a sector to congestion.

- Importance of time reliability of transport: If in general reliability is an important quality for transport demand (e.g. beside transport price), the vulnerability of a sector to congestion is increasing.
- Difficulties of enterprises to react on congestion (time or space): If there are limited possibilities for a sector in the short run, the vulnerability to congestion is increasing.

Each sector is ranked for all four criteria. Each criteria can be ranked as 1 “very high”, 2 “high”, 3 “medium”, 4 “rather low” or 5 “hardly”.

The following table shows the qualitative evaluation of the vulnerability of the sectors to congestion.

Table 4-3: Qualitative evaluation of the vulnerability of the sectors to congestion

Sector Number		Deleteriousness of the Products	Importance of quick transport for further value added chain	Importance of time reliability of transport	Difficulties of enterprises to react on congestion (time or space)
1	AGRICULTURE, HUNTING, FORESTRY AND FISHING	1	2	2	1
2	MINING AND QUARRYING	5	3	3	2
3	FOOD PRODUCTS, BEVERAGES AND TOBACCO	2	3	1	2
4	TEXTILES, TEXTILE PRODUCTS, LEATHER AND FOOTWEAR	4	4	3	4
5	WOOD AND PRODUCTS OF WOOD AND CORK	5	3	3	3
6	PULP, PAPER, PAPER PRODUCTS, PRINTING AND PUBLISHING	5	2	2	2
7	COKE, REFINED PETROLEUM PRODUCTS AND NUCLEAR FUEL	5	2	2	2
8	CHEMICALS EXCLUDING PHARMACEUTICALS	4	2	2	2
9	PHARMACEUTICALS	3	2	1	2
10	RUBBER AND PLASTICS PRODUCTS	4	2	2	4
11	OTHER NON-METALLIC MINERAL PRODUCTS	5	3	3	4
12	IRON & STEEL	5	2	2	4
13	NON-FERROUS METALS	5	2	2	3
14	FABRICATED METAL PRODUCTS, except machinery and equipment	5	2	2	4
15	MACHINERY AND EQUIPMENT, N.E.C.	5	2	2	3
16	OFFICE, ACCOUNTING AND COMPUTING MACHINERY	4	3	3	4
17	ELECTRICAL MACHINERY AND APPARATUS, NEC	5	3	2	4
18	RADIO, TELEVISION AND COMMUNICATION EQUIPMENT	4	2	2	3
19	MEDICAL, PRECISION AND OPTICAL INSTRUMENTS	4	2	1	3
20	MOTOR VEHICLES, TRAILERS AND SEMI-TRAILERS	5	2	2	3
21	BUILDING AND REPAIRING OF SHIPS AND BOATS	5	2	3	2
22	AIRCRAFT AND SPACECRAFT	5	2	3	2
23	RAILROAD EQUIPMENT AND TRANSPORT EQUIPMENT N.E.C.	5	2	2	3
24	MANUFACTURING NEC; RECYCLING	5	3	4	3
25	ELECTRICITY, GAS AND WATER SUPPLY	3	2	1	1
26	CONSTRUCTION	5	2	2	2
27	WHOLESALE AND RETAIL TRADE; REPAIRS	2	2	2	3
28	HOTELS AND RESTAURANTS	3	3	3	2
29	TRANSPORT AND STORAGE	2	1.5	1	1
30	POST AND TELECOMMUNICATIONS	2	1	1	3
31	FINANCE, INSURANCE	4	3	3	2
32	REAL ESTATE ACTIVITIES	4	4	3	3
33	RENTING OF MACHINERY AND EQUIPMENT	3	2	2	2
34	COMPUTER AND RELATED ACTIVITIES	3	1	2	3
35	RESEARCH AND DEVELOPMENT	4	4	4	3
36	OTHER BUSINESS ACTIVITIES	3	2	2	2
37	PUBLIC ADMIN. AND DEFENCE; COMPULSORY SOCIAL SECURITY	4	4	4	2
38	EDUCATION	4	4	2	2
39	HEALTH AND SOCIAL WORK	2	2	2	1
40	OTHER COMMUNITY, SOCIAL AND PERSONAL SERVICES	3	4	3	2

Source: own elaborations

The following table shows the vulnerability on congestion for the differentiated sectors as result of the qualitative evaluation (shown in the table above) and a proportional weighting of all four dimension of vulnerability looked at.

Table 4-4: Vulnerability of the sectors to congestion resulting from the qualitative evaluation

	Sector	Indicator for importance of transport within the Country (>100 more than average of country mean)	Indicator for importance of transport in international comparison (>100 more than level 3 "medium)
1	AGRICULTURE, HUNTING, FORESTRY AND FISHING	187	200
2	MINING AND QUARRYING	86	92
3	FOOD PRODUCTS, BEVERAGES AND TOBACCO	140	150
4	TEXTILES, TEXTILE PRODUCTS, LEATHER AND FOOTWEAR	75	80
5	WOOD AND PRODUCTS OF WOOD AND CORK	80	86
6	PULP, PAPER, PAPER PRODUCTS, PRINTING AND PUBLISHING	102	109
7	COKE, REFINED PETROLEUM PRODUCTS AND NUCLEAR FUEL	102	109
8/9	CHEMICALS INCL. PHARMACEUTICALS	118	126
10	RUBBER AND PLASTICS PRODUCTS	93	100
11	OTHER NON-METALLIC MINERAL PRODUCTS	75	80
2/13	IRON & STEEL AND NON FERROUS STEEL	90	96
14	FABRICATED METAL PRODUCTS, except machinery and equipment	86	92
15	MACHINERY AND EQUIPMENT, N.E.C.	93	100
16	OFFICE, ACCOUNTING AND COMPUTING MACHINERY	80	86
17	ELECTRICAL MACHINERY AND APPARATUS, NEC	80	86
18	RADIO, TELEVISION AND COMMUNICATION EQUIPMENT	102	109
19	MEDICAL, PRECISION AND OPTICAL INSTRUMENTS	112	120
20	MOTOR VEHICLES, TRAILERS AND SEMI-TRAILERS	93	100
2/23	BUILDING AND REPAIRING OF SHIPS AND BOATS, AIRCRAFT, SPACECR	93	100
24	MANUFACTURING NEC; RECYCLING	75	80
25	ELECTRICITY, GAS AND WATER SUPPLY	160	171
26	CONSTRUCTION	102	109
27	WHOLESALE AND RETAIL TRADE; REPAIRS	125	133
28	HOTELS AND RESTAURANTS	102	109
29	TRANSPORT AND STORAGE	204	218
30	POST AND TELECOMMUNICATIONS	160	171
31	FINANCE, INSURANCE	93	100
32	REAL ESTATE ACTIVITIES	80	86
33	RENTING OF MACHINERY AND EQUIPMENT	125	133
34	COMPUTER AND RELATED ACTIVITIES	125	133
35	RESEARCH AND DEVELOPMENT	75	80
36	OTHER BUSINESS ACTIVITIES	125	133
37	PUBLIC ADMIN. AND DEFENCE; COMPULSORY SOCIAL SECURITY	80	86
38	EDUCATION	93	100
39	HEALTH AND SOCIAL WORK	160	171
40	OTHER COMMUNITY, SOCIAL AND PERSONAL SERVICES	93	100
	Total	100	107

This rating of the vulnerability of the sectors on congestion is valid for all countries and gives information about the vulnerability on congestion based on the characteristics of a special sector. The table shows how vulnerable each sector is due to his general attributes of the goods produced, due to the specific production function, the degree of division of work and the different value added chain.

An example how to read the table: “Food products” for example have a higher vulnerability on congestion than the mean of the sectors (first column of indicators) and ”health” is more vulnerable on congestion than “medium” (medium is - as explained equal - to the value “3” in the table before).

The qualitative ranking of vulnerability of the sectors, the economic importance as share in percentage points of total output, the transport intensity in percentage points per sector and country are the basic information for calculating the final IVEC.

If the different sectoral structures of the countries in conjunction with the qualitative evaluation do not fully explain the different degrees of national vulnerabilities, the different transport intensities of a specific sector between the countries may contain additional information for explaining different vulnerabilities on congestion between countries.

4.4 Results for the 11 selected countries

The IVEC has been calculated for 11 countries based on the input-output-tables of all these countries with base year 2000. The following table shows the results for the 11 countries selected. A lower index indicates a lower vulnerability, an IVEC of 100 shows a "medium" vulnerability on congestion.

Table 4-5: Index of vulnerability on congestion, year 2000.; source: own calculation

Country	Ranking	IVEC	Grouping
Czechia	1	78	80-100
Germany	2	86	
Hungary	3	91	
United States	4	112	101-120
France	5	117	
Spain	6	120	
Poland	7	125	121-140
United Kingdom	8	143	141-180
Netherlands	9	156	
Finland	10	167	
Denmark	11	172	

Having the information of vulnerability on congestion per countries we wanted to group the analysed countries into different categories. The aim of this is to see similarities in specific structures (and combination of characteristics) of economies making them less or more vulnerable to congestion. The following figure shows the functional grid tried to apply.

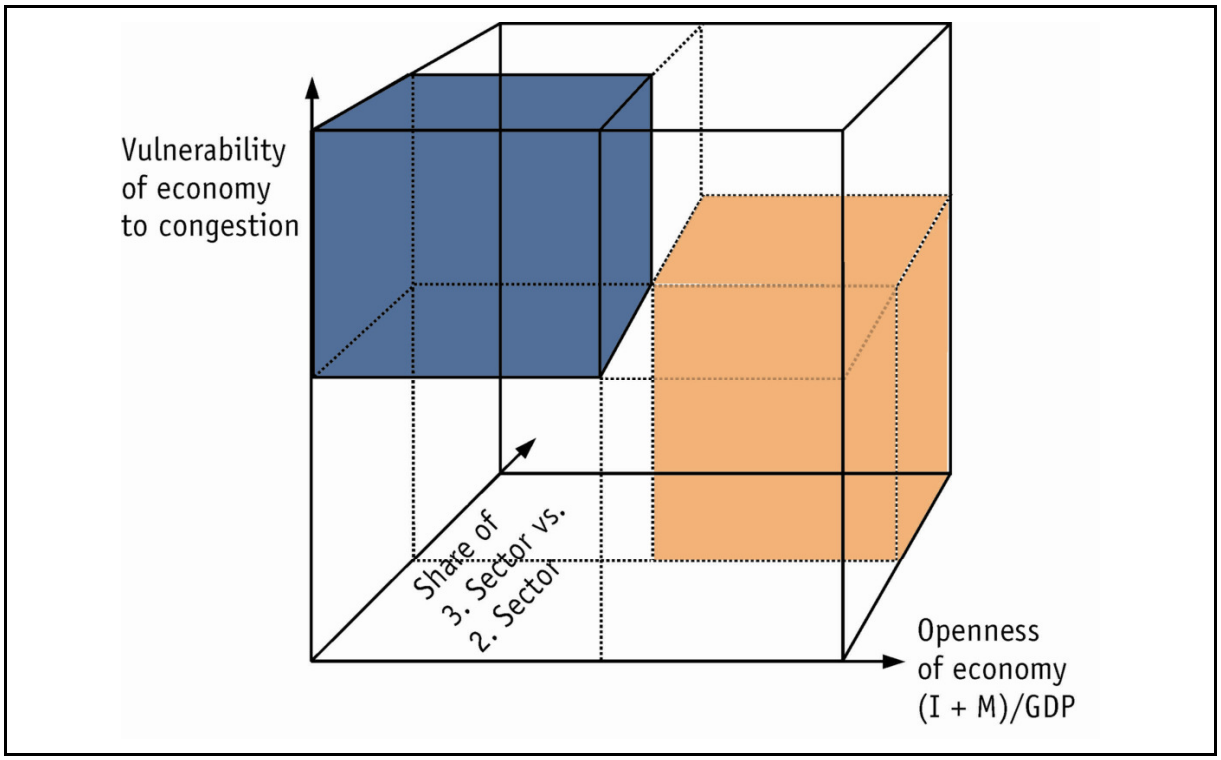


Figure 4-4: Grid for grouping countries with different vulnerability to congestion.

The cube in the figure above has 8 segments and the countries analysed were positioned within. It showed up that this attempt to explain the differences failed.

Generally four Groups of countries may be identified:

- Group 1 "Low vulnerability": Czechia, Germany, Hungary (IVEC < 100)
- Group 2: "Mean vulnerability": US, France, Spain (IVEC between 101-120)
- Group 3 "Increased vulnerability": Poland (IVEC between 121-140)
- Group 4 "high vulnerability": United Kingdom, Netherlands, Finland, Denmark (IVEC > 141)

The Hypothesis of IVEC is, that vulnerability of a country is high, if the goods and services from sectors that have most importance are vulnerable according to the four indicators

- deleteriousness of products
- importance of quick transport
- importance of reliable transport
- possibilities of substitution to other transport mode or product

The analysis of the four group showed, that the different degrees of vulnerability on congestion is not only due to the sectoral structures of the countries. Another important reason of the different vulnerability is the fact that countries of group 3 and 4 with increased and high vulnerability show higher transport intensities for the country overall and for the single sectors than the countries of group 1 and 2. The following table shows estimates on which part of IVEC is explainable through the different structure of the sectors and which part through different transport intensities for same sectors or the country overall.

Table 4-6: Degree of explanation of IVEC through differences in the sectoral structure, year 2000. Source: own calculation.

Country	IVEC	Explained through different structure of sectors	Explained through different transport intensity of country overall
Czechia	78	2%	98%
Germany	86	5%	95%
Hungary	91	36%	64%
United States	112	35%	65%
France	117	20%	80%
Spain	120	51%	49%
Poland	125	20%	80%
United Kingdom	143	9%	91%
Netherlands	156	40%	60%
Finland	167	33%	67%
Denmark	172	28%	72%

The table shoes that hypothesis that high vulnerability on congestion of countries is because they have strong sectors that produce goods and services that are especially sensitive on congestion holds partly true for Hungary, United States, Spain, Netherlands, Finland and Denmark, France and Poland. In these countries the sectoral structure of the economy explains between 20%-51% of differences in vulnerability on congestion. For Czechia, Germany and United Kingdom sectoral structure explains less than 10% of vulnerability of the countries. For all countries it is to conclude that the degree of vulnerability of a country is as well influenced by other factors than the sectoral structure. If we would rank the countries according to their transport intensity per country the ranking would look quite similar as with IVEC. Hungary, Spain and Poland would be ranked a bit bitter than according IVEC.

This means IVEC gives a good impression of the vulnerability of the countries on congestion but the differences are as well due to differing transport intensities of the single sectors between countries.

The question arising is, why is there such a difference between the transport intensities between the countries?

Differences of transport intensity of one and the same sector in comparison between countries may arise due the differences in efficiency of the transport system or due to differences in operating costs. When comparing different operating costs and IVEC per country it gets obvious that road operating cots show the closest relation with IVEC. This means that the level of operating road costs is a good indicator for the level of expenditures for transport in a country.

Only a small part of the different share of expenditures for transport on total expenditures for intermediates may be due to differences in the efficiency of transport sector, because mainly on the road and rail transport sector competitiveness is high. Because the transport on roads is most important in all of the countries considered, the differences in the costs for transport of passengers and mainly freight have to be considered. This is a direct link the chapter operating costs in this study, where is shown, that differences in transport costs per vehicle kilometre are mainly due to different tax systems.

This means a country is more vulnerable on congestion if:

- personal costs (of the drivers) are high
- taxes on transport or fuel are high
- the sectoral structure shows that the most important sectors of a country specifically sensible on transport

Additional indicators are

- the regional structure of the countries that may be connected with shorter or longer average transport distances between several levels of the production process and value added chain. US or Finland e.g. have rather long distances for transport per unit. This parameter is included in IVEC because longer distances are one reason for higher transport costs and therefore higher transport intensity
- the quality of the infrastructure. This parameter is very important. Even if transport intensities in a country are low and only sectors with low vulnerability on congestion are important, congestion may be a problem for the economy because of the low quality of the (road) infrastructure.

The following table shows a qualitative overview over the vulnerability of the countries selected over the five parameters shown above. The first four parameters are included in the IVEC, the fifth is separately shown. The qualitative judgement on the overall vulnerability on congestion constitutes an aggregation of the two qualitative rows.

Table 4-7: Vulnerability on congestion

Country	IVEC	IVEC qualitatively	Quality of infrastructure road*	**Overall vulnerability on congestion**
Czechia	78	+	0	**+**
Germany	86	+	+	**++**
Hungary	91	+	+	**++**
United States	112	-	0	**-**
France	117	-	++	**+**
Spain	120	-	0	**-**
Poland	125	-	--	**--**
United Kingdom	143	--	+	**-**
Netherlands	156	--	++	**0**
Finland	167	--	+	**-**
Denmark	172	--	0	**--**

** sources: CEDR 2004 and COMPETE report, Annex 3 (Panorama of congestion: country reports, e.g. for Poland, etc.).*

The overall ranking of the countries considered on vulnerability on congestion results then as follows:

Table 4-8: Overall ranking of the vulnerability on congestion of the 11 countries considered

Country	**Overall vulnerability on congestion**
Germany	++
Hungary	++
Czechia	+
France	+
Netherlands	0
United States	-
Spain	-
United Kingdom	-
Finland	-
Poland	--
Denmark	--

The countries highly vulnerable on congestion are Poland and Denmark, Denmark due to its high road transport operating cost and due to its sectoral structure, Poland due to the bad quality of infrastructure and a rather inefficient transport sector. A significant vulnerability on congestion is observed for United States, UK, Spain and Finland. The Netherlands have a sectoral structure that is quite vulnerable. The good quality of infrastructure helps The Netherlands to be medium vulnerable on congestion overall. Czechia and France reveal a reduced vulnerability on congestion. France shows a reduced vulnerability mostly due to the good infrastructure. Czechia faces quite low road transport operating costs. A quite low vulnerability on congestion is estimated for Hungary and Germany. Hungary has quite low road transport operating costs, Germany a quite efficient transport sector and both countries disposes of a good quality of road infrastructure. Additionally, Hungary shows a favourable sectoral structure in relation to vulnerability on congestion.

The IVEC does not show whether a country suffers today from congestion, but whether the economic structure of a country (of sectors and transport intensity per sector) is generally more or less vulnerable on congestion. This means if two countries have already a similar high level of congestion, the country with a higher IVEC will be more negatively influenced in its economic performance due to the specific sectoral structure.

In countries with much congestion and a high structural vulnerability of the economy on congestion the economy is most negatively influenced by congestion and suffering from losses in economic competitiveness due to congestion. Additional infrastructure investments seem most effective in countries where the indicator of the economy to congestion is high and the actual level of service (on roads and rail) is low. Whereas UK, the Netherlands and Germany are highly congested, the general impact of congestion to national economy will be more relevant in UK and the Netherlands than in Germany, since these countries face a high vulnerability indicator.

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