Benchmarking Intermodal Freight Transport

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ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

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– to achieve the highest sustainable economic growth and employment and a rising standard of living in Member countries, while maintaining financial stability, and thus to contribute to the development of the world economy;

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Transport intermodal de marchandises

UNE ÉVALUATION COMPARATIVE

FOREWORD

The mission of the OECD Programme of Research on Road Transport and Intermodal Linkages (RTR) is to promote economic development in its Member countries by enhancing transport safety, efficiency and sustainability through a co-operative research programme on road and intermodal transport. To achieve this objective, the Programme recommends options for the development and implementation of effective transport policies for Members, and encourages outreach activities for non-member countries. All 30 Member countries participate in the Programme.

The 1998-2000 Programme included a mandate for the establishment of an Intermodal Freight Transport Advisory Group. The Intermodal Freight Transport Advisory Group is examining key topics focusing on critical aspects of the role of governments in promoting intermodal transport including:

- Institutional aspects.
- Benchmarking intermodal freight transport performance.
- Urban freight logistics.
- International freight corridor development.

These topics are being addressed in sequence. This report on *Benchmarking Intermodal Freight Transport* represents the second output of the Intermodal Freight Transport Advisory Group, following the 2001 report on *Intermodal Freight Transport: Institutional Aspects*. It is published on the responsibility of the Secretary-General of the OECD.

ABSTRACT

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The global marketplace requires integrated, intermodal transport systems. An important issue in dealing with this challenge is to assess which mode or modal combination, including transfer points, offers the "best" overall level of performance. Benchmarking is an instrument which can help answer this question. It aims to improve performance by identifying best practices, analysing the reasons for differences in performance and suggesting potential changes that could be introduced by decision makers.

The issue of identifying appropriate benchmarks that could be applied to assess the relative efficiency of transport chains was investigated by the Intermodal Freight Transport Advisory Group, which was established by the Steering Committee for the Programme of Research on Road Transport and Intermodal Linkages (RTR) in 1998. This is the second report prepared by the Group, following its 2001 report *Intermodal Freight Transport: Institutional Aspects*.

The report summarises the outcomes of the analysis of benchmarks studied and used in OECD Member countries, and provides recommendations to policy makers for conducting effective benchmarking exercises to improve system performance.

Field classification	Economic and administration; environment; traffic and transport planning.
Field codes	10; 72.
Keywords	Decision process; economic efficiency; economics of transport; evaluation (assessment); freight transport; intermodal transport (freight); logistics; OECD.

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EXECUTIVE SUMMARY

Background

The Organisation for Economic Co-operation and Development (OECD) has an ongoing commitment to freight-related transport research. The Programme of Research on Road Transport and Intermodal Linkages (RTR) for the 1998-2000 period had three key elements:

- Multimodal transport strategies.
- Economic performance, transport infrastructure and management.
- Sustainable development.

The RTR Steering Committee established the Intermodal Freight Transport Advisory Group to investigate four topics:

- Institutional aspects of intermodal transport.
- Benchmarking and system performance measures.
- Economic and fiscal instruments.
- International freight corridor development.

Each of the above topics is being addressed in sequence. Work on the subject of institutional aspects has been completed, and the conclusions have been published in OECD (2001), *Intermodal Freight Transport: Institutional Aspects.*

The overall focus of the work on "benchmarking" is centred on comparing the relative efficiency of modes, modal combinations and modal interfaces. Government policy makers (along with transport industry and logistics service providers) have an interest in the efficiency (including time, cost and reliability), safety and sustainability of transport systems, although at a more aggregate level than the private sector. The Working Group was asked to develop a vision for intermodal transport and to identify appropriate benchmarks that could be applied to assess the relative efficiency of modes/modal combinations and intermodal transfers, and to identify sources of inefficiency that could contribute to modal choice.

In line with the original intent of the project, the benchmarking analysis also seeks to develop policy options for governments to address impediments to intermodal transport efficiency, encompassing institutional aspects, technology, including the role of intelligent transportation systems (ITS) and infrastructure. As such, the focus is on organisational aspects, from a government public policy perspective, rather than on the performance of industry players. The conclusions should be seen as a guide to improving system performance, rather than a regulatory framework.

This report summarises the outcomes of the following tasks, with contributions from each of the Member countries that were associated with the Working Group:

- A review of studies on benchmarking and the available data.
- An analysis of benchmarks used in Member countries to assess the performance of modes, modal combinations and the performance of ports and terminals at the modal interface.
- An analysis of benchmarks currently applied by Member countries to key transport corridors and commodities.
- A compendium of benchmarking studies available in Member countries.
- A summary of benchmarking methodologies.

Each of the four studies undertaken by the Advisory Group uses the following definition as a baseline for intermodal transport:

> *Intermodalism implies the use of at least two different modes of transport in an integrated manner in a door-to-door transport chain.*

While the concept of intermodalism encompasses all freight movements involving two or more modes of transportation, the principal focus in this study was on movement of non-bulk and containerised freight.

Overview

The global marketplace requires integrated, intermodal, single-waybill transport chains. An important issue in dealing with this challenge is to assess which mode or modal combination is the best. Benchmarking is an instrument which can help to answer this question.

Differences in the performance of various modes within the transport sector of a given country, and between the transport systems of different countries, imply that there is a significant potential for improvement. Ongoing technological advances and changes in institutional approaches ensure that this potential is constantly evolving. The transportation sector is influenced and moulded by ongoing economic, environmental and political (usually in the form of public finances) pressures to realise its potential for improvement.

Benchmarking has been identified as a tool for identifying potential improvements in the transport sector. It aims to improve performance by identifying best performance and best practices, analysing the reasons for differences and suggesting potential changes that could be implemented by decision makers.

The decision makers, or target groups, of these efforts include policy makers, infrastructure and facility operators, shippers and transport operators. Each of these target groups is a unique, but at the same time, essential component of the overall integrated transportation system. As such, each target group has its own motivation for employing tools such as benchmarking to identify potential improvements in the transport sector.

Lessons learned

Analysis of existing benchmarking studies has shown that different benchmarking methods are used for different purposes. The methods chosen depend on the stakeholders and their objectives for conducting the benchmarking exercise, since different objectives require different indicators.

Governments are responsible for national transportation and intermodal policy. Policy makers want to know if the direction they are proceeding along is the right one, how their policies affect the development of intermodal transport and how they compare to other countries. Included in these considerations is the support of economic growth, facilitation of the competitive position of national carriers in a global market, improved efficiency leading to decreased cost, and the reduction of environmental and social costs.

Facility operators, such as terminal and other infrastructure operators, aim to operate as efficiently as possible. Benchmarking offers an opportunity to compare the efficiency, service level and cost of their operations to similar services offered by other operators on a national and international scale.

Shippers make their choices based on the relative performance of the different transport modes. Factors such as cost, transit time, reliability and services offered influence their choices. Comparative analysis allows shippers to make sound decisions, based on their needs and priorities.

Transport operators need to know how their performance compares to other transportation companies. In an era of global competitiveness and pressure from environmental and social concerns, companies are increasingly interested in identifying, adopting and implementing recognised “best practices”.

In conducting benchmarking exercises, care needs to be taken when drawing conclusions from such applications, for two reasons. First, both supply chains and interactions between transport policies and other driving forces of transport demand are becoming increasingly complex, and second, there are limitations to availability of relevant and comparable data.

Global supply chains involving intermodal transport are longer, more complex and inherently more expensive. In a just-in-time environment, all stakeholders are intent on identifying more efficient and productive approaches to reduce transport costs and eliminate impediments to improved efficiency. Comparative analysis and the identification of best practices is one tool to achieve this objective.

Transport benchmarking has to take into consideration the complexity and interactions between transport policy and the other driving forces between transportation supply and demand. This is a complex scenario even when the analysis is limited to national and individual modal scenarios. When dealing with intermodal transportation in an international context, the complexity of the interactions is substantially magnified.

Benchmarking studies are limited in scope by the availability of data, in particular data that are standard across the facilities or modes on which the comparative analysis is being made. Policy makers, and other decision makers, must ensure that the conclusions drawn from a benchmarking exercise reflect the limitations of the information and the approach used.

Analysis of existing benchmarking studies has shown that methodologies for benchmarking have yet to be fully developed. The actual application of these methodologies is at the experimental stage, particularly in terms of benchmarking performances of holistic supply chains, due to the complexities of the supply chains and limitations in data availability.

The existing studies also show that there are many measurement issues to be resolved. In addition to the limitations of data availability, aggregated benchmark results, which are often used in such studies, can be misleading since changes in important factors may be buried in the aggregation process.

It was encouraging to find that benchmarking exercises that were conducted under the co-operation of relevant stakeholders could be regarded as successful examples.

Recommendations

One of the many difficulties in benchmarking intermodal activities is that the limits of the intermodal transport chain are not clearly defined. Policy makers wishing to use benchmarking as a tool should ensure that the objectives and scope of the exercise are clearly defined. This will help in ensuring that conclusions, and development of future policy, correctly reflect the true outcome of the benchmarking exercise.

The choice of indicators is crucial for benchmarking exercises. Policy makers must ensure that indicators which are most appropriate for the objectives and scope of the exercise are used, although the availability and reliability of the data must also be taken into account.

Given the complexity of benchmarking intermodal transport chains, shipper surveys could provide valuable insight into the overall performance of such systems by identifying "what aspects are most important to the shipper". Benchmarking of these "aspects" to assess relative performance across transport chains could assist the development of transport policy by laying the foundation for performance improvement.

Benchmarking is one of many tools that can be used in the development of transport, and intermodal, policies. The complexity of the interactions between transport policy and the other driving forces influencing the supply and demand of transportation services must also be known, understood and taken into account.

Benchmarking exercises are often most effective when comparing similar activities (for example, gantry crane operations at two ports). Benchmarking may also be successful when comparing larger-scale operations of similarity (for example, Class I rail freight service in two or more countries). It is important to note that when using aggregate indicators such as, for example, tonne-kilometres or revenue passenger kilometres, there are numerous micro-level indicators that make up the aggregate indicator. The methodology may not be capable of addressing how best to improve micro-level performance of the elements that comprise an intermodal chain.

To be effective, benchmarking should focus on the expected outcomes of the comparative analysis. In order to improve performance, emphasis needs to be placed on "how to" address underlying differences between the "home" organisation and the performance of its "competitor". A

10% shift in own performance may fall short of ensuring competitiveness if efficiency levels continue to be below those attained by other operators in the marketplace. Attention should be paid to selecting key performance indicators for which data can be collected, and which have relevance to the organisation's outcomes. In undertaking benchmarking of transport activities, it is important that primary stakeholders be involved in the exercise, both in the identification of the indicators and in the analysis of factors contributing to lack of performance, including those requiring action by governments.

Policy makers must be aware that the benchmarking exercise is only as good as the quality, and availability, of the data that it is based on.

Chapter 1

INTRODUCTION

Background and objectives

This century will see a continuously evolving set of factors and pressures influencing the way in which transportation systems will be expected to meet the requirements of a global marketplace. For most of the 20th century, each of the modes evolved and functioned under a "modally" based regulatory structure. With the advent of containerisation in the mid-1900s, deregulation during the last two decades and the recent focus on logistics, global supply chains, e-commerce and advanced information technology, the climate is rapidly shifting towards integrated transport single-waybill shipments.

It is likely that the growth of intermodal freight transportation over the short to medium term will be driven and challenged by four complex factors:[1]

- Measuring, understanding and responding to the role of intermodalism in the face of changing customer requirements and "hypercompetition"[2] of supply chains in a global marketplace.

- The need to reliably and flexibly respond to changing customer requirements with seamless and integrated co-ordination of freight and equipment flows through various modes.

- Knowledge of current and future intermodal operational options and alternatives, as well as the potential for improved information and communications technology (ICT) and the challenges associated with its application.

- Constraints on and co-ordination of infrastructure capacity, including policy and regulatory issues, as well as better management of existing infrastructure and the broader considerations concerning future investment in new infrastructure.

The Organisation for Economic Co-operation and Development (OECD) has an ongoing commitment to freight-related transport research. The Programme of Research on Road Transport and Intermodal Linkages (RTR) for the 1998-2000 period had three key elements:

- Multimodal transport strategies.

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1. *Intermodal Freight Transportation,* Committee on Intermodal Freight Transport, TRB – 1999, William DeWitt, University of Maryland, Jennifer Clinger, Louis Berger Group, Inc.

2. Worldwide competition between global supply chains.

- Economic performance, transport infrastructure and management.

- Sustainable development.

The RTR role[3] with respect to multimodal transport strategies is focused on helping Member countries to meet national and international challenges in developing seamless transport systems. Key projects in this area include:

- Trilateral Logistics (TRILOG).

- Influencing Road Traffic Demand.

- Implementation of Intelligent Transportation Systems (ITS).

- The Intermodal Freight Transport Advisory Group.

In determining its mandate, the Intermodal Freight Transport Advisory Group considered a range of public and private sector transportation concerns. The RTR Steering Committee authorised the Advisory Group to investigate four topics:

- Institutional aspects of intermodal transport.

- Benchmarking and system performance measures.

- Economic and fiscal instruments.

- International freight corridor development.

Each of the above topics is being addressed in sequence. Work on the subject of institutional aspects has been completed, and the conclusions published in OECD (2001), *Intermodal Freight Transport: Institutional Aspects.*

The overall focus of the work on "benchmarking" is centred on comparing the relative efficiency of modes, modal combinations and modal interfaces. Government policy makers (along with transport industry and logistics service providers) have an interest in the efficiency (including time, cost and reliability), safety and sustainability of transport systems, although at a more aggregate level than the private sector. The Working Group was asked to develop a vision for intermodal transport and to identify appropriate benchmarks that could be applied to assess the relative efficiency of modes/modal combinations and intermodal transfers, and to identify sources of inefficiency that could contribute to modal choice. In line with the original intent of the project, the benchmarking analysis also seeks to develop policy options for governments to address impediments to intermodal transport efficiency, encompassing institutional aspects, technology, including the role of intelligent transportation systems (ITS) and infrastructure. As such, the focus is on organisational aspects, from a government public policy perspective, rather than on the performance of industry players. The conclusions should be seen as a guide to improving system performance, rather than a regulatory framework.

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3. "The Challenge for Transport in the New Century: How to Develop Sustainable Transport", presentation by Dr. Anthony Ockwell, OECD, at the Annual Conference on Sustainable Transport, Alghero, Sardinia (Italy), 15-16 June 2000.

It must also be noted that with respect to benchmarking government policies, it is first necessary to clearly enunciate governments' objectives, which may vary significantly across countries or even between regional and central governments. These different objectives are evidenced, for example, by the different objectives of road-pricing policies being considered and implemented in Member countries.

This report summarises the outcomes of the following tasks, with contributions from each of the Member countries associated with the Working Group:

- A review of studies on benchmarking and the available data.
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The list of members of the Working Group is provided in Annex 1.

Definitions[4]

One of the first objectives of the Intermodal Freight Transport Advisory Group was to agree on a definition of "intermodal transport" that could be used throughout the four research projects undertaken by the group. Many concepts and definitions are in use, depending on the context and objectives. For example, the notion of "multimodal transport" is generally used for the carriage of goods by at least two modes.

The notion of "intermodal transport" as used in the common terminology in force within the European Union (EU), UN Economic Commission for Europe (UN/ECE) and the European Conference of Ministers of Transport (ECMT) concerns the movement of goods in one and the same loading unit (*e.g.* a container) or vehicle which uses successively several modes of transport without handling the goods while changing modes.

In the same terminology, the term "combined transport" is used for intermodal transport of unitised cargo when the major part of the European journey is by rail, and any initial or final leg is carried out by road. For EU subsidy schemes, this definition is even more detailed.

In the light of the objectives that appeared to be predominant in most of the countries studied in this project, we have chosen to emphasise that *intermodalism refers to the goal of making the optimal use of all the various modes of transportation*. It assumes that the use of multiple modes for a single trip can be better from an efficiency and environmental point of view. All freight movements involving at least two or more modes of transportation, from a point of origin to a destination, can

4. Various terms and abbreviations have been used throughout this report. For a detailed glossary of these terms, please refer to Annex 2.

therefore be defined as intermodal. The modes involved can encompass van and truck, railroad, barge and ship, air cargo liner and pipeline.

This notion of intermodalism is not limited to the promotion of modal shift to achieve a more efficient use of modes. It also comprises the promotion of improvements in the transport chain without modal shift. For the purpose of this study, a fairly general and broad definition has been adopted.

Each of the four studies undertaken by the Advisory Group uses the following definition as a baseline for intermodal transport:

> *Intermodalism implies the use of at least two different modes of transport in an integrated manner in a door-to-door transport chain.*

While the concept of intermodalism encompasses all freight movements involving two or more modes of transportation, the principal focus in the present study was on movement of non-bulk and containerised freight.

Benchmarking is attracting serious attention because of the difficulty of defining, in the absence of comparisons with other sectors, what constitutes "good" performance. In order to overcome this difficulty, the performance of a given sector is compared to that of a reference sector, and this practice is taking on increasing importance in competitive markets.

As a general rule:

> *The benchmarking process will provide meaningful comparisons of the most important dimensions of intermodal performance in a way that provides insight into the reasons for performance differences and lays the foundations for performance improvement. Hence, it involves the establishment of a standard(s) against which the performance of transport sectors, and government policies can be evaluated. It suggests first, the choice of indicators of performance; second, the determination of the reference sector; third, the measurement of indicators for the sector under consideration and the sector which serves as a reference; and fourth, the comparison of the sector under consideration against the reference sector.*[5]

The underlying premise here is the availability of sound, quantitative information. Unfortunately, in many cases, data that could be used as performance indicators for both the reference sector and for the sector under consideration, may not be readily available in the public domain.[6] Furthermore, a large proportion of intermodal transport of goods takes place in more than one jurisdiction. Accurate benchmarking of any aspect of the intermodal supply chain would require the availability of standardised data – an obstacle that is almost impossible to overcome for most potential performance indicators at the present time.

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5. A more in-depth explanation of each of these facets can be found in Chapter 2 – Issues in Benchmarking.

6. Even when the required information is available, it may be considered proprietary by the organisation that could provide it (*e.g.* cost/revenue/traffic data related to port or other infrastructure providers). In some cases, national statistical agencies may have confidentiality restrictions at increased levels of disaggregation (*e.g.* traffic data by carrier). In many cases, the required data are simply not collected or saved over time.

Considering the very real problem of data availability, it is not a feasible ambition of this report to provide "real" empirical data on benchmarking intermodal transportation in OECD countries. Rather, the report aims to stimulate the development of benchmarks in Member countries to compare the (economic and environmental) effectiveness and efficiency of modes, modal combinations and modal interfaces by providing examples of practical experiences. It is also hoped that it will contribute to the understanding of methodological issues related to benchmarking.

Challenges facing the transport sector

A well-functioning freight transport system is an essential element of a successful economy. In transportation, smooth flows and profitability tend to be highly correlated. Smooth flows reflect effective loading/unloading and transfer in terminals, reliable vehicle performance, a minimum of starts and stops along the route, and high utilisation levels for the fixed assets required in the system. Actions or conditions that interrupt trip flow or increase trip time typically add to the cost and erode asset turnover. Conversely, modifications that improve flows and trip times usually reduce cost and improve asset turnover.

In the coming years, the freight transportation system will face challenges requiring the development of entirely new approaches to operations and planning. These challenges will not remain static, and governments and service providers must be prepared to meet them in a flexible, responsive manner. The factors that will drive the key issues and challenges affecting freight transportation in the future include the following:

- Domestic and international freight demand will continue to grow. For example, distance travelled by heavy trucks is expected to almost double from 1995 to 2020.[7] The consumption of goods will increase as new segments of the population enjoy more disposable income. The incorporation of the former socialist republics into the world trade system and the expansion of economic activities in developing countries will significantly augment the flow of goods and merchandise. Pressure for increased economic competitiveness will grow as a consequence of factors such as the economic unification of Europe, the resurgence of the Asian economies and regional trade alliances such as NAFTA and APEC.

- Businesses and consumers are ordering goods with less lead-time and requiring predictable delivery within ever-narrower windows of time. Freight transportation systems will have to become more and more responsive to user needs and expectations as consumers continue to demand greater control over the services they receive. This trend will be accentuated by the availability of information systems and technologies that enable users to specify the kinds of service they require and to integrate their operations effectively with the freight transport system. As a result, users of the freight transportation system will be increasingly involved in closely managed logistics chains, where customer decisions drive supply decisions relating to quantities, location and delivery times.[8] Continuous information about production schedules is already being fed to suppliers, to arrange just-in-time (J-I-T) delivery of inputs to the production schedule and final delivery to the customer within a guaranteed response

7. OECD, 2001, *OECD Environmental Outlook.*

8. The requirement to reduce inventory investment by reducing cycle time is decreasing reliance on "push" systems, which are driven by the supply of materials and goods, and increasing reliance on "pull" systems, in which actual demand triggers product flow.

period. These trends present a challenge at the domestic level; in the context of the global marketplace, the tensions placed on transportation systems are significantly exacerbated.

- Smooth product flow is maintained through flows of information and increased integration of management processes by all participating organisations. Extra complexity is introduced by any door-to-door service that relies on intermediate transfers of the shipment between carriers/modes. The freight transportation system is increasingly turning to information technology to help it increase both efficiency and productivity in an integrated system. Steadily declining prices of new technology, combined with a growing awareness by the industry of the benefits of these technologies, is leading to increased use of information technology. However, as supply chains take on global dimensions, the integration of complex technologies takes on added importance, especially considering the lack of universal standards or harmonisation of systems. These challenges are not limited to those technologies directly used by transportation service providers, but also affect government (*e.g.* customs, immigration, regulatory agencies) and private organisations (*e.g.* brokers, Third Party Logistics, infrastructure providers).

- In dealing with the growing volumes of domestic and international merchandise trade, freight planners have to consider limitations on infrastructure. Additional infrastructure will be increasingly difficult to obtain, and may even be considered undesirable in some communities or regions. Economies or regions which are seen – or see themselves – primarily as conduits between trading areas may be unwilling to expend the resources and face the social costs of expanding their infrastructure to meet transportation demands. More efficient use of existing infrastructure, and careful development of new infrastructure and facilities,[9] will become a key priority.

- Finally, the notion of "sustainable development" and, as applied to this sector, "sustainable transportation", will have significant long-term impacts on the transport industry.

The concept of sustainable development was introduced into mainstream thinking by the United Nations' Commission on Environment and Development in its 1987 report *Our Common Future*.[10] In this report, sustainable development was defined as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs". Since 1987, the concept has evolved to address specific issues in different sectors of the economy.

Internationally, there are various interpretations of the concept of "sustainable transportation". The Environment Directorate of the OECD has defined environmentally sustainable transportation as:

- "One that does not endanger public health or ecosystems and meets the needs for access consistent with the use of renewable resources at below their rates of regeneration; and

- Use of non-renewable resources at below the rates of development of renewable substitutes."

When viewed at the global level, sustainable transportation means finding solutions which satisfy our economic, social and environmental goals. This is an extremely complex challenge that has major

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9. Planners will be required to ensure that location and access to facilities such as transfer terminals will significantly increase the efficiency of the transportation network.

10. Commonly referred to as the "Bruntland Report", attributed to the chair of the Commission.

implications for global economies, the environment and society in both the developed and developing world.

In summary, the challenges facing the transportation sector can be categorised as follows:

- The growing demand for freight transportation and logistics services, and the ability of the physical and information infrastructure to meet these demands.

- The sometimes seemingly contradictory goals of meeting freight transportation demand and sustainable transportation strategies.

- The impact of information technology on goods movement, and the issues surrounding the integration of complex systems in order to increase, rather than impede, transport efficiency.

- Development of the necessary “connectivity linkages” in a global supply chain in which transportation service providers will increasingly find themselves acting as both competitors and partners on an ongoing basis.

Benchmarking is a tool which can help not only governments but also other stakeholder groups to meet these challenges. The issues involved are discussed in Chapter 2.

Chapter 2

ISSUES IN BENCHMARKING

Background

As stated in the introduction to this report, the 21st century will present multiple challenges for the transportation sector. Governments, transportation service providers and associated organisations and industries must be prepared, in a flexible and responsive manner, to meet those challenges. Public decision makers are becoming more aware of the need to gain insights into the effectiveness of specific policy measures, the extent to which certain goals have been achieved and to know which aspects are measurable and which are not. At the same time, Parliaments and other interest groups are increasingly calling for more transparent and cost effective measures. This requirement is reflected in the growing use of performance indicators in the presentation of government budgets.

Benchmarking is essentially a learning process. It helps organisations to focus and drive for consensus on what needs to be done and how to achieve it in an organised, rigorous manner. It can provide the stimulus for improvement at all levels through an externally focused, competitive assessment. It can also stimulate cultural change, by encouraging inward-looking organisations to look outside and recognise that better practices are being utilised elsewhere. Benchmarking is primarily used to identify better ways of doing things; in short, to identify “best practices”. Throughout the exercise, gaps between how things are currently being done, and how they are done better elsewhere, are identified.

Long-range strategies require organisations to continuously change and adapt to the market place of today, while at the same time preparing for the challenges of the future. In order to achieve this, they must understand that there is a need for change, determine the changes required and form clear goals for how the organisation, and the operations of the organisation, will look once the changes are made.

While individual companies and non-governmental organisations (NGOs) most certainly have a stake in ensuring that their organisations follow “best practices”, government policy and decision makers must also be aware of the consequences of having legislative and regulatory regimes which impede, rather than facilitate, the competitive position of their national economy.

Furthermore, global issues such as sustainable development and climate change dictate that countries can no longer implement policies in isolation. From a policy perspective, “best practices” must now, in many instances, reach across national and regional borders.

Hence, it is necessary to assess the advancement of logistics from the viewpoints of both the industry sector and society as a whole. Logistics performance indicators can be used to assess the system, mainly from the following viewpoints:

Consumers' perspective (better services at lower prices):

- There is a need to evaluate the reduction in logistics costs, taking into account consumer service levels provided by the logistics systems. In particular, the security level of transported goods should be included in any consideration of service levels.

Shippers' and logistics service providers' perspective (better services at lower cost):

- Accurate evaluation of reductions in logistics costs in relation to the quality of logistics services and transportation.

- Estimation of total logistics costs, including production, sales, collection, storage, transportation and data processing.

- Selection of the most appropriate transportation service(s) from origin to destination by assessing all the factors, including time, cost, reliability and flexibility.

Government perspective (balance between efficiency and environmental friendliness of logistics, improvement in transport safety):

- Efficiency: efficient infrastructure development projects in terms of the advancement of logistics.

- Deregulation and standardisation to enable improvements in logistics efficiency.

- Environmentally friendly logistics: comprehensive assessment of external costs of logistics systems (*i.e.* air and noise pollution, congestion), and improvement in intermodal transport systems.

- Improvement in transport safety.

In summary, different target groups have different objectives. These "different objectives" lead to the requirement for specific performance indicators that will meet the organisational, financial, policy or stockholder needs of the user. For example,[11] transport policy makers are generally more interested than shippers in macro data on modal split. They are also more interested in data concerning general safety, environment and efficiency. Conversely, shippers have a greater interest than policy makers in a micro-level comparison of the costs and performance of specific modal combinations for particular merchandise streams. Transport service providers such as trucking companies focus on comparing costs and revenues at the micro business level (*e.g.* owner's road transport company *vs.* the average road transport company). Terminal operators are interested, among other things, in container crane efficiency.

As previously stated, *benchmarking involves the establishment of a standard(s) against which the performance of an industry can be judged.* It suggests: *i)* the choice of indicators of performance; *ii)* the determination of the reference sector; *iii)* the measurement of indicators for the sector under consideration and the sector which serves as a reference; and *iv)* the comparison of the sector under consideration against the reference sector.

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11. The following examples are not an attempt to make strict distinctions, but rather to provide the reader with broad general examples of user needs.

Choice of indicators of performance

When the performance of a sector is under scrutiny, one of the first tasks is to reach consensus on the choice of indicators. As a rule, economists will choose indicators of efficiency/productivity, unit costs or price changes. Financial analysts will use financial returns. Others will prefer safety or environmental performance. All of these indicators are valid. The choice of a particular indicator will depend, among other things, on the objectives of the analysis and the availability of data.

The choice of potential indicators in the transport sector can be overwhelming. The first order of business is to ensure that analysts are clear on the objectives of the benchmarking exercise. Second, they must ensure that the indicators are available and are reliable.

The United Kingdom and the Netherlands have provided examples of indicators used by policy makers as a means to quantify and illustrate (*i.e.* to benchmark) progress in achieving stated policy objectives. They are used to make informed policy decisions by government and to help the public understand the impacts of decisions that both government and they make on the wider economy, the environment and society. In developing indicators, the framework is set within which both public and private decision makers can take appropriate action.

United Kingdom

In the United Kingdom, a series of 15 headline indicators designed to demonstrate progress towards sustainable development have been developed. These are:

Achieving a sustainable economy	Total output of the economy (GDP and GDP per person) Total and social investment as a percentage of GDP Proportion of people of working age who are employed
Building sustainable communities	Indicators of success in tackling poverty and social inclusion Qualifications at age 19 Expected years of healthy life Homes judged unfit to live in Level of crime
Managing the environment	Emissions of greenhouse gases Days when air pollution is moderate or higher Road traffic Rivers of good or fair quality Population of wild birds New homes built on previously developed land
Prudent use of natural resources	Waste and waste management

Below these headline indicators lies a core set of 135 non-headline indicators. These indicators describe more specific objectives and are linked to the specific policies and actions of government and other sectors – for example, central and local government, the health service, manufacturing, the freight industry and consumers. In relation to transport, the United Kingdom collects information on the following set of core indicators:

- Freight transport intensity (ratio of total freight moved to GDP).
- Lorry traffic intensity (ratio of HGV mileage to GDP).
- Road traffic by type of vehicle (vehicle-km).
- Freight transport by mode (tonne-km).
- Energy consumption by road freight.
- Energy efficiency of road freight (energy consumption in relation to output measures as tonne-km).

A wide variety of transport statistics are collected to construct these indicators. Statistics on use can be classified by mode, relating to:

- Employment in transport and Retail Price Index.
- Environmental impacts.
- Safety.
- Vehicle stock.

This information is used to benchmark, for example, trends in accidents involving freight vehicles, congestion, the relative success of different transport modes and the efficiency of use of vehicles.

The Netherlands

In the Netherlands, the following performance indicators, among others, are used for the budget of the Directorate-General for Freight Transport:

Goal: Safe freight transport	**Internal safety of road transport** • Number of casualties caused by freight traffic • Number of people injured by freight traffic who had to be hospitalised **Internal safety of railroads** • Number of casualties on railroad crossings **Internal safety of water** • Number of accidents in the North Sea • Number of accidents on inland waterways **External safety** • Number of violations of standards relating to the transport of dangerous goods • Number of goods traffic emplacements meeting the requirements
Goal: Strengthening the network of freight transport	**Main ports and seaports** • Value added of main ports and seaports • Employment at main ports and seaports **Functioning of the nodal points** • Growth of transhipment through main ports • Growth of transhipment through nodal points • Number of terminals in service **Quality of linkages** • Modal split in tonnes and tonne-kilometres • Average flow speed on certain routes • Indicators for capacity of infrastructure for other modalities
Goal: Efficient freight transport system	**Healthy transport industry** • Value added of naval clusters • Value added of other sectors **Logistic efficiency** • Degree of utilisation per transport mode • Share of logistic costs in total sales
Goal: Sustainable freight transport	**Transport reduction** • Number of projects leading to transport reduction **Silent and clean transport** • SOx emissions per transport mode • NOx emissions per transport mode

In addition, a range of indicators are proposed by policy makers, semi-public organisations, shippers, and transport industry and logistic service providers. These are listed in Annex 8. These indicators show how different target groups have different objectives, each of which requires specific indicators.

Chapter 3 presents a number of benchmarking studies that have been completed by Member countries. Each of these reports considers, directly or indirectly, the choice of performance indicators. Tables indicating available performance indicators, by country, are also available in Annexes 3-9 of this report.

Choice of reference sector

The determination of an appropriate reference sector, in particular from a policy perspective, can be a rigorous exercise. If the objective is to study the transportation sector as a whole, it must be borne in mind that the sector is made up of several industry components. As a result, the reference sector could be the average of the transportation sector, or all transport industries other than the selected one. However, it could be argued that these comparisons have limited value since, for example, the air industry has little in common with rail. In most cases however, benchmarking involves particular aspects of the sector; for example, safety standards and related indicators, financial performance, productivity or efficiency, to name but a few.

The performance of transport industries can be related to other sectors of the economy, in particular the business component. The basis for the comparison is that transportation is a derived demand, based on the rest of the economy, and that the performance of the transport sector can be assessed in relation to that of the users of transport services. While economic and financial criteria can, in theory, be measured for both the transport sector and the rest of the economy, safety and environmental indicators of the transportation sector and other sectors of the business economy are not easily comparable.

In the context of a global economy, benchmarking components of the transportation sector as well as benchmarking whole transport corridors, across national lines, is becoming increasingly relevant. Interest in such comparisons arises not only from the realisation that transport is a traded service, but from an increased recognition that in order to achieve regional or global objectives, best practices must be identified and applied across the board. However, difficulties arise in trying to gain access to relevant data, the absence of which makes comparisons almost irrelevant.

The transportation sector is under constant pressure to improve. Policy makers, in searching for ways to facilitate this improvement, have identified benchmarking as one of the tools available to them. By identifying best practices in other countries and regions, policies can be formulated which can stimulate such changes as improved efficiency, productivity, standards related to safety and regulatory harmonisation. It is also the role of governments to put in place mechanisms that ensure the continued competitive position of industries and transportation service providers. One of the biggest advantages of benchmarking, if done properly, is that it is an ongoing, dynamic approach to stimulating required change. However, quantitative indicators do not always fully reflect the complex inter-relationships between transport policy and other factors that influence transportation and the transport market, or between transportation supply and demand in general.

In some instances, in particular when dealing with policy-related concerns, the benchmarking exercise will start with a "base-case" study, *i.e.* a detailed snap-shot of the situation as it currently exits. One example of this would be a benchmarking study of intermodal transportation in an economy where no clear intermodal policy exists. The reference sector in this case would be identification of all factors that influence intermodal transport at a particular point in time, with the ultimate objective of determining policy and other impediments (inappropriate or lack of infrastructure, facilities, and equipment; intra-modal relationships, regulatory constraints, congestion, procedural constraints *e.g.* customs, immigration, etc.) to the efficient movement of goods by more than one mode. Policy makers also place a particular emphasis on general safety, environmental and efficiency data. The "factors" influencing the efficient movement of goods can then be compared to policies or approaches in other countries during the same period or can be followed over time as changes are implemented. Appropriate (and available) indicators would be identified which could be used to measure the results as changes are implemented.

Measurement issues

Many measurement issues are primarily a consequence of the availability and reliability of appropriate performance indicators. Availability of performance indicators is influenced by such factors as:

- Confidentiality constraints.
- Information is not collected.
- Information is not kept over time.
- Only partial information is collected and/or maintained over time.
- Differences in definitions of like concepts across jurisdictions or sectors.
- Changes in thresholds over time or across sectors.
- Jurisdictional constraints.
- Budget constraints.

Problems associated with the availability of required indicators become magnified when cross-modal or international comparisons are undertaken.

Many of the factors that influence the availability of data also impact upon the reliability of available information. For example, while state agencies or private sector enterprises may collect certain data, budget constraints may preclude adequate editing and verification of the statistics. Other factors, such as use of inappropriate or flawed methodological concepts or approaches (*e.g.* for surveys) can seriously detract from the reliability of required performance indicators.

Even when indicators are available and are considered reliable, measurement issues arise during their use. Some indicators are expressed as a ratio of a numerator over a denominator. When a sector is compared with itself over time, numerators and denominators can be estimated with some degree of certainty although care must be applied in their selection. In the transport sector, aggregate tonne-kilometres or passenger-kilometres have long been seen as a good proxy for output, *i.e.* the denominator. Their widespread use by transport analysts is based on their availability and ease of utilisation. However, these measures may be deceptive, as changes in levels of service are buried in the aggregation process. Analysts strongly recommend computing output measures, using the highest level of detail possible (*e.g.* commodity, size of shipment, length of haul).

Difficulties also arise when one sector is compared with another. The measurement of comparable/compatible denominators represents a major task. In safety, for example, it is difficult to develop comparable measures of exposure across modes, making it difficult to compare the safety performance of each mode with that of other modes. The same issue pertains to environmental indicators, where fuel emissions can be computed by mode but not in terms of output.

While economic indicators by mode can be developed, these measures change over time and do not necessarily accurately indicate comparative levels. Even among freight carriers that have theoretically similar outputs – tonne-kilometres, for example – comparisons are misleading.

Difficulties are often compounded by the volatility of traffic data, which may have more to do with problems related to data capture than with economic cycles.

On the numerator side of efficiency measures, *i.e.* in measuring input utilisation, issues arise from the diversity of input used. The challenge is to develop composite measures of input utilisation. The problem becomes more complex when the analyses are cross-modal in scope.[12] When comparisons are extended to the international scene, analysts must consider, for instance, the issue of price of labour, which may reflect not only the relative wealth of each country but also different degrees of experience and education.

Notwithstanding the many issues that arise with respect to measurement, effective benchmarking exercises regarding the transport sector are possible and have been used effectively by decision makers at all levels. It must be emphasised, however, that the objectives of the exercise must be well defined and understood. Considerable research and effort must be expended to ensure the availability of data to meet the needs of the exercise.

Comparison of the sector under consideration with the reference sector

It is only when measurement issues are resolved that meaningful comparisons can be made. These comparisons can then be passed on to target groups; for example, policy makers, infrastructure providers, shippers and transportation service providers. Decision makers must, however, be aware of the limitations of the performance indicators used. They must also exercise keen judgement to ensure that they do not draw conclusions that fall outside the objectives of the analysis, or misinterpret results. As stated earlier, aggregate indicators such as tonne-kilometres or revenue passenger-kilometres are comprised of a large number of micro factors.

Based on the comparative analysis, the identification of best practices followed elsewhere, and the particular circumstances of the sector being studied,[13] required changes can be identified and implemented. Follow-up monitoring programmes can be used to identify whether these initiatives have produced the desired results, or to raise the necessity for further changes.

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12. For example, marine carriers utilise bunker "C," a cheap fuel with a high BTU content. This problem can be addressed by developing measures of BTU or petajoule content. The marine mode makes extensive use of vessel chartering as a source of input, while trucking industries rely on resources from outside the firm, for example owner-operators. However, such forms of input are not available in other modes.

13. For example, the performance of a newly privatised carrier or sector cannot be effectively compared with that of a carrier or sector which continues to enjoy state subsidies. Conversely, even commercial enterprises may enjoy the benefits of indirect subsidies which affect aggregate performance indicators.

Chapter 3

BENCHMARKS TO ASSESS THE PERFORMANCE OF THE TRANSPORT CHAIN

Chapter 3 presents examples of benchmarking activity in a number of Member countries,[14] including the reasons for undertaking the benchmarking activity and the approaches followed. The primary performance indicators used are shown in the Annexes.

Benchmarking the logistics chain

In terms of the supply chain, it is possible to differentiate three types of benchmarks:

- Infrastructure performance.
- Asset performance.
- Service-level performance.

United Kingdom programme for benchmarking supply chain logistics

An important use of indicators is to highlight the key issues and objectives for sustainable growth for industry to help firms to understand how their business practices affect not only their own efficiency and competitiveness but also the wider objectives for the economy, the environment and society. To this end, the UK Government has been working with the freight distribution industry to develop a set of key performance indicators.

Infrastructure-based benchmarking

The amount, design and management of the transport infrastructure are of interest to both government and industry. The government collects information on transport infrastructure in terms of amount and type of infrastructure, costs of maintenance and repair and amount and type of traffic (and hence extent of use). This information is used by government when deciding on the nature and level of infrastructure development and on policies which influence modal choice, vehicles emissions, safety improvements, enforcement levels, and so on. At the business level, it informs decisions on modal choice. Annex 9 provides benchmark data for the UK transport infrastructure, by mode.

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14. The United Kingdom, the Netherlands and Western Europe, Japan, the Czech Republic, Sweden. See also, European Environment Agency, 2000, “Are We Moving in the Right Direction? – Indicators on Transport and Environment Integration in the EU”, TERM 2000, and European Environment Agency, 2001, “Indicators tracking transport and environment integration in the EU”, TERM 2001.

Asset-based benchmarking

Asset and resource benchmarking have long provided a robust business management tool in the drive for improvements in efficiency and effectiveness. This usually involves the examination of business functions at the micro level. Such information is of value to government, since at the macro level such information can be used to gauge industry competitiveness and performance against criteria such as environmental performance and safety.

Improvement in efficiency, environmental and social performance is one of the key goals of the UK Government's Sustainable Distribution Strategy. The government has therefore established a programme of work with the distribution industry to develop a series of key performance indicators (KPIs) which can be used by individual companies to benchmark their transport performances with financial and environmental benefits.

The first set of KPIs has been developed with the help of the Cold Storage and Distribution Federation. These KPIs are used to measure transport efficiency within the food industry, in terms of vehicle and energy utilisation, both at company and sector level.[15] Five types of KPI have been monitored successfully:

- *Vehicle fill:* measured by payload weight, pallet numbers and average pallet height.
- *Empty running:* measured as the number of miles the vehicle travelled empty and the number of miles the vehicle travelled with only returnable items.
- *Time utilisation:* measured on an hourly basis as one of seven activities (running on the road; rest period; loading or unloading; preloaded and awaiting departure; delayed or otherwise inactive; maintenance and repair; and empty and stationary) over a 48-hour period.
- *Deviations from schedule:* measured as problem at collection point, problem at delivery point, own company actions, traffic congestion, equipment breakdown and lack of driver.
- *Fuel efficiency of tractor and trailer:* measured as km per litre, ml fuel required to move one standard industry pallet 1 km.

The programme of work for the next two years will see further extension of the KPI work within the food distribution sector, and the launch of KPI initiatives with the construction, parcels, chemicals, air freight, ports and automotive industries. In the case of the chemicals and automotive industries, the work will examine the possibility of benchmarking both road and rail movements.

Benchmarking performance of intermodal transport in the Czech Republic

Infrastructure-based benchmarking

The Czech Government promotes intermodal transport using various measures, including development of infrastructure. For this purpose, the government collects information on transport infrastructure in terms of amount and type of infrastructure and amount and type of traffic. The

15. DETR (1999), *Benchmarking Vehicle Utilisation and Energy Consumption: Measurement of Key Performance Indicators*, DETR Energy Efficiency Best Practice Programme Energy Consumption Guide 76.

government also collects information on the development of intermodal transport in order to evaluate the effectiveness of policy measures. Annex 4 provides benchmark data for the Czech Republic.

Current state of intermodal transport in the Czech Republic

In the past, the terminal network in the Czech Republic was rather dense, consisting of 16 terminals. Due to the rapid decrease in production, and especially of exports, between 1992-96, some terminals became redundant. Therefore, one of the most important operators, CSKD Intrans, commenced reducing the number of terminals (six terminals were closed and two are being modernised).

Currently, the most frequently used transport system is containerised freight. The use of the swap-body (SB) system is also increasing. Articulated trucks are not used, but their operation in some terminals is possible.

Existing terminal equipment meets the needs for containers, but only partly for swap-bodies. Combined transport is focused on freight containers (20-40 feet), and in some terminals also on High Cube 45 feet (HC).

Government support to intermodal transport

The principal programme for the intermodal transport area is described in the paper "System Support of Combined Transport Development in the Czech Republic in 1999-2000/2005", which has as one of its objectives the partial transfer of freight from road transport to rail and water transport, which are more environmentally friendly. The paper outlines the following objectives:

- Creation of an information system for electronic exchange and data transfer for combined freight transport.
- Creation and implementation of UN/EDIFACT form.
- Development of a decision support system for intensified utilisation of combined transport.
- Investigation of infrastructure conditions of combined and integrated transport from the standpoint of wider exploitation in transport and logistic systems.
- Research into changes in the vehicles fleet-split needed for combined transport use.

Development of the transportation infrastructure in the Czech Republic is focused on:

- Connection of the transport network between the Czech Republic and adjacent countries.
- Co-ordination of the development of international transport corridors.

Support programmes of the Czech Ministry of Transport and Communications are focused on the following spheres:

- Purchase of special railway wagons for combined transport for Czech Railways (also for other railway operators in the future).

- Support of projects concerning new systems of combined transport and vehicles (*e.g.* swap-bodies, semi-trailers).

- Modernisation of lifting mechanisms.

- Adaptation of vessels for combined transport.

- Modernisation of terminal and other buildings.

- Improving services in terminals.

In addition, the Czech Republic participates in Pan-European programmes concerning development and support of combined transport.

Benchmarking exercises led by industry organisations in Europe

Service-based benchmarking

Service-level information is used by the distribution industry to compare performance either within sections of the supply chain or across different supply chains and modes. Once aggregated, such information can supply indicators of the efficiency of supply chains and hence provide a measure of potential impacts on GDP. Hence, much of the work in this area has been carried out by industry organisations.

Key performance indicators in the air-freight industry

Led by the Freight Transport Association, the European Air Shippers' Council has developed key performance indicators and best practice for the air-freight industry. This focuses on:

- Delivery to the airline.

- Collection by/delivery to the agent.

- Flown as booked.

- Arrived as agreed.

- Aircraft arrival.

- Collection.

The approach has been successfully applied in the air-freight market and an agreed set of performance measures is now in place. The performance indicators established in this project will be used by shippers to improve their decision making. The approach used in this project is demand-led and focuses on service levels.

Key performance indicators in short-sea shipping

The European Shippers Council, the Freight Transport Association (United Kingdom), the Maritime Forum (Sweden), the Ministry of Industry, Employment and Communications of Sweden and the Ministry of Transport, Public Works and Water Management of the Netherlands (and other organisations) is undertaking a study to develop key performance indicators for the short-sea sector.

The project concerns the establishment, verification and dissemination of consistent service performance indicators for freight transport and concentrates on short-sea shipping, rail and road. The output from the project will provide European supply chain managers with a package of consistently calculated performance standards that will allow the relative service-level performance of each freight mode to be consistently compared on each of their European flow corridors. This removes a large “step into the unknown”, thereby encouraging companies to shift away from their current mode towards more sustainable modes, especially combined transport.

The key performance indicators will focus on:

- Time.
- Cargo care.
- Compliance.
- Customer service.

The short-sea shipping section of the project was implemented in 2001, principally focusing on the freight corridor that links Rotterdam and Göteborg. On a Europe-wide, multimodal basis, use of the approach developed in the project will help to identify commercially important freight flow corridors, under-performing infrastructure and bottlenecks.

Best practice guide for collection and delivery of cargo at airports

The Airline Operators Committee Cargo, together with the British International Freight Association, have established a working group to look at ways in which forwarders and transit shed operators could improve the way in which they handle cargo arriving at and departing from Heathrow Airport.[16] The working group has developed a best practice guide for collection and delivery of cargo. This covers guidance on scheduling of deliveries, dealing with missing packages and the vetting of documentation and an agreed procedure for sharing wooden pallets. Statistics are collected on truck dwell times at the transit sheds.

Benchmarking the output of logistics chains

In terms of outputs of the logistics chain, three types of benchmarks may be developed:

- Performance indicators on logistics costs.
- Logistics-related social costs and charges.
- Benchmarking on road safety.

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16. AOCC and BIFA (1998), *Heathrow Best Practices and Cargo Handling Guide*, September.

Evaluation of logistics systems in Japan

Why develop logistics performance indicators?

Developing logistics performance indicators is essential to evaluating the efficiency and sustainability of logistics systems, and to monitoring the implementation and outcome of logistics policies. In particular, in developing performance indicators, it should be borne in mind that, while the private sector's goal is globalisation of business and optimisation of supply chains, government's role is to evaluate the performance of intermodal transportation and to reflect the result on future transport policies and international policy co-ordination. In other words, logistics performance indicators should be designed to reflect the different perspectives of the different stakeholders.

Ideally, comparative evaluation of logistics systems in different countries should be conducted using the same performance indicators. However, data constraints make it extremely difficult to conduct complete comparative evaluation of logistics systems. Therefore, logistics efficiency and sustainability improvements can very often only be identified through partial evaluation. It is possible to evaluate logistics systems in different countries by identifying best practices in some countries as the standard evaluation criteria. It may also be possible to recommend more desirable policies by examining logistics policies implemented in various countries to address the recent trend towards globalisation and trade liberalisation.

Classification of performance indicators

Logistics costs and services

Logistics performance indicators can be classified into two types: cost indicators and quality indicators.

Cost indicators include the following:

- Transport cost.
- Inventory cost.
- Sorting and packing cost.
- Packaging cost.

Quality indicators include the following:

- Knowledge of goods and customer services.
- Availability of goods.
- Lead-time from order to delivery, and its accuracy.
- Flexibility: response time to special orders.
- Ability to organise information: time, accuracy, and details of contents.
- Response and restoration time when a mistake or problem occurs.

- Aftercare and response time (technical information, stocks of spare parts, repairs).

In any discussion of the performance of logistics systems, it is necessary to balance reduction in logistics costs and the level of logistics services. Logistics costs include not only transport costs, but also inventory, sorting, packing and production costs. Therefore, a reduction in transport costs will not necessarily lead to a reduction in total logistics costs. Even in the relationship between logistics costs and services, transport services include various factors (time-designated delivery, missed delivery, delay and re-delivery, etc.), which affect inventory costs.

This makes the relationship between logistics costs and logistics services a complex one. As shipping size becomes smaller, the shipping order becomes more frequent and the lead-time from ordering to receiving becomes shorter, making fleet management more complicated. As a consequence, loading factors decrease, and total transport costs increase. On the other hand, inventory costs, which include safety and average inventory costs, decrease as transport frequencies increase and lead-times become shorter.

Prices and consumer services

There is a need to evaluate the reduction in logistics costs not only from the viewpoint of price reduction, but also from more comprehensive aspects such as consumer service quality and security of transported goods. For example, supplying huge quantities of cheap goods using mass freight transport is not always effective, because small retailers who do not need such large deliveries often play unique and significant roles in the consumer goods market, with their better knowledge of goods, efficient repair services and their own parts suppliers.

Cost indicators include prices of goods and annual expenses needed for purchasing (*i.e.* transport expenses for shopping, e-commerce transmission expenses). Quality indicators include safety and reliability of goods and reliable and timely delivery of goods.

Socio-economic costs and transport policies

When evaluating reduction in logistics costs, non-monetary and socio-economic costs such as environmental costs should also be taken into consideration. These costs are often neglected by the private sector, but they are borne by society. For example, as the number of vehicles rises due to declines in loading rates of trucks, traffic congestion becomes worse and average vehicle speed decreases. This results in an increase in vehicle emissions and aggravates air pollution. In such cases, governments are expected to play a leading role in improving this situation by implementing effective transport policies (*e.g.* regulations restricting trucks in certain areas, taxes imposed on heavy trucks, etc.). Logistics performance indicators should be designed in such a way that they incorporate indicators by which socio-economic costs can be evaluated.

The need for comprehensive evaluation of logistics systems

Traffic- and business-related cost indicators can easily be found and used in evaluating logistics systems. For example, when average vehicle speed in an urban area is low, it is clear that the physical distribution of goods is not operating at the optimal level of efficiency. However, by combining these cost and quality indicators or by aggregating them into a regional or national average value, a more comprehensive evaluation can be conducted.

Traditional logistics performance measures

Traditional performance indicators for logistics systems have largely relied on simple quantitative measurements. While such simple measurements are convenient for conducting comparative analyses among different nations, they are sometimes inadequate for comparing the efficiencies of supply chains as a whole. For example, road transport has the highest energy consumption share among the different transport modes. However, a simple modal shift from road to rail or sea does not directly induce a decrease in energy consumption. These inter-urban modes generate huge volumes of feeder truck transport. Therefore, the single modal approach is not adequate for assessing the real impact of freight transport on the environment.

The need for new performance indicators

Door-to-door approach for intermodal transport

There is a need to develop new logistics performance indicators that better reflect actual conditions of supply chains as a whole. In order to improve transport policies in a competitive market, intermodal statistics that provide details on the volume and structure of transport flows are also needed. Data on transport modes and loading units used, types of goods transported, and other parameters of transport are required in order to enable comparative analysis with a single transport mode. There are several types of indicators for intermodal transport systems. The following discussions include some case studies in which several performance indicators are tested.

The door-to-door approach, which involves the direct transfer of goods of intermodal transport from origin to destination, is preferred to evaluate the whole supply chains. Logistics costs depend on the type of cargo and the conditions of transport, including distance and weight, and other services such as handling at night or on holidays. The key factor usually depends on truck feeder transport costs.

Table 3.1. **Cost composition of intermodal chain from Southeast Asia to Japan**

Percentages

Total	100.0
Southeast Asian terminal	37.2
Sea	35.2
Domestic inland cost in Japan	27.6

Note: Aggregates of 31 samples. Does not include inland transport cost in Asian countries.
Source: The Japan Institute of Logistics Systems (JILS).

Table 3.2. **Detailed composition of cost**

	Percentage	JPY per container
Total	100.0	419 003
Southeast Asian terminal	*37.2*	*155 843*
Export inspection	1.8	7 358
Packaging	21.0	88 123
Loading	2.1	8 693
Transport to yard	6.6	27 824
Custom	3.9	16 436
Loading to ship	1.8	7 409
Sea transport cost	*35.2*	*147 453*
Terminal in Southeast Asia	3.4	14 147
Sea transport	26.1	109 408
Domestic terminal	4.6	19 120
Others	1.1	4 778
Domestic inland cost in Japan	*27.6*	*115 707*
Receiving	4.8	20 316
Unloading	9.6	40 051
Inspection	0.7	3 050
Customs	2.7	11 215
Inland transport	9.5	39 665
Other	0.3	1 410

Source: JILS.

Table 3.2 shows detailed composition of cost in the case of international sea and land transport. It can be seen that handling costs in terminals are very high. In the case of domestic rail and road transport, as shown in Table 3.3, the ratio of road feeder cost to the total intermodal transport cost is high (48.7% in production goods and 32.1% in consumer goods). The road feeder cost includes total cost of the road transport component:

- collection of freight from consignor and carriage to rail terminal for loading and transport by rail; and
- collection of freight from rail terminal upon arrival and carriage to consignee.

Therefore, it is important in intermodal transport to identify not only the role of major trunk transport by sea or rail but also the role of handling in terminals and road feeder transport. In addition, when road transport costs are lowered, even intermodal transport becomes more attractive, although there are constraints on delivery time.

Furthermore, in regard to the environmental impacts of intermodal transport, energy consumption of total truck transport (single-mode transport) is not necessarily greater than intermodal transport, when the feeder truck transport is longer and not only the fuel consumption of transport but also the energy consumption of equipment and physical infrastructure is included.

Table 3.3. **Cost and time comparison between single modal (road) and intermodal (road and railway) transport**

Cost	Tokushima to Tokyo Product goods Case A		Kanagawa to Saitama Consumer goods Case B	
	JPY	%	JPY	%
Road only	166 600		143 900	
Intermodal	135 600	100.0	134 000	100.0
-Road 1	42 200	31.1	24 000	17.9
-Rail	69 600	51.3	91 000	67.9
-Road 2	23 800	17.6	19 000	14.2

Time	Case A		Case B	
	Minutes	Intermodal/Road only	Minutes	Intermodal /Road only
Road only	600		720	
Intermodal	1 540	2.567	4 270	5.931

Source: Survey by Japanese Ministry of Land, Infrastructure and Transport.

Table 3.4. **Energy consumption**

Kcal/km

	Length of door-to-door		
	100 km	200 km	500 km
Truck only	444	417	396
Intermodal: Rail short feeder	398	363	305
Rail only	557	436	363

Note: 1993 Estimates. Feeder 20 km on both sides.
Truck: trunk 80km/h, feeder 20km/h, load volume: 11 tonnes.
Source: Institute of Highway Economics (1993), *Road Transportation: Energy and Environmental Problems*.

Macro-cost on logistics

Transport costs represent a significant share of total logistics costs. For Japan, macro-logistics costs represented some 10% of GDP in 1995, and transport costs accounted for 65% of logistics costs at the sales delivery stage. Therefore, improvement of transport systems is a very important component in improving the performance and international competitiveness of logistics systems in Japan. In considering this, the interdependency between transport costs and inventory costs should also be taken into account.

Table 3.5. **Macro-cost on logistics**

JPY trillion, FY 1998

Total	47.1
Transport	30.5
Stock	14.5
Management	2.1
GDP	494.4
Total cost/GDP	9.5%

Source: JILS.

Table 3.6. **Composition of logistics cost in manufacturing industry, 1997**

Percentages

Total	100.0
Transport	58.9
Stock	20.1
Other	21.0

Source: JILS.

Efficient prices for transport in the Netherlands

Indicators of the social costs of various transport modes are available in the Netherlands. These indicators can be useful in considering policy options for internalising the social costs, thereby enabling a more appropriate distribution of costs and better modal choice based on full costs.

In principle, the social costs of vehicular traffic embrace all the costs (direct and indirect) associated with that traffic. A correction for market distortions caused by government intervention should only be considered for those costs that are ignored by users in their mobility decisions and which are passed on to society as a whole.

The marginal social costs (MSC) are the social costs arising when one additional vehicle or vessel joins the existing traffic volume. By consistently confronting each and every mobility decision as precisely as possible through marginal social costs – by means of a cost-effective pricing policy – mobility can be regulated at the social optimum. Hence, an efficient pricing policy should lead to enhanced efficiency in transport and to greater overall economic welfare.

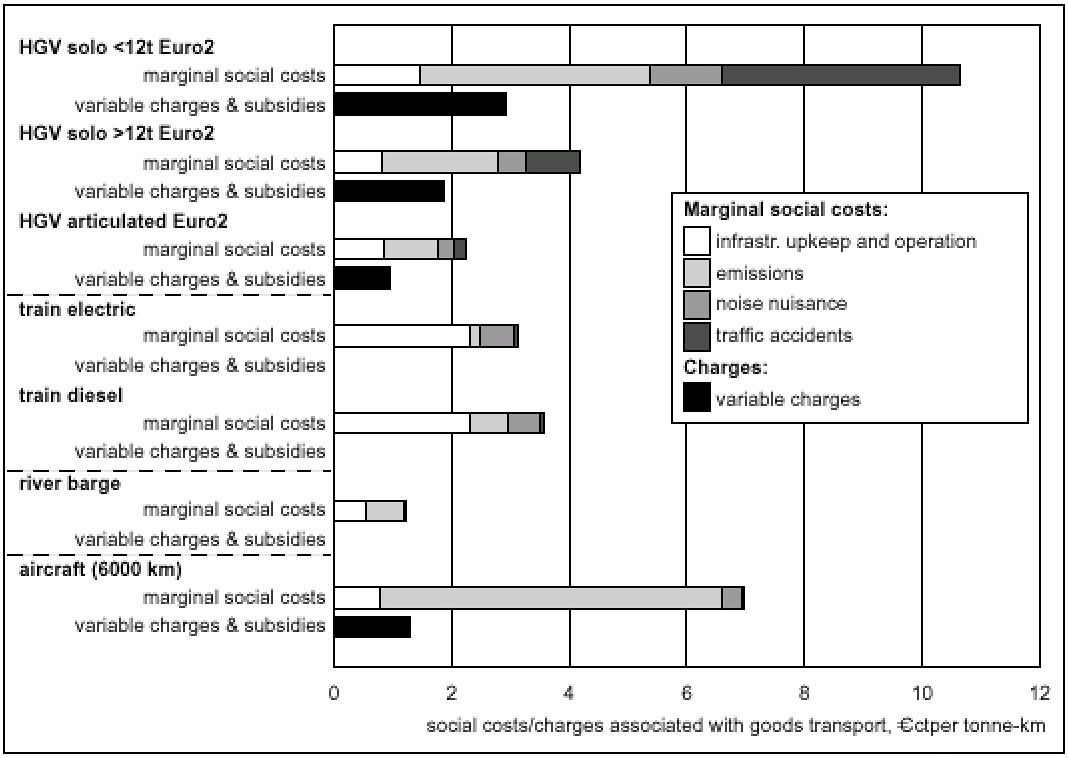
Marginal social costs can be internalised in a variety of ways, of which government pricing policy is just one. In the past, vehicle standards relating to emissions, noise and safety have proved to be effective means of reducing the external costs of transportation.

Figure 3.1 shows the marginal costs associated with the various means of transportation of goods. The marginal social costs are divided into infrastructure upkeep and operation costs, the external costs of traffic incidents, noise nuisance and emissions. For each transportation mode, the variable charges are added below the marginal social costs.

The cost-charge differential varies from about EUR 0.01 per tonne-km for inland shipping to EUR 0.06-0.07 for aviation and small HGVs. No category of goods vehicles covers its external costs through payment of variable user charges. The cost-charge differential (in EUR per tonne-km) is currently greatest for the lightest category of HGVs and smallest for the articulated HGV. On long hauls, served by rail, shipping and articulated HGVs, the differential is greatest for rail (about EUR 0.03 per tonne-km) and least for inland barges and articulated HGVs (over EUR 0.01 per tonne-km). In the case of air freight, there is a gap of about EUR 0.06 between the MSC and variable charges, which amounts to the high external costs of airborne emissions.

Figure 3.1. **Marginal social costs and charges**

EUR cents per tonne-kilometre (excluding congestion costs)



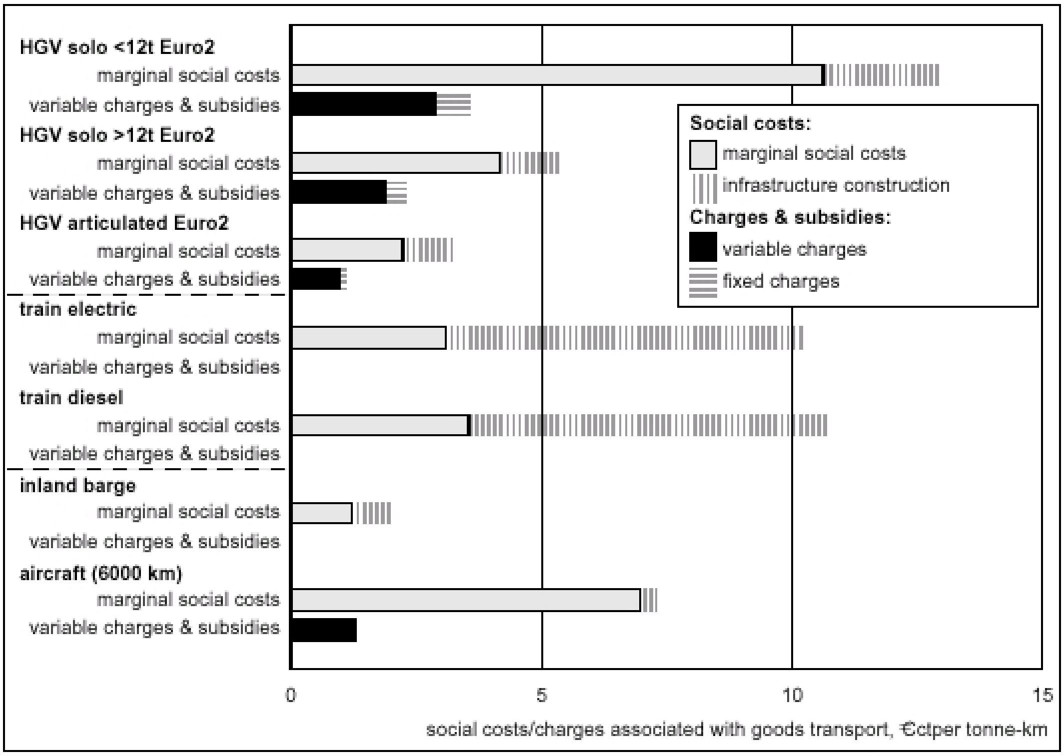
Source: Centre for Energy Savings and Clean Technology, *Efficient Prices for Traffic*.

Figure 3.2 shows the marginal social costs and the costs of infrastructure construction. Of the fixed social costs, only the costs of infrastructure construction have been quantified, with no consideration being given to the external costs of space occupation by parked vehicles, ecological fragmentation and landscape deterioration. Given the considerable differences in the amount of "parking" space occupied by the various vehicle categories, inclusion of the associated external costs would lead to changes in the differences among the various modes of transport. Hence, the present results underestimate the fixed costs.

As with marginal social costs, the construction costs per tonne-km decrease with the size of the vehicle, ranging from about EUR 0.02 for a small HGV to about EUR 0.01 for an articulated HGV. Rail freight is confronted with high construction costs of about EUR 0.07 per tonne-km, exceeding the MSC. The costs of infrastructure for inland barges are about EUR 0.01 per tonne-km, about equal to the MSC. The infrastructure construction costs for air freight are low (about EUR 0.003 per tonne-km) compared to other modes of goods transport.

Figure 3.2. **Total social costs and charges**

EUR cents per tonne-kilometre (excluding congestion costs)



Source: Centre for Energy Savings and Clean Technology, *Efficient Prices for Traffic*.

Road safety and benchmarking

Safety is a crucial factor in attaining sustainable development in the transport sector. There are two sides to the road safety issue. One is the societal perspective: What are the impacts for society of road crashes and victims? What should society do to reduce the problem? The other is the individual perspective: How are road crashes influencing the life of citizens? What could a road user do to reduce the problem? Difficulties arise because the two perspectives are radically different: what is clearly a huge problem for society is often perceived as a small problem for the individual.

To date, no comprehensive benchmarking work has been carried out in the area of road safety. However, the OECD and the World Road Association (PIARC) Road Safety Committee (C13) have touched upon the problem and have produced some valuable documents. The EC, in its latest road-safety programme, indicates the need for a better information system within the Union. This is a necessary, but not sufficient, step towards benchmarking. The ETSC (European Traffic Safety Council) has launched a project to construct road-safety performance indicators – a prerequisite for an effective benchmarking activity in the area of road safety. Outside Europe, Australia is probably the country which has the most experience in road-safety benchmarking.

Chapter 4

DEVELOPMENT OF BENCHMARKING METHODS FOR COMPARISONS OF THE RELATIVE EFFICIENCY OF MODES

Framework for intermodal benchmarking

This chapter aims to provide potential users with a range of approaches that can be either used directly, or modified to meet their own objectives.

Most of the existing work on benchmarking of transport activities uses *partial productivity (PP)* analysis, such as labour or capital productivity (*e.g.* revenue tonne-kilometres per employee, containers handled per hour). There are a number of reasons for this:

- Benchmarking studies are limited in scope by the availability of data, in particular, data which are standard across the facilities or modes on which the comparative analysis is based.

- Such analyses appear to be more relevant when comparing activities at facilities that have the same function (*e.g.* container yards) and which have similar operational, political and geographic characteristics. These similarities provide the “level playing field” that allows:

  – Policy makers to compare a specified activity or operation (*e.g.* container stacking procedures in a container yard, administration required for entry at the yard gates, crane capacity utilisation, stevedoring productivity, etc.) and establish that it requires improvement.

  – A designated “best practice” to be transferred from one jurisdiction to another and result in a predictable improvement in efficiency.

In order to be an effective tool, the use of partial productivity measures is therefore limited to instances of like operations and to analysis of specific and singular activities. In an intermodal context, however, partial productivity cannot fully take into account all of the various operations and issues involved.

When two jurisdictions have dissimilarities, and when it is desirable to benchmark the efficiency of a sequence of activities or a group of operations, partial productivity measures have been shown at times to be inadequate or misleading. For example, comparing Port C which is capital-intensive to dissimilar Port L which is labour-intensive, using a capital productivity measure, might show that Port L is more productive. Should Port L replace labour with capital, its (capital) productivity would diminish whereas overall cargo handling would probably become more efficient. It is therefore vital that the results of a benchmarking exercise be correctly understood and interpreted.

When benchmarking a sequence of transport activities the likelihood of dissimilarities increases markedly. Within an integrated transport chain, every difference in line-haul activity, cargo transfer activity, border crossing operation, policy environment, route geography, commodity mix, etc., adds an additional layer of complexity to a benchmarking exercise. A balanced approach must be used that could allow, for example, the efficiency of transport activities of an island nation to be accurately compared to those of a landlocked nation or for a credible comparison of various intermodal corridors.

In theory, the use of *total factor productivity (TFP)* analysis addresses these difficulties to some extent by providing for the varying use of all factors of production. It must be emphasised, however, that when referring to the benchmarking of intermodal activities, it is not intended that one operation be applied to the entire analytical exercise.[17]

Total factor productivity is derived from cost data. An important consideration is that intermodal services are provided by a number of carriers and, with the exception of shipping lines, carriers do not generally provide publicly available information on the cost of intermodal services. Therefore, in practice, the information required to apply this methodology would not generally be available. As such, the use of TFP has been generally confined to the study of a particular modal sector, or comparison of modal interfaces such as maritime ports. The analyses also tend to focus on activities with similar jurisdictional characteristics (political, administrative, and geographical).

Essentially, TFP is calculated by dividing all outputs (weighted by revenue contribution) by all inputs (weighted by cost shares). There are various ways to calculate TFP, but for an example, crude TFP can be calculated as follows:

$$TFP(k)= Y(k)/ X(k)$$

for:

$$Y(k)=v_1y_1(k)+v_2y_2(k)+\ldots v_my_m(k),\Sigma v_i=1$$

$$X(k)=w_1x_1(k)+w_2x_2(k)+\ldots+w_nx_n(k),\Sigma w_i=1$$

where

$Y(k)$ is an output index for Firm k

$X(k)$ is an input index for Firm k

y_m are output quantities

x_n are input quantities

and v_m and w_n represent revenue and cost shares for the respective outputs and inputs.

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17. It is not possible to conduct a credible TFP benchmarking exercise between modes and facilities, in a number of countries, along an integrated supply chain, in a single operation. There are also a number of other issues, such as border crossing delays, etc., that complicate this comparative analysis. However, given the resources and adequate data, it would be theoretically possible to "benchmark" the various modal components of an integrated transport chain and arrive at a set of "best practices" for the entire chain.

TFP analysis has a number of limitations. It is a high-level measure applied to a particular modal component or facility within the transport chain. Insofar as the ultimate goal of any benchmarking exercise is to improve one's operations*:*

- Total factor productivity comparisons will not indicate where in the transport chain such improvement is required.[18]
- Data requirements are substantial.[19]
- There is disagreement regarding which inputs and outputs must be considered and how they are to be measured.

Although the second point above may suffice to impair any thorough TFP analysis of an intermodal movement, it is the last point that truly limits the soundness of an accurate evaluation.

Inputs

Evaluating inputs: *i*) on a cross-modal basis; and *ii*) on an international basis, present the following problems.

Cross-modal (or inter-modal)

Consider a comparison of two intermodal movements, one that is predominantly a truck movement and the other that is predominantly a maritime movement. The types of fuel input for these two movements are not the same, but they can be normalised using British Thermal Units (BTUs).

However, some modes have inputs that are not available to others, such as vessel chartering which is available for ocean line-haul, or the use of owner-operators in the trucking industry. The limits associated with driver hours in trucking are not present to the same degree in the rail and maritime industries. There is no clearly accepted method of normalising such inputs.

Consider a second comparison of two intermodal movements, one with truck-maritime-rail segments, and the other with only truck-rail segments. The presence of the extra modal interface in the first movement presents an added complexity – the first productivity measure will have to include elements related to the operation of port equipment, berthing and other port-related charges, and pilotage requirements. Some composite measure of input utilisation must be developed, but again there is no clearly accepted method for doing so.

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18. One possible approach would be to target specific functions and to carry out specific benchmarking analysis on these activities, and then re-evaluate the whole chain. For example, one element in an intermodal movement would be gantry crane operations, so a "micro-analysis" might be completed on this activity. Improvement in gantry operations, however, may not result in a significant improvement in the TFP – perhaps the biggest impediment to an efficient movement is a lengthy customs clearance process. Any change to the clearance process may affect other links of the chain so use of TFP to improve the performance of an intermodal movement as a whole would be an iterative process.

19. In attempting to develop a series of performance indicators for the 2001 OECD report on *Intermodal Freight Transport: Institutional Aspects*, it became clear that it was very difficult to obtain standardised data across Member countries. Achieving a consensus on definitions for indicators represents an additional challenge.

International

Expanding a benchmarking analysis to an international level requires an even greater degree of sophistication. Most important are the complexities added at border crossings. For example, the input portion of the productivity ratio must reflect customs clearance requirements. If train crews are required to be changed at a border, the difference in costs for the skilled/unskilled labour will have to be accounted for, and the price of labour may reflect not only the relative wealth of each country but also different degrees of education and experience. Currencies, taxes, speed limits, weight and dimension regulations are just some examples of issues that may need to be factored into the analysis.

Outputs

The use of aggregated freight tonne-kilometres as an output is inadequate in itself. The value of a tonne-kilometre can vary with the type of commodity being shipped, and (particularly in the case of rail or maritime movements) with the shipment distance. A distinction must be made if the movement involves unprocessed bulk commodities rather than a high-value containerised merchandise. If the movement is a long one, where the fixed costs associated with a tonne-kilometre are less than for a short haul, this too must be accounted for in the analysis. Therefore as much detail as possible must be used for output measures and their associated input measures should be similarly disaggregated.

Other measurement issues

A number of other measurement issues arise when attempting all-encompassing analyses like TFP. These can be broken down into four main groups of issues relating to:

- *Safety:* There is little consensus in the designation of values for accidents, injuries and fatalities. Further, the method of measurement of these can vary; for example, some countries require death to occur within a certain time after an accident for it to be allocated to that accident.

- *Environment:* Environmental issues are currently the subject of careful scrutiny by various international groups. The costs associated with various pollutants, as well as those related to congestion and interference, are all acknowledged to be deserving of consideration and should be included in a thorough TFP analysis.

- *Service quality:* Even more obscure than safety and environment are costs or revenues associated with service quality. These can include a broad spectrum of areas such as on-time performance/service rates, use of electronic data interchange (EDI) and other technologies, and customer satisfaction.

- *Infrastructure:* Costs associated with infrastructure development and maintenance are difficult, if not impossible, to obtain. Where they are available, the allocation of these costs to a particular freight movement would involve quantifying the damage inflicted by that movement relative to: *a)* damage by other freight and passenger movements; and *b)* deterioration due to environmental factors.[20]

20. Allocation of infrastructure costs is a controversial domestic issue in many jurisdictions. International agreement on an allocation framework would be difficult to achieve.

The use of total factor productivity to analyse the performance of an intermodal movement may be ideal in theory but may not be feasible in practice. Its use to evaluate modal interfaces may hold greater promise, although measurement and definitional issues remain a significant challenge.[21]

The intermodal chain

One of the many difficulties in benchmarking intermodal activities is that the limits of the intermodal transport chain are not clearly defined. The term can be, and has been, applied to the full spectrum of transport activities – from the assembly of goods on the factory floor to their appearance on the retailer's shelf.

It is reasonable to argue that it is the performance of this entire chain that matters, and that benchmarking of intermodal activity should include all elements of it. To do so would be immensely complex, perhaps unmanageably so. While it is true in principle that a focus on anything less than the full chain runs the risk of encouraging partial optimisation, in practice this risk may be small. For the purpose of developing a benchmarking methodology, it is better to focus on a smaller but more manageable set of activities.

At the other extreme, "intermodal" is often used as a synonym for intermodal road/rail, road/sea or rail/sea operations.

For the purpose of benchmarking intermodal transport, the intermodal system may be defined as those activities that occur between the point at which cargoes are consolidated (into containers) and the point at which they are de-consolidated. This eliminates many of the most variable elements of the transport chain, and concentrates on the major unitised movements that form the core of the intermodal system as it is commonly understood.

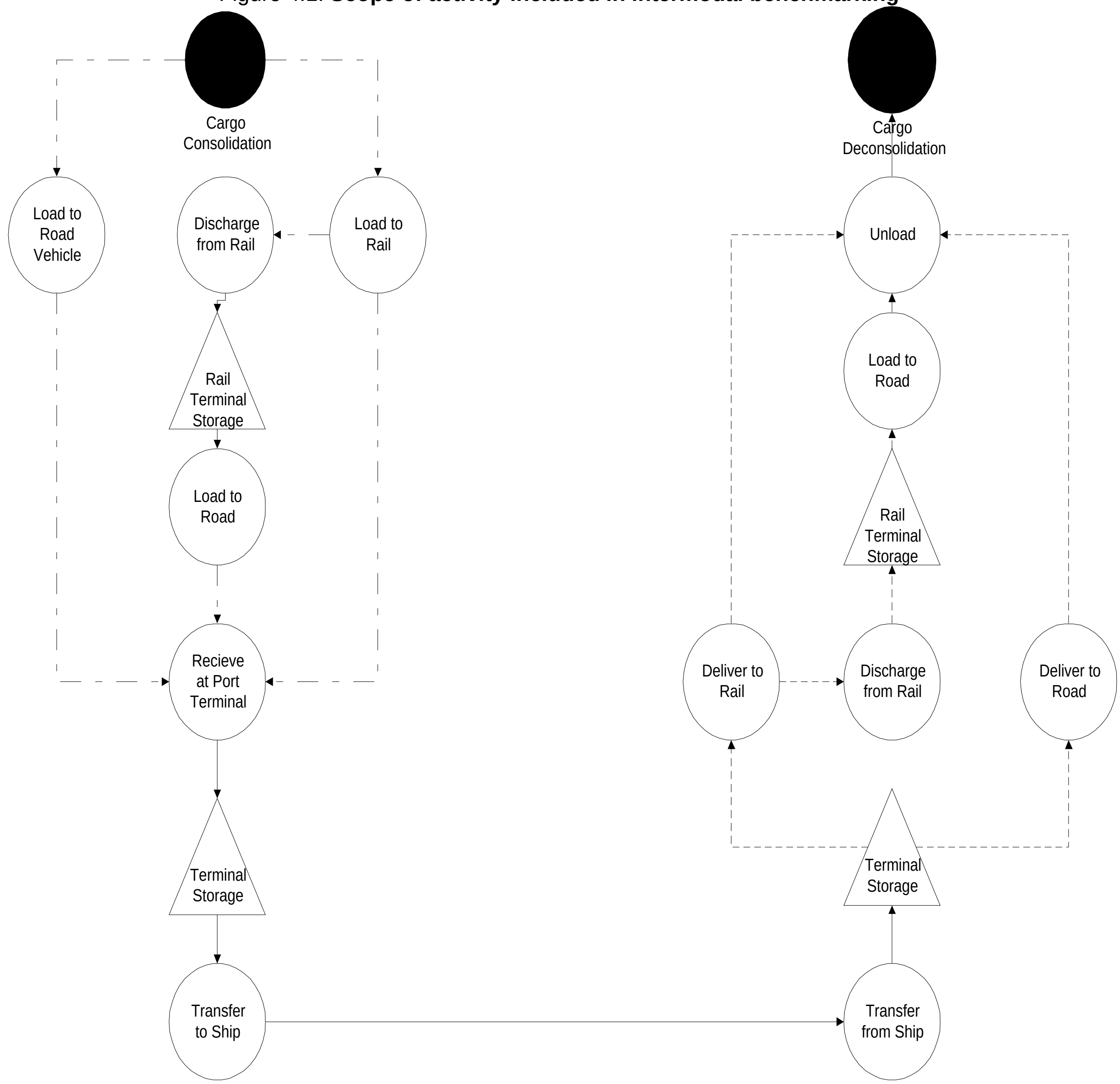
Figure 4.1 indicates the broad range of activities that would be included in intermodal benchmarking if this more limited definition were adopted. This transport chain involves the transportation modes of sea, road and rail and all the interchange points – seaports, land intermodal yards and terminals. The efficiencies of all the intermodal linkages are seen as the distinguishing sections that separate the benchmarking of individual modes or terminals from the benchmarking of the total supply chains. This section therefore concentrates on developing inter-connecting performance indicators for each of the links of the supply chain and incorporating the single modal and terminal performance indicators where appropriate.

It is possible to disaggregate the intermodal supply chain further than outlined in Figure 4.1. In particular, the various intermodal exchange activities can be isolated and separately benchmarked to gauge their impact on total supply chain performance.

Figure 4.2 shows this from an import perspective. This transport chain would include: sea transport, ship to port wharf, wharf terminal, port warehousing, port warehouse exit terminal, wharf/port road access, road operators, (and where relevant, direct rail siding on the wharf), urban warehousing/de-consolidation (where de-consolidation takes place at which point, for the purposes of this study, the supply chain ends), access roads to receiver's distribution (typically urban road), receiver's receiving depot's access, receiver's receiving depot.

21. The solution to benchmarking intermodal services is to develop measures of cost of services, along with service factors such as speed and reliability of services.

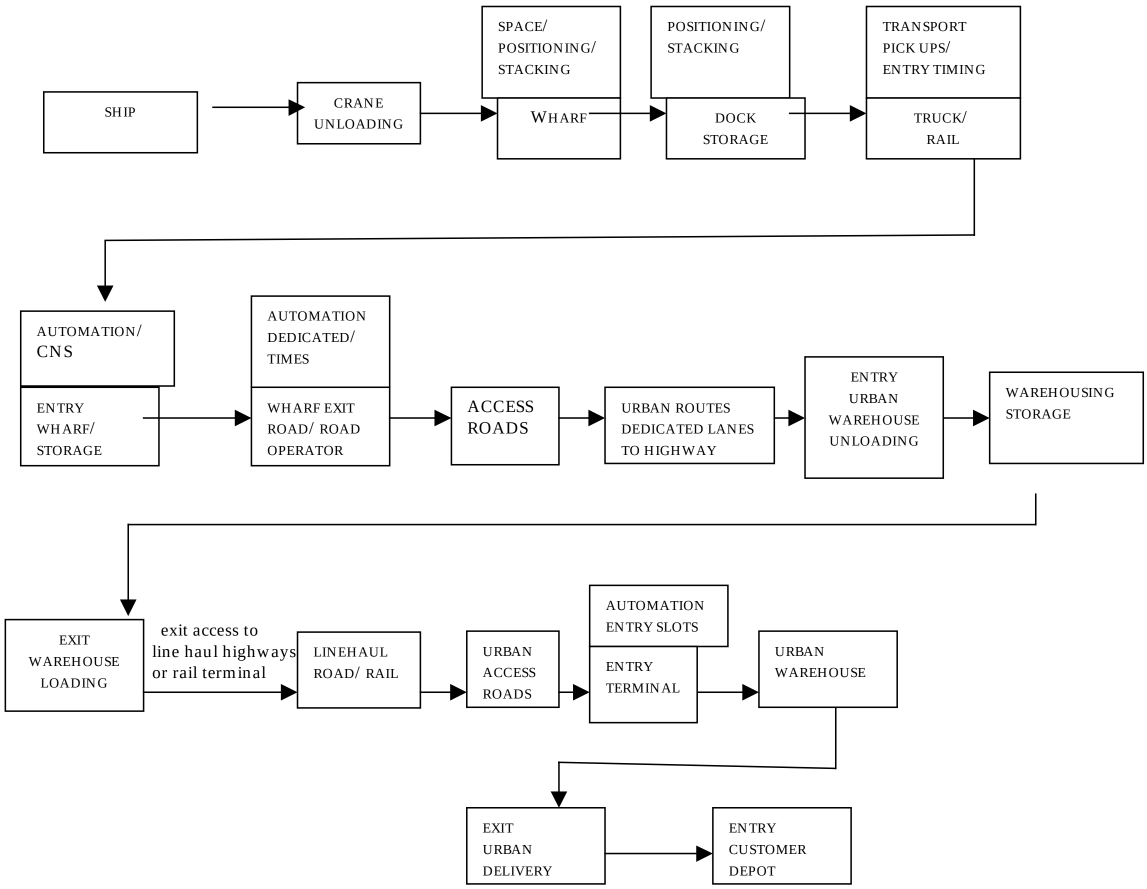
Figure 4.1. **Scope of activity included in intermodal benchmarking**



Similarly, from an export perspective, the transport chain for container traffic may include: exit from an urban or inland supplier's warehouse, urban transport or line-haul including access roads to port, incoming terminal to port warehouse, wharf storage, port wharf loading to ship.

A major issue for intermodal benchmarking is the amount of detail collected and reported. For example, a benchmarking study that carefully monitors each of the supply chain linkages outlined in Figure 4.2 would be thorough, and very likely able to isolate the key factors affecting performance. However, it may provide too much detail to allow easy understanding by its target audience. Hence, reporting according to the framework outlined in Figure 4.1 may be more useful.

Figure 4.2. **Importers' intermodal supply chain**



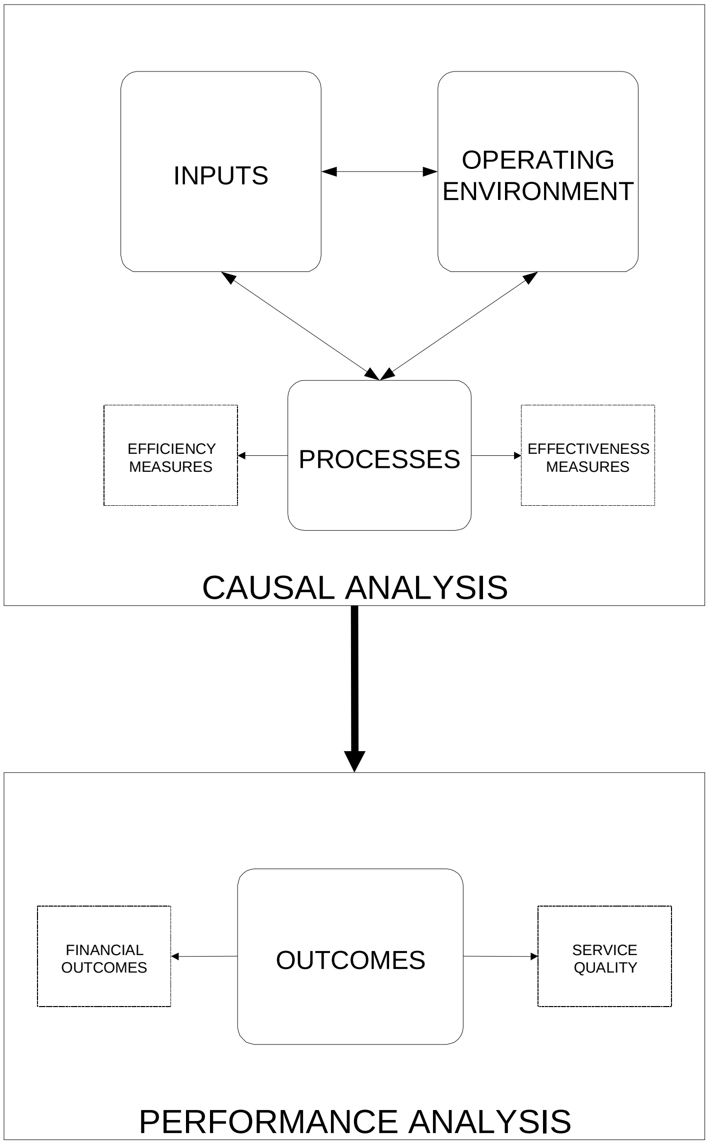
What to measure

If the objective suggested for this project is to be achieved, the benchmarking strategy must pay attention to the monitoring and measurement not only of performance outcomes, but also of those factors that are likely to be responsible for intermodal performance, or lack thereof.

To some extent, this is inevitably an iterative process. As the benchmarking process progresses, understanding of what is most important in determining differences in performance will increase, and the focus of attention can be refined. Although a literature survey did not reveal any former benchmarking studies of intermodal performance, some of the earlier studies on performance of elements of the chain do help to illuminate areas of likely importance. However, given the limited amount of work that has so far been done in this area, it is almost certainly wise to maintain a general measurement framework at this stage.

Such a framework is outlined in Figure 4.3, and used to structure the comments of the remainder of this presentation. In the sections that follow, the approach has tended to err on the side of inclusiveness. However, it is unlikely that any individual study will be able to cover all of the aspects encapsulated within such an approach.

Figure 4.3. **Framework for intermodal performance analysis**



The focus of this discussion is on:

- Reasons for benchmarking the holistic supply chain.
- Outcomes for the entire intermodal transport chain.
- Measures of the performance of the main elements of this chain.
- The impact of key infrastructure and equipment inputs.
- The operating environment.

The aim is to achieve a manageable, like-with-like methodology for benchmarking intermodal transport.

Partial analysis vs. holistic analysis

Traditional economic analysis of transport tasks looks at the different elements of the supply chain on an individual modal basis. With only a limited analysis of each of the interfaces between the key elements, such research produces, at best, a partial analysis of the interdependency of the total supply chain. This approach is inadequate because it:

- Ignores interdependencies between the elements and the importance of the entire transport chain for given tasks.

- Yields a partial assessment of performance.

- Ignores the fact that interfaces are important and can exert a significant influence on modal choice and overall performance.

- Provides little or possibly inappropriate signals to the users of multi-transport services.

As a result, interest is growing in a system-wide analysis using a multi or intermodal framework as the reference point for evaluating the efficiency of transport chains. This approach stresses not only the performance of individual elements and linkages between them but also the need for system-wide efficiency measures. Performance in this context needs to be assessed having regard to the technical, pricing and dynamic efficiencies of the overall supply chain.

Efficiency in intermodal transport requires each mode and each terminal comprising the total supply chain to operate in an efficient manner. To achieve this, each component of the total freight transport chain must perform at that level which achieves maximum output level for the lowest cost. Overall efficiency is obtained when these individual participatory efficiencies are combined in such a manner that holistic efficiency is achieved.

Performance efficiency relates to how well the resources are being utilised. Performance effectiveness relates to how well the goals of all the participants (shippers/customers/operators) of the total transport chain are being attained. Efficiency is a minimiser or maximiser concept. Performance effectiveness relates to desired achievements of the participants. Emphasis on customer service requirements (such as price/costs, timeliness, loss and damage or any other goal that each of the participants perceives to be important) will differ between participants and over different time periods. Thus, in some instances, the supply chain may be efficient but not effective: *i.e.* there are no wasted resources, but major goals of key participants are not being achieved.

Interdependencies of the holistic supply chain

When a transport chain is viewed in a holistic manner, maximum efficiency will only be achieved if all modal and terminal operators are providing maximum service at minimal cost. If any service provider is not attaining the optimum at their particular link of a particular transport chain, then the entire intermodal freight service will fall below maximum efficiency. Further, when all participants of the container transport supply chain are operating efficiently, there are compounding benefits that result in higher supply chain efficiencies.

Consequently, any generic benchmarking study of intermodal supply chains for container traffic must first identify the weakest link of the particular supply chain corridor being benchmarked. As in any chain, the weakest link determines the overall strength of the entire chain. Due to the interdependencies of transport supply chains, the weakest link will impact differently depending on the position it holds within the supply chain. For example, if the weak link occurs early in the transport chain, then choices relating to immediate partners in the chain will be different from the most efficient choice. These inefficiencies will compound throughout the chain. If the weak link occurs towards the end of the supply chain, then choices relating to the ongoing partners of the chain will not be as adverse.

Similarly, if one part of the chain is markedly more efficient due to superior managerial talents, technology, etc., than the remaining links of the chain, then this "kink" in efficiency may be detrimental to the overall efficiency of the total chain. For example, bottlenecks may occur and other participants either backwards or forwards in the chain may suffer from lumpiness in delivery flows.

Dynamic inefficiencies may develop in that such shifts away from a particular junction may lead to other modal or terminal links, which are the most efficient, being by-passed, and less efficient (second-best) alternatives being used. In the longer term these less efficient modes or terminals will compound inefficiencies along the entire transport chain. The stakeholders of these less efficient transport links will attempt to maintain their market share, which may prevent the most efficient or "first-best" transport link from being used for considerable periods. Further inefficiencies may permeate outwards on either side of this link and compounding inefficiencies will occur along the total transport freight chain. Not only will quality of service drop but costs will become distorted.

Measuring performance outcomes for the entire intermodal transport chain

Measuring outcomes of the supply chain is usually of considerable interest to users and other stakeholders as it provides an indication of relative performance between the benchmarked services (perhaps different corridors, trades or points in time). It is one of the most straightforward elements of the intermodal transport chain to report.

Performance outcomes for the entire intermodal supply chain can be reported on three separate levels:

- Key performance indicators of the transport chain as a whole (*i.e.* from commissioning to decommissioning containers).
- Measures of the seamlessness of the "holistic" supply chain.
- Survey-based measures of customers' perception of the supply chain.

Key performance indicators of intermodal supply

The major categories of performance indicators of the intermodal transport chain include:

- Pricing.
- Financial (including profitability).

- Timing (including transit time, frequency of service and on-time reliability).

- Service quality (loss and damage control).

- Ease of use (including administration, asset management and human resources).

These factors are discussed below, including recommendations of preferred measures. Table 4.1 outlines the range of measures from each category that may be applied to intermodal container benchmarking depending on circumstances and objectives.

Pricing outcomes

Pricing outcomes monitor the sum of the direct transportation charges paid by the user to move the container from the point of commissioning to the point of decommissioning. Assuming that intermodal operation will usually apply a through transport freight rate, this should be comparatively straightforward to measure.

Some suggested measures include "freight rate per TEU" and "freight rate per FEU". It may also be desirable to obtain information on both dry and refrigerated containers.

Financial outcomes (including profitability)

It is useful to view the financial outcomes from both the user and the producer perspective, if adequate information is available.

Financial measures from the producer perspective would include measures of profitability. It is particularly useful to monitor profitability where there is reason to believe that one or more of the core operations in the intermodal chain is explicitly or implicitly subsidised.

Information availability is likely to be a problem here. It is more likely that information will be available for rail operators and port terminals than for road and shipping operators, but even in the former cases it is far from certain. As the core enterprises involved in the intermodal transport chain are capital-intensive, an asset-based ratio is probably the most appropriate measure of profitability.

Financial measures of users should include the sum of the direct freight charges plus any other costs associated with transportation. These may include the cost of holding the inventory, losses associated with any delays incurred and their own administration costs. The appropriate measures include "rate of return on assets" (producer) and "total freight cost per TEU" (customer).

Timing

Three main temporal issues emerge in discussions of user choice in freight transport:

- Frequency of service.

- Transit time.

- Predictability or reliability.

Table 4.1. **Framework for intermodal performance analysis**

Price	Financial	Timing	Loss & damage control	Ease of use	Technical	Asset management
Door-to-door (distance-based)	Return on assets	Total cycle time (distance based)	Ratio of L&D claims to total number of containers carried (distance-/value- or time-based per cycle)	Invoicing accuracy Claims processing (insurance/damage)	Flexibilities Scheduling/ Equipment/ Computer links/ slottings	In-transit privileges
Door-to-door (value-based)	Return on equity	Transit time variances (distance-based)	Notification procedures to shipper of L&D	Shipment tracing/ asset visibility	Slotting ease	Flexibility of routings
Door-to-door (time-based)	Trading margin	On-time performance (sustainability factor)	Tracing abilities to pinpoint L&D within chain	Feedback across all sections of the chain Courtesy levels	Equipment availability	Technological superiority in total chain
Willingness to negotiate	Total freight cost to customer	Timeliness reliability (% level of reliability to published or quoted estimated time of arrival)	Value of L&D claims to total number of containers carried (distance-/value- or time-based per cycle)	EDI/Common documentation	Equipment mobility Physical condition of equipment	Ability of negotiating service changes
			Common insurance	Knowledge of shipper's needs Shipper relationship	Specialised equipment	Infrastructure compatibility

In principle, measurement of service frequency is straightforward. However, there may be practical difficulties. Consider, for instance, the case where three competing shipping lines each offer a weekly intermodal service between an origin and a destination. Acting in its own right, each line will offer one service per week to its customers. However, a freight forwarder operating in competition and buying slots from each of the operators, could advertise three services per week.

Monitoring transit times is more straightforward. In keeping with the boundaries proposed in this report, the relevant duration is from the time of container availability for collection at the point of consolidation to the time of delivery at the point of de-consolidation.

Two dimensions of reliability warrant separate measurement: consistency can be measured as the variance of the transit time referred to above; reliability will generally be far more difficult to measure and relates to occasions on which a service that is offered and accepted is not delivered (this could result, for instance, from short-shipment of booked cargoes; the appropriate measure is the percentage of cargo for which failure occurs).

Loss and damage control

Loss and damage is often less important for containerised cargo than for general freight or even break-bulk cargoes. However, losses and damage do occur and need to be measured in an intermodal benchmarking study.

The core output measures relate to the ratio of the number of loss and damage claims per container carried, and the value of loss and damage claims per container carried. However, if data are available, it is also useful to identify reasons for loss or damage within the chain and to understand how and when the shipper is notified about any associated problems.

Ease of use

Ease of use in the intermodal transport chain relates principally to administrative procedures such as the simplicity of documentation. It also includes the error rate in invoicing clients, shipment tracing capability and aspects of the relationship between the service providers and the client.

Appropriate measures include those outlined below and indicated in Table 4.1:

- The proportion of transactions performed by electronic data interchange (EDI).
- The number of documentary clearances required for a "typical" unit of cargo in transit.
- The number of documents that must be prepared for each unit of cargo.

The section below on key performance indicators of holistic supply chains focuses on ease of use as these generally relate to the seamlessness of transfers between major transport modes in intermodal container movements.

Key performance indicators: holistic supply chains

As discussed earlier, any generic benchmarking study of intermodal supply chains must develop inter-connecting performance indicators for each of the links of the supply chain. In many instances, these will focus on intermodal linkages and how these allow a seamless transfer of containers between the different core transport modes (*i.e.* rail, road and sea transport).

The ability to provide an integrated intermodal transport service depends largely on the compatibility of transportation equipment, the meshing of operating schedules and the extent of commonality in administrative arrangements such as invoicing and other documentation using EDI or manual methods.

Table 4.2 provides a list of the major aspects of the intermodal supply chain that will determine the ease of transition between transport modes from the point of consolidation of containers to their ultimate de-consolidation. The table shows that there are many administrative requirements, such as billing, packaging and insurance, that need to be standardised to ensure an easy transition between transport modes and thereby reduce freight costs and the potential for delays.

There are also a number of aspects of the intermodal transfer that are more difficult to alter in the short term, yet are often critical to the overall performance of the intermodal freight services. These include the meshing of schedules, for example between trucks and freight trains, and the flexibility of lifting equipment to easily cater for containers of different dimensions.

Table 4.2 also suggests a number of measures of electronic data interchange (EDI).

Table 4.2. **Indicators of the seamlessness of the holistic supply chain**

Indicator	Explanation
Meshing of schedules	Measured in terms of time delays either per comparable section of the supply chain or whole comparable supply chains.
Design compatibility	Measures standardisation of equipment along length of chain.
Flexibility to cater for all container sizes along total length	Measures the ability of each section of supply chain to accommodate any container size. Measure of adaptability of equipment per section or entire length.
Complete asset visibility	Measured by time and/or distance that container is visible (real time) over total time and/or distance.
Common documentation	Measures the number of separate items of documentation required.
Common EDI access to documentation	Measures the compatibility of EDI systems and the extent of access possible for each of the key stakeholders throughout the transport chain.
Equitable level of security	Assesses whether all stakeholders have adequate and equitable security of cargo.
Common insurance	Determines whether a single, or multiple, insurance policies are required.
Singular billing arrangements	As per common documentation, measures the number of separate invoices required.
Singular customs requirements	Assesses whether there are singular, all-inclusive customs and other border requirements and fees.
Common packaging identifications	Measures the number of items of separate identification required.
Inclusive institutional acceptance of ISO standards.	This would include dimensions, specifications and testing for all general purpose, thermal, dry bulk, tank, small and other sized containers.

Key performance indicators: critical success factors

In transport benchmarking studies, it is advisable to carry out customer surveys to obtain comparative data. Such surveys serve two purposes. First, they focus on overall customer requirements, which are sometimes ignored in the search to identify what to benchmark. Second, they provide an alternative source of data that can be used either to verify data provided by the service providers or other sources or as a replacement if such data are not otherwise available, as is often the case.

Customer surveys aim to establish "which aspects of the intermodal transport service are most important to the shipper" and "to what level of satisfaction have these aspects been provided". It is possible to combine these themes and ask questions about critical success factors. Examining critical success factors is equivalent to asking the question "what factors have had the greatest impact on the performance of the shipper?".

Shippers often differ in their critical success factors. The typical format used by companies to identify their critical success factors relating to intermodal transportation include the following questions:

- What is the most critical factor to my organisation's success (*e.g.* customer satisfaction, expense to revenue ratio, return on asset performance)?
- What factors are causing the most trouble (*e.g.* time delays, invoicing problems)?
- What services provided to my customers are directly related to the supply chain functions?
- What factors directly related to the supply chain functions affect my customer's satisfaction?
- What specific operational problems have been identified in the supply chain?
- What are the major costs (or cost drivers) in the supply chain?
- Which functions in the supply chain represent the highest percentage of cost?
- Which functions in the supply chain have the greatest room for improvement?
- Which functions in the supply chain have the greatest effect (or potential) for differentiating the organisation from competitors in the marketplace?

Answers to these questions should contribute to achieving the main purposes of an intermodal benchmarking study; that is, to provide insight into the reasons for differences in performance and to lay the foundation for performance improvement.

Performance measures of separate modal components

After examining the performance of the transport chain as a whole, it would be necessary to consider its major elements to determine the main causes of good or poor performance. This would involve examination of the major transport modes – sea, rail and road – and the interchange interfaces at the port and at rail and/or road terminals.

To undertake a thorough examination of every facet of each of the elements of the intermodal transportation would require an extensive data collection exercise. It is likely that it would be very difficult to collect such an exhaustive set of data and the effort may require more time and resources than is often available for such studies. Thus, it would usually be better to refine the benchmarking of intermodal components to a limited number of measures of the main elements of the transport chain, plus any areas that have been identified in the holistic measures as either high priority to customers or recording sub-standard performance.

Examining the core transport modes would involve repeating many of the questions that were posed for the holistic transport chain – but targeted at the modal level. These include measurement of price, financial performance (including profitability), timeliness, frequency of service, reliability and the incidence of lost and damaged freight. It would also involve some process or efficiency measures that are outlined below. It may also involve the ease-of use-questions, although some of these are more relevant to the intermodal transport chain.

This section presents many of the measures that may be applied to the components of intermodal transport supply chains. Total factor productivity is considered briefly before looking at the application of partial productivity analysis to examine the performance of the terminals (*i.e.* port, rail and road) as these are often the crucial elements of the intermodal supply chains that do not have readily available comparable data. Benchmarking the transport modes, rail, road and sea, is summarised in terms of the key measures across the categories of price, efficiency and service quality (including timeliness, consistency, and loss and damage rates).

Measures of the productivity of shipping terminals

Benchmarking the performance of port services can be a very detailed exercise in its own right, and many studies are available on this topic. Rather than discussing port benchmarking methodologies in detail, attention is given to the possible scope of such studies, focusing on the most important measures which should be included in intermodal benchmarking studies.

Key performance indicators could be compared for the following port related activities:

- Pilotage.
- Towage.
- Mooring and un-mooring.
- Stevedoring.
- Port authority/government services (*e.g.* providing channels, navigation aids and berths).
- The port-land interface.

For intermodal benchmarking studies, key performance indicators should first be reported for the port activities in their entirety, and then individually for stevedoring and any other aspect that is identified as a problem or high-priority area. Table 4.3 reports key performance indicators of total port operations.

Table 4.3. **Indicators of the performance of total port activities**

Cost	Cost per TEU. This could be measured as the sum of the cost per TEU of ship-based charges, shore-based charges, and government and port authority charges.
Productivity – inherently terminal based	TEU/hectare of land storage. TEU/berth metre. TEU/unit of handling equipment.
Timing	Average time taken to discharge containers from their arrival at the berth to their availability for collection. Early/late ship arrival. This data can be broken down into ship arrival and departure advice either at 24 hours or inside 24 hours as well as the *ex post* measure of actual arrival and departures. Reliability: Variance of discharge time outlined above.
Loss and damage	Number of staff accidents per 100 employees or part thereof. Absentee rate – hours absent as a proportion of hours worked. Number of containers damaged per 100 handled. Number of containers lost per 100 handled. Value of loss/damage claims per annum.

The most useful indicators include the total port cost per TEU and the measures of timeliness. In many cases, loss and damage are not major issues. Port productivity measures are often best viewed by examining stevedoring performance.

Stevedoring performance

Many factors impact on the stevedoring performance of individual ports. Some of the major factors include institutional arrangements and legislative requirements, ship characteristics, terminal equipment and technological developments. As with all parts of the supply chain, stevedoring productivity should be compared judiciously at all times. Geographic groupings can be more accurately benchmarked than global benchmarks. Where port productivity is incorporated into the supply chain, the benchmarks should reflect the port performance in conjunction with the wharf and container park management as well as the land transport and land access connections. Shipping companies are diversifying into the management of container wharves, container parks and even into road fleets in order to have greater control and improve scheduling meshing over these sections of the supply chain corridors.

A ready supply of data exists on stevedoring productivity throughout most of the world's major ports. Table 4.4 outlines common measures of capital and labour partial productivity measures of stevedoring performance.

Table 4.4. **Partial productivity measures of stevedoring performance**

Capital productivity measures	
Crane rates	Measures productivity on an individual crane basis. That is, the average number of lifts or twenty-foot equivalent units (TEUs) moved over a set period (usually an hour) by any individual crane.
Elapsed crane rate	Number of containers or TEUs moved per crane per elapsed hour of operations. An elapsed hour is calculated on the basis of the total time over which a ship is worked, measured from first labour aboard to last labour ashore.
Net crane rate	Number of containers or TEUs moved per crane per net hour of operations. A net crane hour is calculated on the basis of elapsed time minus the time unable to work the ship due to award shift breaks, ship's fault, inclement weather, awaiting cargo, industrial disputes, closed port holidays, or shifts not worked at ship operator's request.
Ship rates	Measures productivity on a ship basis. That is, the average number of containers or TEUs loaded or unloaded from the ship per hour by any individual crane.
Elapsed ship rate	Number of containers or TEUs moved per ship per elapsed hour of stevedoring operation.
Net ship rate	Number of containers or TEUs moved per ship per net hour of stevedoring operation.
Ships handled – per wharf/pa	Number of ships loaded and unloaded per wharf per annum.
Ships handled – per berth/pa	Number of ships loaded and unloaded per berth per annum.
Labour productivity measures	
Annual lifts per terminal employee	Number of containers or TEUs moved per full-time equivalent terminal employee per year. Terminal employees include all those engaged in terminal activities.

As indicated in Table 4.4, crane rates, net crane rates and crane down time measure the productivity or efficiency of crane operations at wharves based on a time measure. In addition, distance and ease-of-movement measures can be used to monitor the efficiency of crane usage. Some measures that incorporate issues of distance and ease of movement include: berth metres per terminal crane, crane spread and reach capabilities, crane height capabilities, crane flexibility, mobility, and adaptability.

Two of the most commonly used capital productivity measures are the number of container movements per net crane hour and the number of TEUs moved per net crane hour. Several of the other more obvious partial productivity indicators for terminal efficiency are simply the inverse of the infrastructure and equipment adequacy measures discussed already. These are:

- TEU/hectare of land storage.
- TEU/berth metre.
- TEU/unit of handling equipment.

Together, these will probably provide an adequate set of indicators of capital productivity. Adding a measure of labour productivity should complete the set. An ideal measure of labour productivity would be TEU/person-hour worked. However, the required data are unlikely to be readily available, and it will probably be necessary to settle for thousand TEU per equivalent full-time employee per annum.

There are several measures of effectiveness (*i.e.* involving timing and service-quality issues) that could be used in the port components of an intermodal transport study (Table 4.5).

Table 4.5. **Measures of stevedoring effectiveness**

Stevedoring timeliness	
Ship turn around time	Average time (hours) taken to load or unload ships.
Length of delivery/pick-up time prior to ship loading/unloading	Minutes.
Stevedoring reliability	
Berth availability	Measures proportion of ship arrivals where a berth is available within four hours of the scheduled berthing time.
Stevedoring reliability rate	Measures the proportion of ship visits where the average crane rate for each ship is within two containers per hour (+or-) of the quarterly average rate for the terminal. This rate provides a partial indicator of the variability of stevedoring productivity at each port.
Cargo receival rate	Cargo receival measures the proportion of receivals (exports) completed by the stevedore's cut-off time. It provides a partial indicator that can assist forecasting performance of terminal. A consistent 100% rate shows a reliability factor of 1.
Crane down time	Number of hours a crane is not working for any reason when scheduled to work as a proportion of hours it is scheduled to work.
Crane breakdown	Number of hours a crane is broken down when scheduled to work, as a proportion of hours it is scheduled to work.
Industrial action	Number of hours lost to industrial disputes as a percentage of hours worked.
Stevedoring loss and damage	
Loss and damage	Number of staff accidents per 100 employees or part thereof.
	Absentee rate – hours absent as a proportion of hours worked.
	Number of containers damaged per 100 handled.
	Number of containers lost per 100 handled.
	Value of loss/damage claims pa.

Similar to the measures for the entire intermodal transport chain, it is important to report data across the categories listed in Table 4.5. This may involve a minimum set of key performance indicators such as:

- Ship turnaround time.
- Berth availability.
- Stevedore reliability rate.
- Number of containers lost or damaged per 100 handled.

Stevedoring cost should be measured using the stevedoring charge per TEU. It may be necessary at times to consider container stevedoring charges and shore-based reefer charges separately.

Timeliness indicators can be broadly divided into two classes: processing duration indicators, and delays. An appropriate measure for processing duration is container dwell time in terminal. A proxy for delays in ports is captured in the ship turnaround measure. Consistency of performance at the process component level is best measured using the variance of the processing duration measures outlined above (*i.e.* container dwell time in terminal).

Measures of the productivity of rail (and road) terminals

The traditional way of measuring the performance of rail or road terminals is to look at turnaround time, plant utilisation and productivity within the terminal. Concepts such as delay are very useful for analysing a whole range of impediments to on-time delivery which, at present, are not captured by traditional performance measures. Terminal location, intermodal arrangements and jurisdictions are very important. Those terminals that are the most innovative in using intermodal solutions are the most successful in overcoming delay. Overcoming institutional and jurisdictional impediments can lead to improved performance and the customer having a real perception of better service. The measurement of these latter two impediments relates to all terminal operators for all modes, and does not just concern rail.

The main procedures to examine (benchmark) for seamless transportation in rail terminals occur at the intermodal interface. Procedures such as road-to-rail transfers, administrative communications and connection times or scheduling meshing are very important. What happens at these interfaces provides the clearest, most meaningful benchmarks for the terminal component of container supply chains. The measurement of terminal performance should not be limited to what goes on inside the terminal. The role that the terminal plays in the container supply chain is equally important.

The first traditional measure of rail terminal performance is turnaround time. Turnaround time describes the time elapsed between when a truck enters a terminal to pick up or deliver a container and when it leaves the terminal. Within the rail terminal there should be sufficient lifting capacity available to minimise delay. In the case of rail terminals based on marshalling yards, turnaround is based on the availability of locomotives for trip trains. Availability of a locomotive in the yard is not enough if it does not have clearance to depart when its wagons are loaded. In this sense, trains can be delayed waiting for clearance to depart within the rail terminal just as trucks can be delayed queuing outside the terminal gates. Consequently, when benchmarking rail terminals it is necessary to be clear about the definition of turnaround times.

Performance measures which include truck turnaround times within the rail or road terminals and the wharves as well as the truck turnaround time between them can be easily measured if dedicated access between container parks, wharf areas, rail terminals and urban road terminals are available.

The main areas of rail and road terminal performance that could be measured as part of an intermodal transport benchmarking study are outlined in Table 4.6.

Table 4.6. **Measures of rail and road terminal performance**

Incoming/outgoing by road	Incoming/outgoing by rail
Truck turnaround times	Computerised efficiency of wagon movements
Automation at entry gates	On-time terminal departures
Slotting availability	Shunting times
Entry waiting times	Locomotive availability
Shipment tracing capabilities	Shipment tracing capabilities
Container dwell time in terminals	Container dwell time in terminals
CNS and EDI links	Crane and wagon harmony

Measures of rail performance

An intermodal transport benchmarking study should focus on a few core measures of rail freight cost, productivity, timeliness and reliability. If major problems are identified with the rail line-haul then it could subsequently be examined in more detail. On this basis, the three important quantifiable process elements likely to impact on the efficiency of rail operations are:

- Train size.
- Equipment utilisation.
- Labour productivity.

While it may be suggested that information be collected on the maximum feasible train length, not all trains will be of the maximum feasible size. As there are significant economies of scale in block train operation, the actual size of train can have an important effect on intermodal economics. Thus, the suggested measure is "actual average TEU/train".

The number of trips made by each wagon is an important measure of capital utilisation. Although this will obviously be affected by haulage distance, it will also be influenced by other operational and management factors. It is therefore worthwhile specifically focusing on this aspect. The suggested measure of equipment utilisation is wagon cycle time.

The preferred measure of labour productivity is TEU-km per full time employee.

As discussed earlier, timeliness indicators can be broadly divided into processing duration indicators and delays. Suggested indicators for processing duration of line-haul container-rail services are average train turnaround and TEU handled per train hour. "Average truck queuing time" could be used to measure delays in the line-haul movement of containers by rail. As was the case for port performance, consistency of performance at the process component level is best measured using the variance of the processing duration measures outlined above.

It is possible to consider a much broader range of effectiveness measures of rail freight movement of containers (Table 4.7). The choice of these measures would depend on the objectives, scope and resourcing of the intermodal benchmarking project.

Measures of road performance

The measurement of line-haul road performance in moving containers is very similar to that outlined above for line-haul rail freight. Given the highly competitive and efficient road transport services in many countries, a wide range of indicators may be considered; however, only a few key indicators are mentioned here, allowing scope for more detailed benchmarking if necessary.

From the point of view of diagnosing intermodal performance differences, the most important element of road transport efficiency is the number of TEU per vehicle per annum. This will be affected principally by four factors:

- Restrictions on operating hours.
- Length of haul.

- The nature of haulage equipment.
- Road vehicle utilisation.

Table 4.7. **Measures of the effectiveness of line-haul container rail services**

Transit times
Train arrival within 10 minutes of schedule
Train departure within 10 minutes of schedule
Care of goods
Security of containers in transit
% of containers/per trip/per annum lost
% of containers/per trip/per annum damaged
Extent of insurance for loss and damage
% of claims in value to total revenue p.a.
Ease of administering claims
Time taken between claim and full settlement
In-transit storage privileges
Shipment tracing capabilities
Price
Administration efficiency
Ease of contact
Timely and acceptable replies to inquiries
Physical condition of equipment
Equipment availability
Wagon availability
Locomotive availability
Technological standards
Comparable road/rail cycle times
Invoicing accuracy

The first three of these factors are operating factors more relevant to the following sections . Probably the most important aspect here is the extent to which road vehicles delivering a container to an intermodal terminal (port or railhead) depart unloaded, and those that collect a container arrive unloaded. The suggested measure is TEU loaded/unloaded per road vehicle at intermodal terminals. Similar to the measures suggested for rail freight, an appropriate indicator of processing duration of line-haul container road services is average truck turnaround. Average truck queuing time could be used to measure delays in the line-haul movement of containers by road. As was the case for port performance, consistency of performance at the process component level is best measured using the variance of the processing duration measures outlined above.

Measures of ship performance

Although the ocean transport leg is an important part of the intermodal transport chain, whether there is any point in attempting to measure the efficiency of this element is questionable. The international mobility of ships and the relative ease of entry have led to a high degree of homogenisation of shipping performance. The performance differences that do exist are generally transitory, except for those that are dictated by the physical characteristics of port facilities used by the vessels. These should be included in the benchmarking framework as infrastructure factors.

However, for the sake of completeness, it would be possible to collect information on a small number of key performance indicators similar to those discussed for rail and road line-haul services.

The cost measure would be either cost per TEU or cost per TEU per 1 000 km travelled.

Ship productivity measures could include TEU kilometres per year or TEU handled per ship per hour while an utilisation measure would be average stacking rates (*i.e.* average number of containers per trip as a proportion of the maximum number of containers per trip).

Timeliness indicators could include frequency of service offered and transit time (in hours or days). Reliability could be measured by the extent of delays in coming to berth (*i.e.* percentage of trips in which arrivals were more than about 10% behind schedule). Other elements of delay may be important in specific instances, but obtaining detailed data on them is generally difficult: their effect can in any case be captured in the ship turnaround measure. Another measure of reliability may be given by the variation in the average transit time compared to the scheduled transit time.

Accounting for the impact of different inputs to intermodal transport chains

The physical attributes of many aspects of the elements of an intermodal supply chain can have a significant impact on productivity. For example, the amount of storage area at terminals will affect both cost and productivity, with larger terminals generally requiring less handling than smaller terminals. The main inputs that should be considered in an intermodal transport benchmarking project may be split between infrastructure and equipment factors.

Infrastructure

Maritime access

Two elements of maritime infrastructure may have sufficient impact on the efficiency of the intermodal transport chain to justify monitoring as part of a benchmarking study:

- Depth of approach channels.
- Berth availability.

The depth of water available in a port will constrain the maximum size of vessel that can be deployed, and hence the ability to realise economies of scale on the ocean transport leg. To appreciate the possible impact of this factor, data should be collected on “draft”.

By far the most common cause of delays to shipping in the container transport industry is the lack of berth availability. If the vessel cannot come to berth on schedule, the implications for the efficiency, timeliness and predictability of intermodal transport movements are obvious. An intermodal benchmarking study should therefore report measures of berth occupancy and the number of berths. These two factors need to be considered simultaneously since the impact of berth occupancy on expected delay depends on the number of berths. Berth length per thousand TEU handled is often used as an alternative indicator of berth adequacy. This measure has the advantage of being readily available from published data and unequivocal.

Modal interchange

The most important factor here is the adequacy of the storage area. Generous storage areas can facilitate intermodal performance by reducing the number of within-terminal moves that are required to handle containers. Hence, the appropriate measure should be thousand TEU per annum per hectare.

Rail transport

Two elements of rail infrastructure that may have sufficient impact on the efficiency of the intermodal transport chain to justify monitoring as part of a benchmarking study are:

- Pathway availability.
- Topography.

The availability of pathways on the rail system can have a significant impact on the performance of intermodal rail operations. This is especially the case where rail operators share track with passenger movements (which are given priority on most networks). Pathways through systems that share track with commuter trains can be a particular problem. Thus, an intermodal benchmarking study should collect information to indicate the relevant priority of rail pathways and their impact on scheduling and operations.

Some studies have also suggested that the topography of rail routes is also important. Clearly, in extreme cases – for instance, where the terrain is very mountainous – topographical differences could have a significant effect on transit times, fuel costs and rail maintenance. In general, however, topography is unlikely to be sufficiently important to justify undertaking the difficult task of developing an appropriate quantitative measure. This can be done by making appropriate assumptions about differences in fuel consumption.

Road transport

The level of congestion on the road network will clearly have an impact on both efficiency and reliability. The appropriate measure is “average travel speeds on relevant trunk road network”. Particularly at maritime terminals, the quality of gate access is often cited as an important determinant of road transport efficiency. A suggested measure is “TEU by road per gate lane”.

Equipment

Terminal

In principle, the quantity and quality of terminal equipment could significantly impact the efficiency of intermodal operations. In practice, it is likely to be an issue only where the most expensive items of equipment are concerned: the obvious case is that of container gantries in marine terminals. Suggested measure: TEU handled per unit of equipment.

Rail

The maximum train capacity is likely to be the most important element here. This will be determined by two factors: the maximum length of train that can be accommodated at the terminal and along the routes that will be transited; and the ability to make use of double-stack technology. Suggested measure: max TEU per train.

Road

Differences in road equipment are far more limited than differences in rail, and in this case are likely to be reduced principally to whether or not double-bottom road vehicles can be used. Suggested measure: proportion of double-bottom vehicles used.

Labour

Intermodal performance will be influenced by both the unit cost and the skill level of available labour. Realistically, only the first of these is likely to be readily amenable to quantification. For most exercises, a simple index of national wage levels for the transport industries will probably provide an adequate indication of the influence of this factor. Suggested measure: unit labour costs, preferably in the transport industry if available.

Accounting for the operating environment

For the most part, characteristics of the operating environment are unlikely to be readily amenable to quantification. However, in some circumstances these may have a significant influence on performance, and it would be wise to provide for a narrative of significant characteristics to be included in any benchmarking study.

Physical

One dimension of the operating environment that is readily amenable to quantification is the length of haul for the intermodal movement. Suggested measures: average length of inland haulage; average length of sea transit.

Institutional

This may cover such factors as the nature of the organisations that control the intermodal chains that are being benchmarked. For instance, are the rail operations effectively extensions of the operations of ocean carriers, as tends to be the case in the major trans-continental movements in the United States? Or are land transport operators – in particular, rail operators – the prime movers? What role is played by third parties that are not aligned with the transport service providers (*e.g.* third-party logistics providers and freight forwarders)?

The use of fixed time-windows for ship and train operations, and booked timeslots for trucks, may be of interest.

Political and regulatory

Political and regulatory factors can also have a major influence on intermodal performance. For instance, the willingness (or unwillingness) of some European governments to expose their rail operations to competition is argued by some to have been a significant determinant in the relative efficiency of European and North American intermodal operations. The attitudes of governments to collective agreements on intermodal services may also warrant attention: the European Community, for instance, does not allow liner shipping conferences to act collectively on the provision of intermodal services, while the United States does.

In some circumstances – most particularly where non-EU countries are concerned, as in the Asia to Europe land-bridging operations, or in new intermodal routes to Central Asian economies – imperfect harmonisation of documentation requirements and inspection processes may be a major constraint on intermodal performance.

Other aspects that may be relevant in particular cases are restriction on the operating hours of port terminals; and regulations governing driving hours for truck drivers and locomotive crews.

Competitive forces within and between container supply chains

The total supply chain must supply a seamless, efficient service along its entire length. There is little market incentive for co-ordination between participants because the same competitive elements that encourage participants to be individually efficient discourage them from working together to become collectively more efficient.

Therefore, while market forces work at the individual participatory level of competition to stimulate greater efficiencies, there are few such incentives to stimulate the entire international supply chain. Although this situation is changing, with shipping companies leading the movement of vertical integration along supply chains, the extent of ownership along any international supply chain is still in its infancy. Consequently, any benchmarking exercise on global transport supply chains needs to include an institutional category. This category needs to list appropriate institutional, governmental policies and industrial associations that work to stimulate overall seamlessness. A broader global level of competition should be benchmarked that guides the total freight transport chain to overall efficiency via seamlessness. Healthy competition thus can occur at the global level, stimulating the total chain, and at the modal level, stimulating individual participants within each chain. Both elements need to be benchmarked.

Applying intermodal benchmarking methodologies

This section briefly examines two issues which need to be considered when applying the intermodal benchmarking methodologies outlined in the previous section. These are:

- Data sources for such studies.
- Examples that may be included to obtain "best practice" comparators.

A detailed examination of data sources or possible best practice ports is not provided, as the selection of data and ports will depend on the objectives, scope and coverage of each particular intermodal benchmarking study. Further, each intermodal benchmarking study would involve extensive contact with customers and key service providers to determine what elements of the chain should be benchmarked, which other supply chains should be involved and to collect data directly.

Overview of data sources

An intermodal benchmarking study would typically require data on:

- Three transport modes: rail, road and sea.
- Three terminal operations: ports, rail terminals and road terminals.
- Performance measures on each of the above services and for the entire chain spanning price, financial viability, timeliness (frequency of service and transit time), reliability (measures of punctuality), loss and damage rates and ease-of-use (mainly administrative) factors.
- Customers' perceptions of service, including their critical success factors.
- Characteristics of the core infrastructure and equipment used.
- Operating characteristics for each of the separate intermodal transport supply chains being benchmarked.

This will require an extensive data collection exercise, with budget, time and data constraints demanding that priority be given to collecting a few key performance indicators across each of the categories listed above.

It appears that no centralised database exists that can be drawn upon to provide all the data required for meaningful intermodal transport benchmarking studies across countries.

As with the modal benchmarking studies we have identified in this report, data collection would typically involve a mix drawing from:

- Statistics publicly reported by each of the service providers (*e.g.* port authority annual reports).
- Other relevant studies published by third parties (*e.g.* government reports on transport performance or industry or academic studies).

- Specific data requests to service providers, often in survey format.
- Other previously private information that service providers are willing to release.
- Data provided by customers.
- Specific data requests of customers.

It would not be possible to undertake a meaningful intermodal benchmarking study without collecting performance and background data directly from all the main service providers and customers. The extent to which such studies could draw on published information provided by third parties would depend on the nature and scope of each individual intermodal benchmarking study. This would need to be examined on a country-by-country basis.

Case study of an integrated intermodal port

There are many geographic groupings that could provide interesting and meaningful intermodal container transport benchmarking studies. For any such grouping, or indeed for any benchmarking study, it is imperative to include an entity that can be considered as "best practice". In this way, the benchmarking study establishes the magnitude of performance improvement that other participants should be capable of achieving and provides a guide to the practical steps that could be taken to achieve these productivity improvements.

Port performance will be central to the effective intermodal operations of supply chains that involve a sea transport component. Thus, it is important that intermodal container transport studies include ports that have implemented leading practices to ensure effective intermodal integration.

A recent study carried out for the Australian Marine and Ports Group (MPG, 1998)[22] by Tasman Asia Pacific and Meyrick and Associates, examined measures to improve the efficiency and effectiveness of container and break–bulk ports. Examining measures to improve intermodal integration was a central part of this study, which included an international fact–finding mission covering eight leading ports: Vancouver, Seattle, Tacoma, London, Felixstowe, Rotterdam, Antwerp and Zeebrugge.

Intermodal integration was a problem in all the ports visited in the MPG study. Port authorities and service providers were generally well aware of the problems encountered by shippers and were initiating a range of actions to improve the flow of cargo. However, many of the problem areas lay outside their jurisdictions. The ports with the best record in achieving integration between modes took a proactive approach to removing bottlenecks by bringing together parties with a mutual interest in solving the problem or by directly providing services themselves. From an institutional perspective, the most innovative solutions to this problem were found in Vancouver.

While Vancouver has many problems to be resolved within its transport chain, it does provide a useful case study of what can be achieved through co-operation among the different players in the chain. For immediate port–related problems, the Vancouver Port Corporation provides a particularly useful role model as a strategic, whole–of–port collaborative manager. At the city level, the Greater

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22. Marine and Ports Group (1998), *Measures to Promote Effective and Efficient Container Port Practices*, report prepared by Meyrick and Associates and Tasman Asia Pacific for the Marine and Ports Group of the Australian Transport Council, Canberra, October.

Vancouver Gateway Council provides a useful model of a formal attempt to co-ordinate transport interests to lobby local government to help solve integration problems. At a higher regional level, the most useful and frequently quoted model is that of WESTAC in Western Canada. By providing high-quality, even–handed research and a forum where senior government, transport company and union representatives can come together to openly discuss problem issues, WESTAC (the Western Transport Advisory Council) has been uniquely successful in advancing awareness of the need to look at the operation of the transport system as a whole.

While not replicating the findings here, the MPG report is recommended as a guide to identifying leading container ports and understanding their intermodal co-ordination strategies.

Evaluation model

The common practice of overall benchmarking is to search for industry or functional activities or outputs that can be classified as best in class, as world-class, or as representing best practice. The basic premise of benchmarking is to learn something of value from someone or someplace else, something that helps you perform more effectively or efficiently. The goal of most benchmarking activities is to learn from the best.

Thus, a so-called intermodal evaluation procedure can be developed that incorporates critical success factors that can be benchmarked with competitors. The benchmarking conditions for comparing like with like have to be adhered to. Then, by reducing all criteria to monetary values an arithmetic model can be used. Often, these models are difficult to apply due to problems in accumulating appropriate data. As a consequence, raw data in the form of KPIs are often used.

Three steps are needed to construct an intermodal evaluation approach. These involve:

- Indicators of the modal split and the intermodal relation for all modes.
- Weights for the indicators.
- An aggregation rule to find one final value for the evaluation procedure.

The indicators should be relevant, complete, and quantifiable. In the best of cases, all indicators should be measurable in monetary items. We have listed numerous indicators above and any of these factors can be used within the model. For example, the following four indicators have been chosen for simplicity:

- Price of transportation over total supply chain.
- Cost of total travel time.
- Cost of total waiting time.
- Value of container load.

As all indicators can be measured in terms of money, no transformation problems of measurement or weightings are incurred before aggregating the values. The only information required is the travel time, the probability of non-arrival, loss or damage insurance sum and a commodity factor. Normally, evaluations are undertaken on specific and targeted components such as by routes or corridors. Geographic groupings incorporating shipping lines, wharves, container parks, and access roads or barge facilities could be benchmarked. Another section of supply chains where benchmarking could be undertaken could include similar geographic road/rail land transport corridors in the United States. Asian regional shipping lines and associated land transport functions may be another possible component. If an aggregate supply chain is benchmarked, then the following model can be used. The aggregation of the data would mean that the use of the results would have some limitations.

The intermodal evaluation model (IEM) is valued by the following formula:

(1) IEM = $(\alpha \cdot d_1) + (\beta \cdot d_2) + (\gamma \cdot d_3) + (\delta \cdot d_4)$

or specified for modes, routes and commodities:

(2) $\text{IEM}_{i,r,c} = (\alpha_{i,r,c} \cdot d_{1,i,r,c}) + (\beta_{i,r,c} \cdot d_{2,i,r,c}) + (\gamma_{i,r,c} \cdot d_{3,i,r,c}) + (\delta_{i,r,c} \cdot d_{4,i,r,c})$

with:

IEM= value calculated by the intermodal evaluation model

i = index of the transportation mode

r = index of the route

c = index of the container

α = container rate factor

d_1 = price of transportation

β = travel time in hours

d_2 = cost of travel time in terms of money per hour and per container

γ = waiting time in hours

d_3 = cost of waiting time in terms of money per hour and per container

δ = probability of non-arrival, loss or damage

d_4 = value of the container contents in terms of money (may be on a per ton basis).

The dimension of the value IEM is money per container. Equations (1) and (2) are only specified for one transport mode on the route *r* for the container *c*. This is only one part of the evaluation model, which has to take into account all modes *I* on all routes *r* and also all types of containers *c*. Therefore, all evaluations *I, r, c* of the total network are summed as shown:

(3) IEM= $M_1 . IEM_1 + M_2 . IEM_2 + \ldots M_1 . IEM_1 \rightarrow$ *min (or max depending on variables used)*

subject to:

(4) $M_i = \sum_{g=1}^{G} m_{i,c}$

where:

IEM= value calculated by the intermodal evaluation model

M = volume of all containers *c = (I,…, C)* in the network transported by mode *I* (in tonnes).

The purpose of this model is to estimate the best set of transport modes and terminal connections for the overall container supply chain. For cost efficiency the equation has to be minimised, but if other indicators are used the function may need to be maximised (*e.g.* a service quality indicator).

The model as presented uses no weights but again, depending on the service quality indicators, various weightings can be incorporated in the equation as only a simple additive aggregation rule applies. Various computer-based models have typically incorporated this simple model to handle large amounts of data. The model needs to be used with caution as the data are often difficult to collect in standardised forms.

This approach was developed for measuring performances of the road and rail transport industries and ports of Australia. The aim was to examine their performance relative to that of their competitors and to identify areas for improvement, thereby providing advice to policy makers on possible policy options for improving performance through industry reforms (BIE, 1992).[23]

In practice, applying the model in its complete form was difficult due to problems of data availability, as well as different approaches to measuring inputs and outputs. Therefore, the model was applied in a modified form, focusing on those indicators which were most relevant to the objectives of the government and industries in measuring performance.

23. Bureau of Industry Economics, Australia, *International Benchmarking/International Performance Indicators (1992-1995).*

Annex 1

INTERMODAL FREIGHT TRANSPORTATION ADVISORY GROUP

Chairman: Fred Heuer (the Netherlands)

Members of the Sub-Group on Benchmarking

Garry Tulipan (Chairman)	Canada
Catherine Kim	Canada
Brigitte Parent	Canada
Miroslav Capka	Czech Republic
Miroslav Kubasek	Czech Republic
Shunsuke Otsuka	Japan
Hiroyuki Yamamoto	Japan
Satoru Mizushima	Japan
Shigenori Kenzaka	Japan
Hideaki Iwasaki	Japan
Ryuichi Yoshimoto	Japan
Fred Heuer	Netherlands
Henriëtte Noordhof	Netherlands
Marjolein Masclee	Netherlands
Matthias Rinderknecht	Switzerland
Rolf Zimmermann	Switzerland
Elizabeth McDonnel	United Kingdom
Judith Ritchie	United Kingdom
Harry Caldwell	United States
Siegbert Schacknies	United States
Robert Radics	United States
Kerstin Sterner	European Commission
Martine Sophie Fouvez	ECMT
Anthony Ockwell	OECD Secretariat
John White	OECD Secretariat
Yuri Furusawa	OECD Secretariat

Annex 2

GLOSSARY OF ABBREVIATIONS AND TERMS

Abbreviations:

OECD	Organisation for Economic Co-operation and Development
UIRR	International Union of Combined Road-Rail Transport Companies
ECMT	European Conference of Ministers of Transport
C	Freight container
SB	Swap body
ST	Semi-trailer
HC	High cube
Ro-La	Rolling motorway
AGTC	European Agreement on Important International Combined Transport Lines and Related Installations
EU	European Union
IT	Intermodal transport
TEU	Twenty-foot Equivalent Unit
FEU	Forty-foot Equivalent Unit

Terms

(European Commission – Directorate General for Transport):

Multimodal transport: Carriage of goods by at least two different modes of transport.

Intermodal transport: The movement of goods in one and the same loading unit or vehicle which uses successively several modes of transport without handling of the goods themselves in changing modes.

Combined transport: Intermodal transport where the major part of the European journey is by rail and any initial and/or final legs carried out by road are as short as possible.

Rolling Road: Transport or complete road vehicles on low-floor wagons.

Accompanied transport: Transport of complete road vehicles via another mode of transport (*e.g.* by ferry or train) accompanied by the driver.

Unaccompanied transport: Transport of road vehicles or part vehicles through another mode of transport (*e.g.* by ferry or train) not accompanied by the driver.

Roll-on-roll-off “Ro-Ro”: The facility for a road vehicle to be driven on and off a ship or, as in the case of rolling road, a train.

Lift-on-lift-off “Lo-Lo”: Loading and unloading of ITU using lift equipment.

Intermodal transport unit (ITU): Containers, swap bodies and semi-trailers suitable for intermodal transport.

Semi-trailer: Any vehicle intended to be coupled to a motor vehicle in such a way that part of it rests on the motor vehicle and a substantial part of its weight of the load is borne by the motor vehicle. These may have to be specially adapted to be used in combined transport.

Loading unit: Container or swap body.

High cube container: Container of standard ISO length and width but with extra height – 9’6” (2.9m) instead of 8” (2.44m). For the time being, this only applies to 40’ containers.

Swap body: Freight carrying units not strong enough to be stackable, except in some cases when empty or top-lifted. Used only in rail/road movements.

Terminal: Place where a modal change takes place.

Annex 3

PERFORMANCE INDICATORS IN CANADA

The following series of tables provides information on all modes of freight transport in Canada for the years 1990, 1993, 1995 and 1998. Data have been provided wherever possible although, due to the unavailability of some data, there are inevitably some statistical gaps in the tables.

Table A3.1. **Comparative table of modes of transport, 1998**

Indicators, 1998	Road	Rail	Shipping	Air
Domestic freight moved (million tonne-km)	76 694	Aggregate domestic and international	35 800	594.3
Domestic freight moved – containers (million tonne-km)	n.a.	28 500	n.a.	n.a.
International freight moved (million tonne-km)	61 396	Aggregate domestic and international	1 871 500	195.1
International freight moved – containers (million tonne-km)	n.a.	4 600	n.a.	n.a.
Percentage share of domestic traffic (tonnes)[1]	42/67	47/27	11/6	<1
Percentage share international traffic (tonnes)[1]	13/30	20/16	67/54	<1
Energy consumption and pollution per tonne-km	n.a.	n.a.	n.a.	n.a.
Reliability	n.a.	n.a.	n.a.	n.a.
Price per tonne	n.a.	n.a.	n.a.	n.a.
Lading factor and degree of utilisation	n.a.	n.a.	n.a.	n.a.

1. Canadian trucking data are available only for the for-hire trucking industry. It is estimated that private trucking accounts for 60-70% of commercial trucking in Canada. The first value shown is modal share using the for-hire figure for trucking. The second value shown is modal share using an estimated value for total trucking; this estimate is the for-hire figure divided by a factor of 0.35.

Table A3.2. **Rail freight**

Indicators	1990	1993	1995	1998
Domestic freight moved (billion tonne-km)[1]	See notes			
Domestic freight lifted (million tonnes)	191.8	180.9	203.0	202.4
Domestic freight moved – containers (billion tonne-km)[2]	n.a.	n.a.	n.a.	28.5
Domestic freight lifted – containers lifted (million tonnes)	7.1	6.7	10.6	13.3
Domestic freight lifted – No. of containers	n.a.	n.a.	n.a.	n.a.
International freight moved (billion tonne-km)	See notes			
International freight lifted (million tonnes)	50.5	59.7	72.1	82.4
International freight moved – containers (billion tonne-km)[3]	n.a.	n.a.	n.a.	4.6
International freight lifted – containers (million tonnes)	2.9	2.9	4.5	4.7
Percentage share of domestic traffic[4]	48/28	49/29	48/28	47/27
Percentage share of international traffic[4]	16/14	19/16	19/16	20/16
Energy consumption & pollution per tonne-km	See following rows			
Fuel intensity (tonne-km per litre)[5]	n.a.	n.a.	135	n.a.
Energy demand (petajoules)[6]	89.5	n.a.	80.9	n.a.
GHG emissions (grams per tonne-km)[5]	n.a.	n.a.	20	n.a.
GHG emissions (megatonnes)	5.640	5.645	5.966	6.355
Carbon dioxide	5.008	5.013	5.298	5.643
Methane	0.006	0.006	0.006	0.007
Nitrous oxide	0.626	0.626	0.662	0.705
Reliability	n.a.	n.a.	n.a.	n.a.
Price per tonne (CAD/tonne)	25.56	25.33	23.78	23.18
Price per tonne (CAD/tonne-km)	0.0241	0.0233	0.0227	0.0227
Lading factor and degree of utilisation	n.a.	n.a.	n.a.	n.a.
Accidents[7]	903	1 025	1 276	1 075
Accidents per million train-miles	13.2	13.4	16.4	14.2

GHG: Greenhouse gas.

1. Cannot disaggregate domestic and international values. Aggregate figures are: 248.4, 256.3, 280.5 and 299.5 for the years listed. In 1998 Class I traffic accounted for 268.7 billion t-km; 74% of this was associated with domestic traffic.
2. Includes traffic between Canadian maritime ports (maritime imports and exports) and other Canadian points.
3. Represents rail movements across the Canada-US border.
4. Canadian trucking data is available only for the for-hire trucking industry. It is estimated that private trucking accounts for 60-70% of commercial trucking in Canada. The first value shown is modal share using the for-hire figure for trucking. The second value shown is modal share using an estimated value for total trucking; this estimate is the for-hire figure divided by a factor of 0.35.
5. Estimates.
6. Data available for passengers and freight.
7. Includes 48, 80, 71 and 68 accidents involving passenger trains for the years listed, since some of these may have involved collisions with freight trains.

Table A3.3. **Air freight**

Indicators	1990	1993	1995	1998
Domestic cargo (tonne-km)	472 798 013	423 975 342	396 080 464	594 336 935
Domestic enplaned cargo (tonnes)[1]	317 623	281 551	223 592	462 964
Domestic freight moved – containers	n.a.	n.a.	n.a.	n.a.
International cargo (tonne-km)	265 800 165	193 706 641	248 373 727	195 053 188
International enplaned cargo (tonnes)[2]	85 017	80 323	97 331	92 861
International freight lifted – containers	n.a.	n.a.	n.a.	n.a.
International freight lifted – value	n.a.	n.a.	n.a.	n.a.
Enplaned belly-hold cargo (tonnes)	305 950	297 332	341 210	373 991
Enplaned freighter cargo (tonnes)	93 104	76 515	55 567	73 614
Percentage share of domestic traffic	<1	<1	<1	<1
Percentage share of international traffic	<1	<1	<1	<1
Energy demand (petajoules)[3]	185.2	n.a.	185.1	n.a.
GHG emissions (megatonnes)	n.a.	6.805	8.000	n.a.
Carbon dioxide	n.a.	6.600	7.759	n.a.
Methane	n.a.	0.004	0.005	n.a.
Nitrous oxide	n.a.	0.201	0.236	n.a.
Total accidents	498	422	390	386
Fatal accidents	47	48	52	31
Reliability	n.a.	n.a.	n.a.	n.a.
Price per tonne	n.a.	n.a.	n.a.	n.a.
Lading factor and degree of utilisation	n.a.	n.a.	n.a.	n.a.

GHG: Greenhouse gas; enplaned cargo: cargo which is loaded as well as traffic stopping over at an airport.

Note: Figures represent cargo mass shipped by level 1 and 2 charter and major scheduled carriers. Regional/local operators are not required to submit cargo data. Figures represent 90% sample of level 2 carriers.

1. Total mass of enplaned cargo destined for Canadian airports.
2. Total mass of enplaned cargo destined for the United States and other international airports.
3. Data available for passengers and freight.

Table A3.4. **Road transport**

Indicators	1990	1993	1995	1998
Domestic freight moved (million tonne-km)[1]	54 701	51 977	65 806	76 694
Domestic freight moved – containers (million tonne-km)	n.a.	n.a.	n.a.	n.a.
International freight moved – total (million tonne-km)[1]	23 070	32 636	44 205	61 396
International freight moved – containers	n.a.	n.a.	n.a.	n.a.
Percentage share international traffic	n.a.	n.a.	n.a.	n.a.
HGV mileage intensity (base: 1980 = 100)	n.a.	n.a.	n.a.	n.a.
Domestic tonnes lifted (thousand tonnes)[1]	149 327	140 383	167 425	177 829
International tonnes lifted (thousand tonnes)[1]	24 919	33 018	43 515	56 102
Tonnes moved (thousand tonne-km)[1]	77 770 727	84 613 208	110 010 741	138 090 057
Average length of haul (km)	446	488	522	590
Average load: rigid (tonnes)	n.a.	n.a.	n.a.	n.a.
Average load: articulated vehicles (tonnes)	n.a.	n.a.	n.a.	n.a.
Empty/ light running	n.a.	n.a.	n.a.	n.a.
Percentage share of domestic traffic[2]	37/63	38/63	40/65	42/67
Percentage share of international traffic[2]	8/20	10/25	12/27	13/30
Number of collisions involving heavy trucks[3] causing fatalities or injuries	n.a.	8 658	8 591	n.a.
Fatal collisions	n.a.	516	465	n.a.
Straight-truck	n.a.	204	159	n.a.
Tractor-trailer	n.a.	319	314	n.a.
Personal injuries collisions	n.a.	8 142	8 126	n.a.
Straight-truck	n.a.	4 673	4 492	n.a.
Tractor-trailer	n.a.	3 573	3 756	n.a.
Fatalities in collisions involving heavy trucks	695	615	581	n.a.
Straight-truck	257	249	175	n.a.
Tractor-trailer	438	366	406	n.a.
Injuries in collisions involving heavy trucks	14 042	11 949	12109	n.a.
Straight-truck	882	6757	6 522	n.a.
Tractor-trailer	5 960	5 192	5 587	n.a.
Lading factor: rigid	n.a.	n.a.	n.a.	n.a.
Lading factor: articulated vehicles	n.a.	n.a.	n.a.	n.a.
Fuel consumption (litres per 100 km)				
Gasoline trucks	13.3	n.a.	13.3	n.a.
Light and medium diesel trucks	21.9	n.a.	21.6	n.a.
Heavy diesel trucks	41.3	n.a.	40.6	n.a.
Fuel intensity (tonne-km per litre)[4]	n.a.	n.a.	24	n.a.
Energy demand (petajoules)[5]	645.4	n.a.	771.1	n.a.
GHG emissions (grammes per tonne-km)[4]	n.a.	n.a.	114	n.a.

Table A3.4. **Road transport** *(cont'd.)*

Indicators	1990	1993	1995	1998
Average speeds				
Motorways (70 mph speed limit)				
Rigid 2 axles	n.a.	n.a.	n.a.	n.a.
Rigid 3/4 axles	n.a.	n.a.	n.a.	n.a.
All articulated vehicles	n.a.	n.a.	n.a.	n.a.
Dual carriageways (70 mph speed limit)				
Rigid 2 axles	n.a.	n.a.	n.a.	n.a.
Rigid 3/4 axles	n.a.	n.a.	n.a.	n.a.
All articulated vehicles	n.a.	n.a.	n.a.	n.a.
Single carriageways (60 mph speed limit)				
Rigid 2 axles	n.a.	n.a.	n.a.	n.a.
Rigid 3/4 axles	n.a.	n.a.	n.a.	n.a.
All articulated vehicles	n.a.	n.a.	n.a.	n.a.
Urban roads (40 mph speed limit)				
Rigid 2 axles	n.a.	n.a.	n.a.	n.a.
Rigid 3/4 axles	n.a.	n.a.	n.a.	n.a.
All articulated vehicles	n.a.	n.a.	n.a.	n.a.
Urban roads (30 mph speed limit)				
Rigid 2 axles	n.a.	n.a.	n.a.	n.a.
Rigid 3/4 axles	n.a.	n.a.	n.a.	n.a.
All articulated vehicles	n.a.	n.a.	n.a.	n.a.
Vehicle safety – VI/testing failure rate (%)	n.a.	n.a.	n.a.	n.a.
Emission standards (thousand tonnes)[6]				
NO_x	n.a.	n.a.	n.a.	n.a.
PM_{10}	n.a.	n.a.	n.a.	n.a.

Note: 1990 data available second week of August 2000. 1998 data available in October 2000.

1. Includes only Canadian domiciled for-hire Class I and II carriers (carriers earning gross annual intercity revenues of CAD 350 000 or more (1987), CAD 500 000 or more (1988-89), CAD 1 million or more (1990-96). Starting in 1997, includes long-distance carriers with annual revenues of CAD 1 million or more, *i.e*. carriers with at least 50% of revenues coming from long-distance (>80 km) movements. Local carriers' activity not captured due to methodological changes (NAICS criteria) making historical comparison inexact (underestimated level of intra-provincial traffic) for the years shown. Private trucking is estimated to account for 60-70% of commercial trucking activity but is not included in the table.
2. Canadian trucking data is available only for the for-hire trucking industry. It is estimated that private trucking accounts for 60 to 70% of commercial trucking in Canada. The first value shown is modal share using the for-hire figure for trucking. The second value shown is modal share using an estimated value for total trucking; this estimate is the for-hire figure divided by a factor of 0.35.
3. Heavy truck: > 4.536 kg.
4. Estimates. Diesel trucks – for-hire.
5. Energy demand for gasoline trucks and for diesel cars and trucks.
6. Data might be available.

Table A3.5. **Maritime freight**

Indicators	1990	1993	1995	1998
Domestic freight moved (billion tonne-km)[1]	n.a.	n.a.	39.0	35.8
Domestic containerised traffic (thousand units)	n.a.	n.a.	n.a.	n.a.
International freight moved (billion tonne-km)[2]	n.a.	n.a.	1 769.4	1 871.5
International containerised traffic (thousand units)[3]	1 232	1 258	1 534	1 959
Domestic freight lifted (million tonnes)	n.a. (See data for coastwise traffic)			
International freight lifted (million tonnes)	232.3	224.2	260.0	279.5
Total international bulk traffic (million tonnes)[4]	172.4	166.2	192.8	204.8
Percentage share domestic traffic[5]	15/9	14/8	12/7	11/6
Percentage share international traffic[5]	76/66	71/59	69/57	67/54
Total domestic combined transport (thousand units)	n.a.	n.a.	n.a.	n.a.
Total international combined transport (thousand units)	n.a.	n.a.	n.a.	n.a.
Total coastwise traffic (million tonnes)[6]	60.3	50.0	50.5	48.3
Total unitised short-sea and near-sea traffic (thousand units)	n.a.	n.a.	n.a.	n.a.
Total inland water traffic (million tonnes)	n.a.	n.a.	n.a.	n.a.
Marine accident figures				
Vessels involved in accidents, excluding fishing vessels[7]	586	398	384	279
Deaths[8]	15	4	21	27
Injuries[8]	63	51	46	43
Fuel intensity (tonne-km per litre)[9]	n.a.	n.a.	311	n.a.
Energy demand (petajoules)[10]	107.3	n.a.	102.8	n.a.
GHG emissions (grammes per tonne-km)[2]	n.a.	n.a.	9	n.a.
Reliability	n.a.	n.a.	n.a.	n.a.
Costs	n.a.	n.a.	n.a.	n.a.

1. Estimate. Represents shipments between Canadian points (including domestic trans-shipment for international destinations).
2. Estimates.
3. Containers loaded and unloaded. Includes empty units.
4. Includes grains, mineral and mine products, and liquid bulk. Transport Canada, Economic Analysis.
5. Canadian trucking data is available only for the for-hire trucking industry. It is estimated that private trucking accounts for 60-70% of commercial trucking in Canada. The first value shown is modal share using the for-hire figure for trucking. The second value shown is modal share using an estimated value for total trucking; this estimate is the for-hire figure divided by a factor of 0.35.
6. As defined by the United Kingdom, as opposed to "domestic freight lifted".
7. Includes Canadian and foreign flag vessels.
8. Shipping accidents and accidents aboard ship, excluding fishing, passenger and ferry vessels.
9. Estimates. Domestic use by eastern carriers.
10. Data available for passengers and freight.

Table A3.6. **Vessel arrival by registered tonnage**

Net registered tonnage[1] (tonnes)	Number of vessels (arrivals)			
	1990	1993	1995	1998
Tankers				
1 – 4 999	2 804	1 950	1 835	1 881
5 000 - 19 999	1 456	1 299	1 220	1 212
20 000 - 99 999	174	174	252	315
100 000+	16	13	28	24
Ro-Ro vessels[2]				
1 - 4 999				
5 000 - 19 999				
20 000+				
Fully cellular container vessels				
1 - 4 999	34	34	82	129
5 000 - 19 999	774	689	844	1 012
20 000+	153	147	163	436
Other dry cargo vessels				
1 - 4 999	31 635	28 097	29 321	23 127
5 000 - 19 999	11 005	10 329	11 172	11 098
20 000 - 99 999	1 180	1 418	1 358	1 408
100 000+	0	0	0	0
Total	54 755	50 149	52 792	46 366

1. Deadweight tonnes as submitted by the United Kingdom are not available for Canadian data.
2. Ro-Ro vessels not consistently distinguished from other vessels for the time series. Ro-Ro arrivals for 1995 and 1998 were generally comparable in number to tanker arrivals.

Table A3.7. **Canada's top three container ports: Montreal**

	1990	1993	1995	1998
Total domestic tonnage	7 606 481	5 088 611	5 690 481	5 848 390
Of which: Bulk	7 225 741	4 799 408	5 339 087	5 315 476
Container & Ro-Ro	227 242	191 152	248 193	246 520
Total international tonnage	13 518 950	10 718 055	12 913 115	15 158 615
Of which: Bulk	6 962 014	3 831 790	4 693 508	4 842 013
Container & Ro-Ro	5 435 577	5 753 386	6 945 858	8 449 173
Quayage (total length of berths)	n.a.	n.a.	n.a.	3 000 m[1]
Draught (metres)	n.a.	n.a.	n.a.	10.7[1]
Total container area (hectares)	60	68	70	70
No. of cranes	13	13	13	14
TEU per metre quay	n.a.	n.a.	n.a.	n.a.
TEU per hectare	n.a.	n.a.	n.a.	n.a.
Movements per hour	n.a.	n.a.	n.a.	n.a.
Crane intensity	n.a.	n.a.	n.a.	n.a.
Movements per crane hour	n.a.	n.a.	n.a.	n.a.
Crane productivity	n.a.	n.a.	n.a.	n.a.
Accident rate	n.a.	n.a.	n.a.	n.a.
Costs	n.a.	n.a.	n.a.	n.a.
TEU per hour	n.a.	n.a.	n.a.	n.a.
Reliability	n.a.	n.a.	n.a.	n.a.

Ro-Ro: Passenger motor cars and vehicles and other motor vehicles.

Note: Total domestic and international tonnages include bulk, containerised and general cargo. Montreal, Vancouver and Halifax handle a large majority of Canada's container traffic, therefore tables for Canada's fourth and fifth largest container ports have not been developed.

1. Current situation, www.port-montreal.com

Table A3.7. **Canada's top three container ports: Vancouver**

	1990	1993	1995	1998
Total domestic tonnage	3 193 805	2 547 410	2 504 656	1 412 840
Of which: Bulk	3 015 601	2 515 612	2 360 119	1 398 540
Container & Ro-Ro	16 744	2 061	100	0
Total international tonnage	61 337 335	56 330 323	66 936 165	69 263 575
Of which: Bulk	58 182 624	51 122 222	60 518 685	59 462 523
Container & Ro-Ro	2 656 686	3 767 773	4 504 193	7 202 657
Quayage (total length of berths)	n.a.	n.a.	n.a.	2 107 [1]
Draught (metres)	n.a.	n.a.	n.a.	15.85[1]
Total container area (hectares)	n.a.	n.a.	n.a.	92[1]
No. of cranes	n.a.	n.a.	n.a.	13[1]
TEU per metre quay	n.a.	n.a.	n.a.	n.a.
TEU per hectare	n.a.	n.a.	n.a.	n.a.
Movements per hour	n.a.	n.a.	n.a.	n.a.
Crane intensity	n.a.	n.a.	n.a.	n.a.
Movements per crane hour	n.a.	n.a.	n.a.	n.a.
Crane productivity	n.a.	n.a.	n.a.	n.a.
Accident rate	n.a.	n.a.	n.a.	n.a.
Costs	n.a.	n.a.	n.a.	n.a.
TEU per hour	n.a.	n.a.	n.a.	n.a.
Reliability	n.a.	n.a.	n.a.	n.a.

Ro-Ro: Passenger motor cars and vehicles and other motor vehicles.

Note: Total Domestic and International tonnages include bulk, containerised and general cargo. Montreal, Vancouver and Halifax handle a large majority of Canada's container traffic, therefore tables for Canada's fourth and fifth largest container ports have not been developed.

1. Current situation.

Table A3.7. **Canada's top three container ports: Halifax**

	1990	1993	1995	1998
Total domestic tonnage	4 009 746	2 885 076	2 569 492	2 625 149
Of which: Bulk	3 624 813	2 615 743	2 352 121	2 360 345
Container & Ro-Ro	309 794	237 299	159 500	166 982
Total international tonnage	12 827 478	11 293 243	10 783 929	10 859 585
Of which: Bulk	8 857 315	7 962 819	7 013 726	7 151 024
Container & Ro-Ro	3 853 802	3 227 704	3 679 669	3 675 111
Quayage (total length of berths)	1 822.5	1 822.5	1 822.5	1 822.5
Draught (metres)	n.a.	n.a.	n.a.	15.3[1]
Total container area (hectares)	50.17	48.57	48.57	48.57
No. of cranes	5	7	7	7
TEU per metre quay	n.a.	n.a.	n.a.	n.a.
TEU per hectare	n.a.	n.a.	n.a.	n.a.
Movements per hour	n.a.	n.a.	n.a.	n.a.
Crane intensity	n.a.	n.a.	n.a.	n.a.
Movements per crane hour	n.a.	n.a.	n.a.	n.a.
Crane productivity	n.a.	n.a.	n.a.	n.a.
Accident rate	n.a.	n.a.	n.a.	n.a.
Costs	n.a.	n.a.	n.a.	n.a.
TEU per hour	n.a.	n.a.	n.a.	n.a.
Reliability	n.a.	n.a.	n.a.	n.a.
Percentage containers moved by rail[1]	80	80	70	70

Ro-Ro: Passenger motor cars and vehicles and other motor vehicles.

Note: Total Domestic and International tonnages include bulk, containerised and general cargo. Montreal, Vancouver and Halifax handle a large majority of Canada's container traffic, therefore tables for Canada's fourth and fifth largest container ports have not been developed.

1. Current situation, www.portofhalifax.ca

Table A3.8. **Length of national rail, road and inland waterway networks**

Kilometres

Year	Rail[1]	Road[2]	Inland waterway
1990	84 567	n.a.	n.a.
1991	83 701	n.a.	n.a.
1992	83 363	n.a.	n.a.
1993	83 225	24 000	n.a.
1994	82 178	n.a.	n.a.
1995	79 081	24 450	n.a.
1996	77 684	n.a.	n.a.
1997	77 111	24 400	n.a.
1998	76 618	24 240	n.a.

1. In track-kilometres. The length of the rail system in route-kilometres in 1998 was 50 430 km.
2. The table shows Canadian National Highway System (NHS) in route-kilometres. The NHS is defined as any existing, primary routes that provide for inter-provincial and international trade and travel by connecting as directly as possible a capital city or major provincial population/commercial centre in Canada with: *i*) another capital city or major provincial population or commercial centre; *ii*) a major port of entry or exit to the US highway network; *iii*) another transportation mode served directly by the highway mode. In 1998 approximately 70% of the NHS was two-lane. More generally, length of public roads in two-lane equivalent kilometres (all road surface types) was 888 898 km in 1991 and 901 903 km in 1998. A "two-lane equivalent" is a length of road measured as if there were only two lanes, *e.g.* a one-kilometre stretch of road with two regular lanes and one passing lane down the middle counts as 1.5.
Source: Transport Canada, Economic Analysis

Table A3.9. **Growth of domestic traffic by road, rail and inland water, 1990-98**

Billion tonne-km

Year	Road[1]	Rail[2]	Inland waterway[3]
1990	54.7	n.a.	n.a.
1991	47.7	n.a.	n.a.
1992	47.8	n.a.	n.a.
1993	52.0	n.a.	n.a.
1994	60.1	n.a.	n.a.
1995	65.8	n.a.	39.0
1996	71.5	n.a.	36.4
1997	72.2	n.a.	39.2
1998	76.7	n.a.	35.8

1. Includes only Canadian domiciled for-hire Class I and II carriers (carriers earning gross annual intercity revenues of CAD 350 000 or more (1987), CAD 500 000 or more (1988-89), CAD 1 million or more (1990-96). Starting in 1997, includes long-distance carriers with annual revenues of CAD 1 million or more, *i.e.* carriers with at least 50% of revenues coming from long-distance (>80 km) movements. Local carriers activity not captured due to methodological changes (NAICS criteria) making historical comparison inexact (underestimated level of intra-provincial traffic) for the years shown. Private trucking is estimated to account for 60-70% of commercial trucking activity but is not included in the table.
2. Tonne-kilometres for domestic and international traffic cannot be distinguished for the time series. See Table A3.11 for total traffic values (domestic + international).
3. Values shown are for domestic traffic (traffic between Canadian points through Canadian and foreign waters) and not for inland shipping *per se*. In Canada, inland shipping would tend to refer to shipping within the St. Lawrence Seaway and the Great Lakes – data for these waters are not designated specifically in existing data sources, but values could be retrieved if required.

Table A3.10. **Growth of *total* traffic by road, rail and water, 1990-98**

Billion tonne-km

Year	Road[1]	Rail	Inland waterway[2]
1990	77.8	248.4	n.a.
1991	70.6	260.5	n.a.
1992	72.9	250.7	n.a.
1993	84.6	256.3	n.a.
1994	101.9	288.4	n.a.
1995	110.0	280.5	1 808.4
1996	121.1	282.5	1 813.1
1997	130.9	306.9	2 030.0
1998	138.1	299.5	1 907.4

1. Includes only Canadian domiciled for-hire Class I and II carriers (carriers earning gross annual intercity revenues of CAD 350 000 or more (1987), CAD 500 000 or more (1988-89), CAD 1 million or more (1990-96). Starting 1997: Including long-distance carriers with annual revenues of CAD 1 million or more, *i.e*. carriers with at least 50% of revenues coming from long-distance (>80 km) movements. Local carriers activity not captured due to methodological changes (NAICS criteria) making historical comparison inexact (underestimated level of intra-provincial traffic) for the years shown. Private trucking is estimated to account for 60-70% of commercial trucking activity but is not included in the table.

2. Includes tonne-kilometres worked in international and foreign waters. Tonne-kilometres allocated to Canadian waters for 1995-98 are as follows: 178.0 B, 172.9 B, 186.9 B and 188.0 B.

Annex 4

PERFORMANCE INDICATORS IN THE CZECH REPUBLIC

The following tables provide information on all modes of freight transport in the Czech Republic for the years 1990, 1993, 1995 and 1998. Data have been provided from: Czech Statistical Yearbook (data from 1990, 1993), Transport Yearbook (data from 1995, 1998) and other sources (Czech Railway Yearbook, Transport Research Centre projects, etc.). Some data are not available. Almost all data from 1990 are valid for former Czechoslovakia, not only for the Czech Republic.

Table A4.1. **Comparative table of modes of transport, 1998**

Indicators, 1998	Road	Rail	Shipping (inland waterways)	Air
Domestic freight moved (million tonne-km)	17 931	8 195	14.8	0.636
Domestic freight moved – containers (million tonne-km)	n.a.	n.a.	n.a.	n.a.
International freight moved (million tonne-km)	15 980	10 514	899.6	54.126
International freight moved – containers (million tonne-km)	n.a.	n.a.	n.a.	n.a.
Percentage share of domestic traffic (tonnage)	89.62	10.33	<1	<1
Percentage share of domestic traffic (tonne-km)	71.54	28.39	<1	<1
Percentage share of international traffic (tonnage)	33.24	64.86	1.76	<1
Percentage share of international traffic (tonne-km)	60.23	36.17	3.39	<1
Energy consumption (GJ/tonne-km)/	0.00051/	0.00055/	0.00059/	0.14/
Pollution per tonne-km (g/tonne-km)	0.094	0.018[1]	0.069	9.20
Reliability	n.a.	n.a.	n.a.	n.a.
Price per tonne	n.a.	n.a.	n.a.	n.a.
Price (USD/tonne-km)	0.0825	0.0425	n.a.	n.a.
Lading factor and degree of utilisation	n.a.	n.a.	n.a.	n.a.

1. Diesel traction only.
Source: Czech Statistical Yearbook 1998, Transport Yearbook 1999.

Table A4.2. **Rail freight**

Indicators	1990	1993	1995	1998
Domestic freight moved (million tonne-km)	26 748[1]	12 570	10 493	8 195
Domestic freight lifted (million tonnes)	n.a.	70.0	54.6	51.1
Domestic freight moved – containers (million tonne-km)	n.a.	n.a.	n.a.	n.a.
Domestic freight lifted – containers (million tonnes)	n.a.	n.a.	n.a.	n.a.
Domestic freight lifted – No. of containers	n.a.	n.a.	n.a.	n.a.
International freight moved (million tonne-km)	14 402[1]	12 520	12 293	10 514
International freight lifted (million tonnes)	170.5[2]	53.8	54.3	53.7
International freight moved – containers (million tonne-km)	n.a.	n.a.	n.a.	n.a.
Domestic and international freight lifted – containers (million tonnes)	3 506	1 016	1 365	2 227
Domestic and international freight lifted – No. of containers	583 645	113 556	140 000	83 686[3]
Percentage share of domestic traffic (tonne-km)	83.45	53.85	41.08	31.34
Percentage share of domestic traffic (tonnes)	n.a.	n.a.	8.75	10.33
Percentage share of international traffic (tonne-km)	56.96	44.18	41.12	29.86
Percentage share of international traffic (tonnes)	n.a.	n.a.	79.40	64.86
Energy consumption & pollution per tonne-km (covers not only freight rail, but total rail transport)		See following rows		
Fuel intensity (tonne-km per litre)	n.a.	n.a.	n.a.	n.a.
Energy demand (petajoules)	n.a.	n.a.	16.532	10.305
GHG emissions (grams per tonne-km)	0.018	0.018	0.021	0.018
GHG emissions (thousand tonnes), diesel traction only	~738.5	~456.5	~476.5	331.458
Carbon dioxide (thousand tonnes)	738	456	476	331
Methane (thousand tonnes)	n.a.	n.a.	n.a.	0.028
Nitrous oxide (thousand tonnes)	n.a.	n.a.	n.a.	0.430
Reliability	n.a.	n.a.	n.a.	n.a.
Price per tonne (USD per tonne)	n.a.	n.a.	n.a.	n.a.
Price per tonne (USD per tonne-km)	0.025	0.029	0.036	0.043
Lading factor and degree of utilisation	n.a.	n.a.	n.a.	n.a.
Accidents	n.a.	2 255	2 288	2 582
Accidents per million train-kilometres	n.a.	0.045	0.045	0.059

Note: For containers transport, data are available only for total volume of container transport, and cannot be divided into domestic and international transport. GHG: Greenhouse gas.

1. Estimate.
2. Domestic and international transport.
3. Number of railway wagons loaded by containers and swap-bodies.

Source: Czech Statistical Yearbook 1998, Transport Yearbook 1999.

Table A4.3. **Air freight**

Indicators	1990	1993	1995	1998
Domestic cargo (thousand tonne-km)	2 017	24	81	636
Domestic enplaned cargo (tonnes)	4 252	120	310	1 656
Domestic freight moved-containers	n.a.	n.a.	n.a.	n.a.
International cargo (thousand tonne-km)	55 706	26 344	33 392	54 126
International enplaned cargo (tonnes)	19 871	10 789	17 252	12 532
International freight lifted – containers	n.a.	n.a.	n.a.	n.a.
International freight lifted – value	n.a.	n.a.	n.a.	n.a.
Enplaned belly-hold cargo (tonnes)	n.a.	n.a.	n.a.	n.a.
Enplaned freighter cargo (tonnes)	n.a.	n.a.	n.a.	n.a.
Percentage share of domestic traffic (tonnes)	n.a.	n.a.	<1	<1
Percentage share of domestic traffic (tonne-km)	<1	<1	<1	<1
Percentage share of international traffic (tonnes)	n.a.	n.a.	<1	<1
Percentage share of international traffic (tonne-km)	<1	<1	<1	<1
Energy demand (petajoules)	n.a.	n.a.	6.681	7.340
GHG emissions (grammes per tonne-km)	5.11	n.a.	6.28	9.20
GHG emissions (thousand tonnes)	~294.7	n.a.	~211.7	503.684
Carbon dioxide	294	n.a.	211	503
Methane	n.a.	n.a.	n.a.	0.044
Nitrous oxide	n.a.	n.a.	n.a.	0.640
Total accidents	n.a.	16	8	10
Fatal accidents	n.a.	4	3	1
Reliability	n.a.	n.a.	n.a.	n.a.
Price per tonne	n.a.	n.a.	n.a.	n.a.
Lading factor and degree of utilisation	n.a.	n.a.	n.a.	n.a.

GHG: Greenhouse gas; Enplaned cargo: cargo which is loaded as well as traffic stopping over at an airport.
Source: Czech Statistical Yearbook 1998, Transport Yearbook 1999.

Table A4.4. **Road transport**

Indicators	1990	1993	1995	1998
Domestic freight moved (million tonne-km)	6 728[1]	10 104[1]	14 695	17 931
Domestic freight moved – containers (million tonne-km)	n.a.	n.a.	n.a.	n.a.
International freight moved – total (million tonne-km)[2]	10 092[1]	15 156[1]	16 572	15 980
International freight moved – containers	n.a.	n.a.	n.a.	n.a.
HGV mileage intensity (base: 1990 = 100)	100	109	123	149
Domestic tonnes lifted (thousand tonnes)	n.a.	n.a.	566 017	443 370
International tonnes lifted (thousand tonnes)	n.a.	n.a.	12 779	27 518
Tonnes moved (thousand tonne-km)	16 820	25 260	31 268	33 911
Average length of haul (km)	n.a.	90.9	107.5	n.a.
Average load: rigid (tonnes)	n.a.	n.a.	n.a.	n.a.
Average load: articulated (tonnes)	n.a.	n.a.	n.a.	n.a.
Empty/light running	n.a.	n.a.	n.a.	n.a.
Percentage share of domestic traffic (tonnes)	n.a.	n.a.	90.79	89.62
Percentage share of domestic traffic (tonne-km)	20.99	43.29	57.53	68.59
Percentage share of international traffic (tonnes)	n.a.	n.a.	18.58	33.24
Percentage share of international traffic (tonne-km)	39.91	53.48	55.44	58.21
Number of collisions involving heavy trucks causing fatalities or injuries (1999 only)				
Fatal collisions	n.a.	n.a.	n.a.	n.a.
Straight-truck	n.a.	n.a.	n.a.	n.a.
Tractor-trailer	n.a.	n.a.	n.a.	n.a.
Personal injuries collisions	n.a.	n.a.	n.a.	n.a.
Straight-truck	n.a.	n.a.	n.a.	n.a.
Tractor-trailer	n.a.	n.a.	n.a.	n.a.
Fatalities in collisions involving heavy trucks	n.a.	n.a.	n.a.	135
Straight-truck	n.a.	n.a.	n.a.	95
Tractor-trailer	n.a.	n.a.	n.a.	40
Injuries in collisions involving heavy trucks	n.a.	n.a.	n.a.	2 073
Straight-truck	n.a.	n.a.	n.a.	1 616
Tractor-trailer	n.a.	n.a.	n.a.	457
Lading factor: rigid	n.a.	n.a.	n.a.	n.a.
Lading factor: articulated vehicles	n.a.	n.a.	n.a.	n.a.
Fuel consumption (litres per 100 km)				
Gasoline trucks	n.a.	n.a.	n.a.	n.a.
Light and medium diesel trucks	n.a.	n.a.	n.a.	n.a.
Heavy diesel trucks	n.a.	n.a.	n.a.	n.a.
Fuel intensity (tonne-km per litre)	n.a.	n.a.	n.a.	n.a.
Energy demand (petajoules)	n.a.	n.a.	34.236	17.192
GHG emissions (grammes per tonne-km)	0.14	0.12	0.13	0.094
GHC emissions (thousand tonnes)	~2 318.5	~3 108.5	~3 962.5	3 178.426
Carbon dioxide	2 318	3 108	3 962	3 178
Methane	n.a.	n.a.	n.a.	0.302
Nitrous oxide	n.a.	n.a.	n.a.	0.124

Table A4.4. **Road transport** *(cont'd.)*

Indicators	1990	1993	1995	1998
Average speeds				
Motorways (70 mph speed limit)				
Rigid 2 axles	n.a.	n.a.	n.a.	n.a.
Rigid 3/4 axles	n.a.	n.a.	n.a.	n.a.
All articulated vehicles	n.a.	n.a.	n.a.	n.a.
Dual carriageways (70 mph speed limit)				
Rigid 2 axles	n.a.	n.a.	n.a.	n.a.
Rigid 3/4 axles	n.a.	n.a.	n.a.	n.a.
All articulated vehicles	n.a.	n.a.	n.a.	n.a.
Single carriageways (60 mph speed limit)				
Rigid 2 axles	n.a.	n.a.	n.a.	n.a.
Rigid 3/4 axles	n.a.	n.a.	n.a.	n.a.
All articulated vehicles	n.a.	n.a.	n.a.	n.a.
Urban roads (40 mph speed limit)				
Rigid 2 axles	n.a.	n.a.	n.a.	n.a.
Rigid 3/4 axles	n.a.	n.a.	n.a.	n.a.
All articulated vehicles	n.a.	n.a.	n.a.	n.a.
Urban roads (30 mph speed limit)				
Rigid 2 axles	n.a.	n.a.	n.a.	n.a.
Rigid 3/4 axles	n.a.	n.a.	n.a.	n.a.
All articulated vehicles	n.a.	n.a.	n.a.	n.a.
Vehicle safety – VI/testing failure rate (%)	n.a.	n.a.	n.a.	n.a.
Emission standards (thousand tonnes)				
NO_x	n.a.	n.a.	n.a.	n.a.
PM_{10}	n.a.	n.a.	n.a.	n.a.

1. Estimate.
2. Domestic and international transport.
Source: Czech Statistical Yearbook 1998, Transport Yearbook 1999.

Table A4.5. **Inland waterways**

Indicators	1990	1993	1995	1998
Domestic freight moved (million tonne-km)	575	487	353	14.8
Domestic containerised traffic (thousand units)	n.a.	n.a.	n.a.	n.a.
International freight moved (million tonne-km)	734	637	995.2	899.6
International containerised traffic (thousand units)	n.a.	n.a.	n.a.	n.a.
Domestic freight lifted (thousand tonnes)	5 060	3 737	2 770	223
International freight lifted (thousand tonnes)	1 175	982	1 670	1 454
Total international bulk traffic (million tonnes)	n.a.	n.a.	n.a.	n.a.
Percentage share of domestic traffic (tonnes)	n.a.	n.a.	<1	<1
Percentage share of domestic traffic (tonne-km)	1.79	2.09	1.38	<1
Percentage share of international traffic (tonnes)	n.a.	n.a.	2.43	1.76
Percentage share of international traffic (tonne-km)	2.90	2.25	3.33	3.28
Total domestic combined transport (thousand units)	n.a.	n.a.	n.a.	n.a.
Total international and domestic combined transport (thousand units)	n.a.	0.41	1.900	1.490
Total coastwise traffic (million tonnes)	--	--	--	--
Total unitised short-sea and near-sea traffic (thousand units)	--	--	--	--
Total inland water traffic (million tonnes)	6.370	4.906	4.440	1.677
Inland waterways accident figures				
Vessels involved in accidents, excluding fishing vessels	n.a.	n.a.	32	16
Deaths	n.a.	n.a.	n.a.	n.a.
Injuries	n.a.	n.a.	n.a.	n.a.
Fuel intensity (tonne-km per litre)	n.a.	n.a.	n.a.	n.a.
Energy demand (petajoules)	0.763	0.658	0.836	0.538
GHG emissions (grammes per tonne-km)	0.041	0.043	0.037	0.069
GHG emissions (thousand tonnes)	~54.1	~48.1	~48.1	30.085
Carbon dioxide	54	48	48	30
Methane	n.a.	n.a.	n.a.	0.005
Nitrous oxide	n.a.	n.a.	n.a.	0.080
Reliability	n.a.	n.a.	n.a.	n.a.
Costs	n.a.	n.a.	n.a.	n.a.

Source: Czech Statistical Yearbook 1998, Transport Yearbook 1999.

Table A4.6. **Types of vessel registered in the Czech Republic**

Type of vessel	Number of vessels 1990	1993	1995	1998
Freight motor ships	n.a.	n.a.	80	79
Tow and push boats	n.a.	n.a.	278	294
Tow and draught tow-boats	n.a.	n.a.	175	154

Source: Czech Statistical Yearbook 1998, Transport Yearbook 1999.

Table A4.7. **Length of national rail, road and inland waterway networks**

Kilometres

Year	Rail	Road	Inland waterway
1980	9 499	56 263	n.a.
1985	9 468	55 933	n.a.
1990	9 451	55 892	303
1991	9 454	55 873	n.a.
1992	9 439	55 874	n.a.
1993	9 441	55 912	303
1994	9 413	55 922	n.a.
1995	9 430	55 875	303
1996	9 430	55 489	n.a.
1997	9 430	55 576	n.a.
1998	9 430	55 393	303

Source: Czech Statistical Yearbook 1998, Transport Yearbook 1999.

Table A4.8. **Evolution of domestic traffic by road, rail and inland water, 1990-98**

Million tonne-km

Year	Road	Rail	Inland waterway
1990	n.a.	n.a.	n.a.
1991	n.a.	n.a.	n.a.
1992	n.a.	n.a.	n.a.
1993	n.a.	12 570	487
1994	12 147	10 991	409
1995	14 696	10 330	353.0
1996	14 100	10 493	165.5
1997	17 046	9 796	27.8
1998	17 931	8 195	14.8

Source: Czech Statistical Yearbook 1998, Transport Yearbook 1999.

Table A4.9. **Evolution of *total* traffic by road, rail and water, 1990-98**

Billion tonne-km

Year	Road	Rail	Water
1990	23.3	59.5	4.4
1991	17.4	46.0	3.9
1992	14.0	44.2	3.0
1993	13.0	22.6	1.2
1994	23.6	22.8	1.2
1995	31.3	22.6	1.3
1996	30.1	22.3	1.1
1997	40.6	21.0	0.8
1998	33.9	18.7	0.9

Source: Czech Statistical Yearbook 1998, Transport Yearbook 1999.

Table A4.10. **Length of tracks, stock capacities and operating hours in terminals**

Terminal	Length of crane track	Number of crane loading tracks	Loading tracks length	Length of other tracks	Stock capacity	Operating hours
Unit	(m)		(m)	(m)	(TEU)	
Operator: CSKD Intrans a.s. – 7 terminals						
Brno - Horni Herspice	270	3	3 x 340	-	408	6.00-18.00
Ceske Budejovice	265	2	2 x 270	2 x 370	450	non-stop
Lovosice	190	2	2 x 190	383	286	6.00-18.00
Ostrava – Privoz	200	2	2 x 200	3 x 250	162	6.00-18.00
Pardubice	205	1	205	2 x 270	300	6.00-18.00
Praha - Žižkov nakl.nadr.	215	3	3 x 215	346	255	non-stop
Prerov - Horni Mostenice	132	1	280	-	66	6.00-18.00
Operator: Metrans a.s. – 2 terminals						
Praha Uhrineves	none	-	7 x 600	2 300	3 000	non-stop
Lipa u Zlina	none	-	2 x 250	2 700	1 000	non-stop
Operator: Hudson Cargo a.s. – 1 terminal						
Breclav	none	-	build	-	1 250	7.00-17.00
Operator: Bohemiakombi spol.s.r.o. – 1 terminal – Rolling motorway						
Lovosice Ro-La	none	-	2 x 550	564+720	0	non-stop

Table A4.11. **Terminal loading equipment characteristics**

Terminal Unit	Mechanism	No.	Spreader lifting capacity (tonnes)	Grapple arms lifting capacity (tonnes)	Loading units manipulated
Operator: CSKD Intrans a.s. – 7 terminals					
Brno - Horni Herspice	Gantry crane	1	32	27	C 20'-40' max 36t); SB (max 27t) HC 45'
	Gantry crane	1	36	27	ST(max 27t)
	Stacker	2	16	-	C 20', 40'
Ceske Budejovice	Gantry crane	1	40	24	C 20'-40' (max 36t); SB(max 24t), ST(max 30t)
Lovosice	Gantry crane on tyres		24	-	C 20', 40',
	PD 25, PD32	2	32	-	
	Single side loading fork truck	2	24	-	C 20'
Ostrava - Privoz	Gantry crane on tyres		25	-	C 20'-40' (max 36t); SB (max 24t)
	PD 25, PD38	2	38	24	ST(max 27t)
Pardubice	Gantry crane on tyres		25	-	C 20', 40'; SB (max 24t)
	PD 25, PD38	2	38	24	
Praha - Žižkov nakl.nadr.	Gantry crane on tyres		25	-	C 20', 40' (max 28t); HC; SB (max 24t)
	PD 25, PD38	2	38	24	
Prerov - Horni Mostenice	Gantry crane on tyres	1	25	-	C 20'-40' (max 20t); HC
Operator: Metrans a.s. – 2 terminals					
Praha Uhrineves	Stacker	2	40, 55	35	C 20'-40' (max 36t); SB (max 24t); HC
	(superstacker)				ST(max 27t)
Lipa u Zlina	Stacker	1	25	-	C 20'-40' (max 36t); HC; SB (max 36t);
	Jib (mobile) crane	2	16, 20	-	ST (max 36t)
Operator: Hudson Cargo a.s. – 1 terminal					
Breclav	Jib (mobile) crane	1	20	-	C 20'
Operator: Bokemiakombi spol.s.r.o. – 1 terminal – rolling motorway					
Lovosice Ro-La	Ro-Ro ramp	2	-	-	-

Table A4.12. **Terminal service characteristics**

Terminal	Year founded	Loading capacity	Entry	Bonded warehouse	Forwarding	Stocking
Unit		(TEU)				
Operator: CSKD Intrans a.s. – 7 terminals						
Brno - Horni Herspice	1976	850	x	x	x	x
Ceske Budejovice	1979	490	x	x	x	x
Lovosice	1977	800	x		x	
Ostrava - Privoz	1976	250	x		x	x
Pardubice	1982	500	x	x	x	x
Praha - Žižkov nakl.nadr.	1974	420	x	x	x	x
Prerov - Horni Mostenice	1973	100	x	x	x	x
Operator: Metrans a.s. – 2 terminals						
Praha Uhrineves	1991	1 000	x	x	x	x
Lipa u Zlina	1995	450	x	x	x	x
Operator: Hudson Cargo a.s. – 1 terminal						
Breclav	1996	150	x	x	x	x
Operator: Bohemiakombi spol.s.r.o. – 1 Ro-La terminal						
Lovosice Ro-La	1994	250 vehicles	x			

Table A4.13. **Length of tracks, stock capacities and operating hours in river ports**

Terminal	Length of crane line	Number of crane loading tracks	Length of loading tracks	Length of other tracks	Stock capacity	Operating hours
Unit	(m)		(m)	(m)	(TEU)	
CESKE PRISTAVY A.S. – 4 river ports						
Decin – Stare Loubi	340	2	415	-	5 000 m^2	6.00-20.00
Melnik – Topulky	none	-	550+220	-	600	7.00-17.00
Praha Holesovice	170	2	2 x 210	-	250	6.00-18.00
Usti n/L – pristav Krasne Brezno	190	3	560+475+190	-	7 500 m^2	6.00-20.00

Table A4.14. **River ports: loading equipment characteristics**

Terminal	Mechanism	No.	Hook lifting capacity	Grapple arms lifting capacity	Loading units manipulated
Unit			(tonnes)	(tonnes)	
Decin – Stare Loubi	Gantry crane	1	32	-	Packages only
Praha Holesovice	Gantry crane	1	40	-	C 20', 40'; HC
Usti n/L – pristav Krasne Brezno	Gantry crane	1	40	-	Packages only
Melnik – Topulky	Stacker	1	40	-	C 20', 40'; HC

Table A4.15. **River ports: service characteristics**

Terminal	Year founded	Loading capacity	Customs	Bonded warehouse	Forwarding facilities	Storage of empty units
Unit		(TEU)				
CSPL a.s. – 1 river port						
Decin - Stare Loubi		460	x	x		x
Ceske přístavy a.s. – 2 river ports						
Praha Holesovice - rented to a.s. Contrans	1991	400	x	x	x	x
Usti n/L -Krasne Brezno, provoz. ČSPL		Packages		x		x
Eurokai a.s. – 1 river port						
Melnik - Topulky		2 500	x	x	x	x

Table A4.16. **Share of intermodal transport in total transport in the Czech Republic**

Transport modes		Units	Year 1995	1996	1997	1998
Road	Goods transported	Million tonnes	583.83	685.74	521.48	470.89
	Volume	Billion tonne-km	31.28	23.17	40.64	33.91
	% share of total transport	%	83.75	86.13	82.16	80.79
Rail	Goods transported	Million tonnes	108.86	107.25	111.38	110.28
	Volume	Billion tonne-km	22.62	22.34	21.01	18.76
	% share of total transport	%	15.62	13.47	17.55	18.92
IT by rail	Goods transported	Million tonnes	2.15	3.96	4.69	5.29
	Volume	Billion tonne-km	0.447	0.565	0.654	0.731
	By containers	Million tonnes	1.36	1.74	1.89	2.07
	By swap-bodies, semi-trailers	Million tonnes	0.09	0.17	0.23	0.29
	By accompanied transport	Million tonnes	0.7	2.05	2.57	2.93
	% share of railway transport	%	1.98	3.69	4.21	4.80
	% share of total transport	%	0.31	0.50	0.74	0.91
	% share of total IT	%	98.90	99.55	99.62	99.66
Inland waterways	Goods transported	Million tonnes	4.39	3.18	1.83	1.68
	Volume	Billion tonne-km	1.32	1.35	0.74	0.82
	% share of total transport	%	0.63	0.40	0.29	0.29
IT by waterways	IT by waterways	Million tonnes	0.024	0.018	0.018	0.017
	% share of waterways transport	%	0.55	0.57	0.98	1.7
	% share of total transport	%	0.003	0.002	0.003	0.003
	% share of total IT	%	1.10	0.45	0.38	0.34
Air	Goods transported	Million tonnes	0.018	0.014	0.014	0.013
	Volume	Billion tonne-km	0.033	0.026	0.027	0.056
	% share of total transport	%	0.00258	0.00176	0.00221	0.00223
Total	Goods transported	Million tonnes	697.098	796.184	634.704	582.863
	Volume	Billion tonne-km	55.25	46.89	62.42	53.55
Total IT	Goods transported	Million tonnes	2.174	3.978	4.708	5.307
	% share of total transport	%	0.31	0.50	0.74	0.91

Source: MT, Czech Railways; 1999.

Table A4.17. **Development of combined transport in the Czech Republic, 1993-2000**

		1993	1994	1995	1996	1997	1998	1999	2000
Terminals/Terminals per thousand square km									
Road-railway	Pcs	17	16	16	15	15	16	11	11
Per thousand sq. km	Pcs	0.22	0.20	0.20	0.19	0.19	0.20	0.14	0.14
Of which:: Ro-La	Pcs	0	1	2	2	2	2	2	2
Per thousand sq. km	Pcs	0	0.012	0.025	0.025	0.025	0.025	0.025	0.025
Railway-water	Pcs	4	4	4	4	4	4	4	4
Per thousand sq. km	Pcs	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051
A) – Railway combined transport – unaccompanied									
a) Freight containers[1]									
	Thous. pcs	113.5	130.2	140.0	172.4	174.0	181.0		
	Million tonnes	1.01	1.009	1.36	1.74	1.89	2.07		
	% change	-32.3	0.0	+34.7	+27.9	+8.6	+9.5		
a1) *Of which:* international									
Total	Million tonnes	0.57	0.6	0.90	1.27	1.42	1.59		
Of which: import	Million tonnes	0.13	0.17	0.30	0.51	0.54	0.58		
export	Million tonnes	0.34	0.26	0.36	0.55	0.58	0.58		
transit	Million tonnes	0.1	0.17	0.24	0.21	0.30	0.43		
a2) *Of which:* interstate									
Total	Million tonnes	0.44	0.4	0.46	0.47	0.47	0.48		
b) Other unaccompanied transport (swap-bodies, semi-trailers)									
Total	Million tonnes	0.025	0.072	0.09	0.17	0.23	0.29		
Number of pieces[2]	Thous. pcs	0.95	1.09	1.45	2.58	9.68	11.5		
Total unaccompanied (a+b = A)									
Total A)	Million tonnes	1.035	1.729	1.45	1.91	2.12	2.26		
B) Railway combined transport – accompanied (Ro-La)[5]									
Vehicles	Thous. pcs	0.939	23.57	85.24	94.81	89.11	99.98		
Goods carried on vehicles	Million tonnes	0.027	0.719	2.557	2.686	2.575	2.934		
C) Total railway combined transport (A+B)									
Total	Million tonnes	1.041	1.73	2.15	3.96	4.69	5.29		
	% change	-30,5	+66,2	+124,2	+184,1	+118,4	+112,7		
Railway IT volume	Mln. t-km	[3]	[3]	446.8	565.4	654.3	731.3		
D) – Water combined transport									
	Thous. pcs	0.41	0.99	1.9	1.5	1.51	1.49		
	Million tonnes	0.005	0.012	0.023	0.018	0.018	0.017		
	% change	-68.8	+140	+91.7	-21.8	+0.66	-1.3		
Intermodal transport in the Czech Republic (C+D)									
IC[4]	Thous. pcs	113.5	131.19	141.9	173.9	75.51	82.49		
ST+SB[4]	Thous. pcs	0.95	1.09	1.45	2.58	9.68	11.5		
Accompanied vehicles	Thous. pcs	0.939	23.57	85.24	94.81	89.11	99.98		
Total IT in CR	Million tonnes	1.046	1.74	2.173	3.978	4.708	5.307		
	% change	-31.0	+48	+24.8	+83.0	+18.3	+12.7		

1. Only loaded containers.
2. Estimate.
3. Not available.
4. Estimate Ro-La.
5. Estimate by Ministry of Transport.

Source: Ministry of Transport, Czech Railways.

Annex 5

TRANSPORT IN CENTRAL AND EASTERN EUROPEAN COUNTRIES

Table A5.1. **Transport development in Central and East European Countries, 1970-98**

Billion tonne-km

Bulgaria	1970	1980	1985	1990	1992	1993	1994	1995	1996	1997	1998
Railways	13.9	17.7	18.2	14.1	7.8	7.7	7.8	8.6	7.5	7.4	6.2
Road*	7	13.1	13.5	13.8	7	8.5	10	11	15.5	14.1	14.5
Inland waterways	1.83	2.61	2	1.61	0.84	0.46	0.36	0.73	0.63	0.68	0.71
Total	22.73	33.41	33.7	29.51	15.64	16.66	18.16	20.33	23.63	22.18	21.41

Czechoslovakia	1970	1980	1985	1990	1992						
Railways	55.9	66.2	66.1	59.4	44						
Road	10.1	21.3	21.5	23.3	14						
Inland waterways	2.43	3.59	4.36	4.42	2.98						
Total	68.43	91.09	91.9	87.12	60.98						

Note: On 1 January 1993, Czechoslovakia was divided into the Czech Republic and the Slovak Republic.

Czech Republic						1993	1994	1995	1996	1997	1998
Railways						25.2	22.8	22.6	22.2	20.7	19.5
Road*						13	22.7	20.8	30.1	40.6	33.9
Inland waterways						1.26	1.19	1.32	1.1	0.78	0.91
Total						39.46	46.69	44.72	53.4	62.08	54.31

Slovak Republic						1993	1994	1995	1996	1997	1998
Railways						13.9	12.3	13.7	11.9	12.4	11.8
Road*						5.5	4.9	5.2	5.2	5.2	4.8
Inland waterways						0.84	0.85	1.23	1.6	1.52	1.53
Total						20.24	18.05	20.13	18.7	19.12	18.13

Estonia	1970	1980	1985	1990	1992	1993	1994	1995	1996	1997	1998
Railways	5.1	5.9	6.5	7	3.6	4.2	3.6	3.8	4.2	5.1	6.1
Road*	2.4	4.2	4.4	4.5	1.5	1.1	1.4	1.6	1.9	2.8	3.8
Inland waterways	0.01	0.01	0.01	0	0	0	0	0	0	0	0
Total	7.51	10.11	10.91	11.5	5.1	5.3	5	5.4	6.1	7.9	9.9

Table A5.1. **Transport development in Central and East European Countries, 1970-98** *(cont'd.)*

Billion tonne-km

Hungary	1970	1980	1985	1990	1992	1993	1994	1995	1996	1997	1998
Railways	19.8	24.4	21.8	16.8	10.0	7.7	7.7	8.4	7.6	8.1	8.2
Road*	5.8	11.4	12.7	15.2	12.8	13.4	13	14.2	14.7	15.0	17.0
Inland waterways	1.76	2.15	2.14	2.04	1.6	1.62	1.35	1.26	1.34	1.64	1.56
Total	27.36	37.95	36.64	34.04	24.4	22.72	22.05	23.86	23.64	24.74	26.76

Lithuania	1970	1980	1985	1990	1992	1993	1994	1995	1996	1997	1998
Railways	13.6	18.2	20.9	19.3	11.3	9.9	8	7.7	8.1	8.6	8.3
Road*	3.4	6.9	7.4	7.3	5	6.9	4.6	5.2	4.2	5.1	5.6
Inland waterways	0.12	0.15	0.17	0.16	0.05	0.05	0.03	0.02	0.01	0.01	0.01
Total	17.12	25.25	28.47	26.76	16.35	16.85	12.63	12.92	12.31	13.71	13.91

Latvia	1970	1980	1985	1990	1992	1993	1994	1995	1996	1997	1998
Railways	15.5	17.6	19.9	18.5	10.1	9.9	9.5	9.8	12.4	14	13.0
Road*	2.9	5.1	5.9	5.9	2.5	1.3	1.4	1.8	2.2	3.4	4.1
Inland waterways	0.05	0.09	0.3	0.29	0.4	0	0	0	0	0	0
Total	18.45	22.79	26.1	24.69	13	11.2	10.9	11.6	14.6	17.4	17.1

Poland	1970	1980	1985	1990	1992	1993	1994	1995	1996	1997	1998
Railways	99.3	134.7	118	81.8	57	63.3	64.7	69.1	67.4	68.7	61.2
Road*	15.8	44.6	36.6	40.3	42	40.7	45.4	51.2	56.5	63.7	69.5
Inland waterways	2.3	2.33	1.41	1.03	0.75	0.66	0.79	0.88	0.85	0.93	1.10
Total	117.4	181.63	156.01	123.13	99.75	104.66	110.89	121.18	124.75	133.33	131.8

Romania	1970	1980	1985	1990	1992	1993	1994	1995	1996	1997	1998
Railways	48.1	75.5	64.1	48.8	24.2	21.9	21.6	24.2	24.3	22.1	16.6
Road*	5.2	11.8	27.9	29	15.7	15.4	18.3	19.7	19.8	21.8	15.8
Inland waterways	1.35	2.35	2.35	2.09	1.89	1.59	1.9	3.11	3.77	4.33	4.20
Total	54.65	89.65	94.35	79.89	41.79	38.89	41.8	47.01	47.87	48.23	36.6

Slovenia	1970	1980	1985	1990	1992	1993	1994	1995	1996	1997	1998
Railways	3.3	3.9	4.3	4.2	2.6	2.3	2.3	2.9	2.6	2.6	2.6
Road*	2.1	3.9	4.7	4.9	2.8	2.8	2.4	2.4	2.3	2.9	3.1
Inland waterways	0	0	0	0	0	0	0	0	0	0	0
Total	5.4	7.8	9	9.1	5.4	5.1	4.7	5.3	4.9	5.5	5.7

* From 1997, national and international traffic by vehicles registered in the country.

Table A5.2. **Freight transport: modal shares in Central and East European Countries, 1970-98**

Percentages

Bulgaria	1970	1980	1985	1990	1992	1993	1994	1995	1996	1997	1998
Railways	61.2	53.0	54.0	47.8	49.9	46.2	43.0	42.3	31.7	33.4	29.0
Road*	30.8	39.2	40.1	46.8	44.8	51.0	55.1	54.1	65.6	63.6	67.7
Inland waterways	8.1	7.8	5.9	5.5	5.4	2.8	2.0	3.6	2.7	3.1	3.3

Czechoslovakia	1970	1980	1985	1990	1992	1993	1994	1995	1996	1997	1998
Railways	81.69	72.68	71.9	68.18	72.15						
Road	14.76	23.38	23.4	26.74	22.96						
Inland waterways	3.551	3.941	4.74	5.073	4.887						

Note: On 1 January 1993, Czechoslovakia was divided into the Czech Republic and the Slovak Republic

Czech Republic	1970	1980	1985	1990	1992	1993	1994	1995	1996	1997	1998
Railways						63.9	48.8	50.5	41.6	33.3	35.9
Road*						32.9	48.6	46.5	56.4	65.4	62.4
Inland waterways						3.2	2.5	3.0	2.1	1.3	1.7

Slovak Republic	1970	1980	1985	1990	1992	1993	1994	1995	1996	1997	1998
Railways						68.7	68.1	68.1	63.6	64.9	65.1
Road*						27.2	27.1	25.8	27.8	27.2	26.5
Inland waterways						4.2	4.7	6.1	8.6	7.9	8.4

Estonia	1970	1980	1985	1990	1992	1993	1994	1995	1996	1997	1998
Railways	67.9	58.4	59.6	60.9	70.6	79.2	72.0	70.4	68.9	64.6	61.6
Road*	32.0	41.5	40.3	39.1	29.4	20.8	28.0	29.6	31.1	35.4	38.4
Inland waterways	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Hungary	1970	1980	1985	1990	1992	1993	1994	1995	1996	1997	1998
Railways	72.4	64.3	59.5	49.4	41.0	33.9	34.9	35.2	32.1	32.7	30.6
Road*	21.2	30.0	34.7	44.7	52.5	59.0	59.0	59.5	62.2	60.6	63.5
Inland waterways	6.4	5.7	5.8	6.0	6.6	7.1	6.1	5.3	5.7	6.6	5.8

Lithuania	1970	1980	1985	1990	1992	1993	1994	1995	1996	1997	1998
Railways	79.4	72.1	73.4	72.1	69.1	58.8	63.3	59.6	65.8	62.7	59.7
Road*	19.9	27.3	26.0	27.3	30.6	40.9	36.4	40.2	34.1	37.2	40.3
Inland waterways	0.7	0.6	0.6	0.6	0.3	0.3	0.2	0.2	0.1	0.1	0.1

Latvia	1970	1980	1985	1990	1992	1993	1994	1995	1996	1997	1998
Railways	84.0	77.2	76.2	74.9	77.7	88.4	87.2	84.5	84.9	80.5	76.0
Road*	15.7	22.4	22.6	23.9	19.2	11.6	12.8	15.5	15.1	19.5	24.0
Inland waterways	0.3	0.4	1.1	1.2	3.1	0.0	0.0	0.0	0.0	0.0	0.0

Table A5.2. **Freight transport: modal shares in Central and East European Countries, 1970-98** *(cont'd.)*

Percentages

Poland	1970	1980	1985	1990	1992	1993	1994	1995	1996	1997	1998
Railways	84.6	74.2	75.6	66.4	57.1	60.5	58.3	57.0	54.0	51.5	46.4
Road*	13.5	24.6	23.5	32.7	42.1	38.9	40.9	42.3	45.3	47.8	52.7
Inland waterways	2.0	1.3	0.9	0.8	0.8	0.6	0.7	0.7	0.7	0.7	0.8

Romania	1970	1980	1985	1990	1992	1993	1994	1995	1996	1997	1998
Railways	88.0	84.2	67.9	61.1	57.9	56.3	51.7	51.5	50.8	45.8	45.4
Road*	9.5	13.2	29.6	36.3	37.6	39.6	43.8	41.9	41.4	45.2	43.2
Inland waterways	2.5	2.6	2.5	2.6	4.5	4.1	4.5	6.6	7.9	9.0	11.5

Slovenia	1970	1980	1985	1990	1992	1993	1994	1995	1996	1997	1998
Railways	61.1	50.0	47.8	46.2	48.1	45.1	48.9	54.7	53.1	47.3	45.6
Road*	38.9	50.0	52.2	53.8	51.9	54.9	51.1	45.3	46.9	52.7	54.4
Inland waterways	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

* From 1997, national and international traffic by vehicles registered in the country.
Source: UIC, ECMT, national statistics, Eurostat.

Annex 6

PERFORMANCE INDICATORS IN FINLAND

The following series of tables provides information on all modes of freight transport in Finland for the years 1980, 1985, 1990, 1993, 1994, 1995, 1996, 1997, 1998 and 1999. Data have been provided wherever possible although, due to the unavailability of some data, there are inevitably some statistical gaps in the tables.

Table A6.1. **Tonnes in goods transport, 1980-99**

Million tonnes

	1980	1985	1990	1993	1994	1995	1996	1997	1998	1999
Total	437.6	470.3	106.0[1]	557.5	124.3[1]	527.6	495.1	510.6	530.4	539.1
Railway transport[2]	29.8	30.8	34.6	37.9	40.2	39.4	37.7	40.3	40.7	40.0
- Domestic	.	.	21.2	23.3	23.7	21.9	21.6	23.6	23.6	23.2
- International	.	.	13.4	14.6	16.5	17.5	16.1	16.7	17.1	16.8
Road transport[3]	342.0	372.0	.	446.6	.	404.8	374.4	383.1	400.1	410.8
Waterway transport	65.7	67.4	71.3	72.9	84.0	83.3	82.9	87.1	89.5	88.2
- Domestic[4]	16.3	15.4	12.4	8.5	9.8	12.1	12.6	11.9	12.9	10.7
- International	49.4	52.0	58.9	64.4	74.2	71.2	70.3	75.2	76.6	77.5
Air transport	0.05	0.08	0.08	0.08	0.10	0.10	0.11	0.11	0.11	0.11
- Domestic	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
- International	0.03	0.05	0.06	0.07	0.08	0.08	0.09	0.10	0.09	0.09

Note: Totals may not add due to rounding errors.
1. Excluding road transport.
2. Since 1995, wagonload tonnes.
3. Statistics revised in 1995.
4. Including domestic shipping, floating and dredged quantities.
Source: Civil Aviation Administration, Finnish Maritime Administration, Finnra, Statistics Finland, VR-Group Ltd.

Table A6.2. **Tonne-kilometres in goods transport, 1980-99**

Million tonne-km

	1980	1985	1990	1993	1994	1995	1996	1997	1998	1999
Total			184 298	206 927	242 854	229 874	231 091	235 147	223 800	210 368
Railway transport[1]	8 335	8 067	8 357	9 259	9 949	9 293	8 806	9 856	9 885	9 753
- Domestic	.	.	.	.	.	5 936	5 699	6 258	6 313	6 380
- International	.	.	.	.	.	3 357	3 107	3 598	3 572	3 373
Road transport	18 400	20 800	26 300	25 000	25 700	23 200	24 100	25 400	26 500	26 475
- Vans, lorries < 3.5 t	500	700	900	900	900	900	900	900	900	900
- Lorries[2] > 3.5 t	17 900	20 100	25 400	24 100	24 800	22 300	23 200	24 500	25 600	25 600
Water transport			153 669	176 051	210 588	200 426	201 573	202 912	183 904	176 907
- Domestic	5 194	4 181	4 031	3 384	3 599	3 276	3 646	3 340	3 238	3 119
- Shipping	3 395	2 692	2 970	3 020	3 290	2 870	3 326	2 950	2 923	2 832
- Floating	1 789	1 479	1 051	354	299	366	280	380	288	276
- Dredged quantities	10	10	10	10	10	40	40	10	27	10
- International			145 607	169 283	203 390	193 874	194 281	196 232	183 877	170 670
Air transport	53	84	157	181	216	231	258	319	300	351
- Domestic	2	2	2	2	3	3	3	3	3	2
- International	51	82	154	179	213	228	256	316	297	349

Note: Totals may not add due to rounding errors.
1. Since 1995, wagonload tonnes.
2. Statistics revised.
Source: Civil Aviation Administration, Finnish Maritime Administration, Finnra, Statistics Finland, VR-Group Ltd.

Table A6.3. **Emissions of vehicles and motor-driven machines in Finland, 1998**

Emissions	CO	HC	NO_X	Particles	SO_2	Pb	CO_2
Total emissions (thousand tonnes)	450[1]	180[1]	252	50	90	0	57 300
National transport total	319	60	226	12	19	.	16 300
Road transport	275	45	118	7	0	.	11 000
- Cars	243	36	69	2	0	.	6 300
- Vans	15	3	8	1	0	.	1 100
- Buses	5	2	11	1	0	.	800
- Lorries	12	4	30	3	0	.	2 800
Other modes of transport[1]							
- Trains	0.6	0.2	4.0	0.1	.	.	300
- Vessels	25.9	9.7	65.4	1.9	18.2	.	2 800
- Aircraft	2.2	0.2	1.3	.	0.1	0	400
- Motor driven machines	15.1	4.5	37.1	3.2	0.6	.	1 900
Proportion of total emissions (%)	71	33	90	24	21	.	28

Note: Statistics revised in 1998.
1. Estimate.
Source: Technical Research Centre of Finland, Statistics Finland.

Table A6.4. **Accidents**

Traffic deaths according to cause of death statistics, 1980-97

	1980	1985	1990	1991	1992	1993	1994	1995	1996[2]	1997
Total (number)	743	679	825	767	762	636	607	574	521	575
Railway transport	24	18	32	25	21	11	17	22	18	14
Other land transport[1]	589	561	680	640	636	516	507	455	448	491
Water transport	125	95	109	99	97	100	82	90	53	65
Air transport	5	5	4	3	8	9	1	7	2	5

Note: Due to differing definitions, etc., the figures in this table differ from those presented in the context of the respective modes of transport.
1. Number of persons killed in road, level crossing and other overland traffic accidents.
2. Statistics revised in 1996.
Source: Statistics Finland.

Table A6.5.**Goods transport by rail, 1980-98**

Thousand tonnes

	1980	1990	1992	1993	1994	1995	1996	1997	1998
Total[1]	29 574	34 562	32 587	37 869	40 150	39 387	37 717	40 321	40 740
By type of consignment									
- Full wagon load	29 085	33 112	31 206	36 109	38 414	39 387	37 717	40 321	40 740
- Smalls	489	1 450	1 381	1 760	1 736	-	-	-	-
National transport	.	21 192	19 758	23 237	23 679	21 903	21 565	23 603	23 613
By type of consignment									
- Full wagon load	.	19 742	18 377	21 477	21 943	21 903	21 565	23 603	23 613
- Smalls	489	1 450	1 381	1 760	1 736	-	-	-	-
International transport	.	13 370	12 829	14 633	16 471	17 484	16 152	16 718	17 127
Tonnes in transit transport	.	.	5 385	6 359	6 216	4 105	3 234	3 368	2 948
Av. length of transport (km)	280.8	237.9	238.1	242.0	244.6	236.0	233.5	244.5	242.8

1. Since 1995, full-wagon consignment.
Source: VR-Group Ltd.

Table A6.6. **Goods transport by rail, 1980-98**

Million tonne-km

	1980	1990	1992	1993	1994	1995	1996	1997	1998
Total[1)]	8 335	8 357	7 848	9 259	9 949	9 293	8 806	9 856	9 885
By type of consignment									
- Full wagon load	8 169	7 877	7 431	8 737	9 413	9 293	8 806	9 856	9 885
- Smalls	166	480	417	522	536	-	-	-	-
National transport	.	.	.	5 590	6 003	5 936	5 699	6 258	6 313
- By type of consignment									
- Full wagon load	.	.	.	5 068	5 467	5 936	5 699	6 258	6 313
- Smalls	.	.	.	522	536	-	-	-	-
International transport	.	.	.	3 669	3 946	3 357	3 107	3 598	3 572
Transit transport	.	480	417	1 386	1 483	911	612	652	578
Av. length of haul (km)	280.8	237.9	238.1	242.0	244.6	235.9	233.5	244.5	242.8

1. Since 1995, full-wagon consignment.
Source: VR-Group Ltd.

Table A6.7. **Energy consumption of rail transport, 1985-98**

	1985	1990	1991	1992	1993	1994	1995	1996	1997	1998
Total (petajoules)	4.20	3.79	3.69[1]	3.70	3.89	4.11	3.98	3.77[1]	3.95	3.97
Consumption of electricity										
- Million kWh	290	340	350[1]	360[1]	375[1]	395	420[1]	420[1]	450	470
- Petajoules	1.04	1.22	1.26[1]	1.30	1.35	1.42	1.51	1.51[1]	1.62	1.69
Consumption of diesel oil										
- Million litres	88.9	72.3	68.4	67.7	71.6	75.7	69.6	63.8	65.8	64.3
- Petajoules	3.16	2.57	2.43	2.40	2.54	2.69	2.47	2.26	2.33	2.28

1. Revised figures.
Source: VR-Group Ltd.

Table A6.8. **Energy consumption and emissions of rail transport, 1998**

Energy consumption	Energy consumption GJ/a	%	Co t/a	%	Hc t/a	%
Total	3 870 521	100.0	588	100.0	232	100.0
Passenger transport	1 427 086	36.9	137	23.3	40	17.2
- Electric locomotives	695 109	18.0	29	4.9	4	1.7
- Diesel locomotives	388 839	10.0	88	14.9	31	13.4
- Change operations/Diesel locomotives	28 044	0.7	7	1.3	3	1.5
- Local transport	315 094	8.1	13	2.2	2	0.8
Goods transport	2 435 375	62.9	449	76.4	191	82.4
- Electric locomotives	640 005	16.5	27	4.5	4	1.5
- Diesel locomotives	1 472 862	38.1	338	57.4	149	64.1
- Change operations/Diesel locomotives	322 508	8.3	85	14.5	39	16.8
Locomotives only	8 060	0.2	2	0.3	1	0.3
- Electric locomotives	663	0.0	0	0.0	0	0.0
- Diesel locomotives	7 397	0.2	2	0.3	1	0.3
Electrical transport	1 650 871	42.7	69	11.7	9	4.0
Diesel transport	2 219 650	57.3	520	88.3	222	96.0

Emissions	NO_X t/a	%	Particles t/a	%	CO_2 t/a	%
Total	3 970	100.0	110.7	100.0	280 465	100.0
Passenger transport	772	19.4	30.6	27.6	105 142	37.5
- Electric locomotives	81	2.0	9.8	8.8	43 198	15.4
- Diesel locomotives	614	15.5	14.6	13.2	40 149	14.3
- Change operations/Diesel locomotives	39	1.0	1.7	1.6	2 102	0.7
- Local transport	37	0.9	4.5	4.0	19 693	7.0
Goods transport	3 185	80.2	79.9	72.2	174 727	62.3
- Electric locomotives	75	1.9	9.1	8.2	40 000	14.3
- Diesel locomotives	2 656	66.9	50.9	45.9	110 557	39.4
- Change operations/Diesel locomotives	454	11.4	20.0	18.0	24 170	8.6
Locomotives only	13	0.3	0.3	0.2	596	0.2
- Electric locomotives	0	0.0	0.0	0.0	41	0.0
- Diesel locomotives	13	0.3	0.3	0.2	554	0.2
Electrical transport	193	4.9	23.3	21.1	102 933	36.7
Diesel transport	3 777	95.1	87.4	78.9	177 532	63.3

Source: VTT – Technical Research Centre of Finland.

Table A6.9. **Accidents**

a) Accidents connected with railway traffic, 1998

	Number of accidents	Number of people killed or seriously injured		
		Killed	Injured	Total
Total	75	24	14	38
Collisions	9	0	0	0
- Train traffic	4	0	0	0
- Shunting	5	0	0	0
Derailments	10	10	10	20
- Train traffic	4	10	9	19
- Shunting	6	0	1	1
Level-crossing accidents	39	11	2	13
- With safety equipment	11	3	2	5
- Without safety equipment	28	8	0	8
Fire in railway vehicles	13	0	0	0
Other accidents	4	3	2	5

Source: VR-Group Ltd.

b) Victims in railway traffic, 1990-98

	1990	1991	1992	1993	1994	1995	1996	1997	1998
Total killed and injured	58	56	46	40	41	32	21	37	38
Passengers	5	15	4	5	4	4	6	3	19
- Collisions and derailments[1]	-	2	-	-	-	-	6	-	18
- Other accidents	5	13	4	5	4	4	-	3	1
Railway employees	7	2	4	5	7	1	1	6	2
Other	46	39	38	30	30	27	14	28	17
Total killed	36	34	31	20	30	17	12	21	24
Passengers	-	9	1	-	3	1	3	1	10
- Collisions and derailments	-	-	-	-	-	-	3	-	9
- Other accidents	-	9	1	-	3	1	-	1	1
Railway employees	2	1	3	-	3	1	1	1	1
Other	34	24	27	20	24	15	8	19	13
Total seriously injured	22	22	15	20	11	15	9	16	14
Passengers	5	6	3	5	1	3	3	2	9
- Collisions and derailments	-	2	-	-	-	-	3	-	9
- Other accidents	5	4	3	5	1	3	-	2	0
Railway employees	5	1	1	5	4	-	-	5	1
Other	12	15	11	10	6	12	6	9	4

1. Includes falling off a moving train.
Source: VR-Group Ltd.

Table A6.10. **Tonnes and tonne-kilometres in road transport, 1991-98**

Lorries registered in Finland

	1991	1992	1993	1994	1995[1]	1996	1997	1998
Total tonnes (thousand)								
National transport	453 400	.	446 600	.	404 750	374 438	383 135	400 131
- Hire or reward	273 000	.	279 100	.	278 585	262 071	259 055	276 158
- Own account	180 400	.	167 500	.	126 164	112 367	124 080	123 972
Total tonne-km (million)								
National transport	23 800	23 800	24 100	24 800	22 339	23 174	24 511	25 611
- Hire or reward	18 100	.	19 300	.	19 657	20 610	21 739	22 944
- Own account	5 700	.	4 800	.	2 681	2 563	2 772	2 668

1. Statistics revised in 1995.
Source: Finnish National Road Administration, Statistics Finland.

Table A6.11. **Energy consumption and emissions**

a) Fuel consumption by Finnish road transport, 1990-98, tonnes/year

	1990	1992	1993	1994	1995	1996	1997	1998
Total	3 508 960	3 399 462	3 251 920	3 355 604	3 309 705	3 280 484	3 451 356	3 487 728
Cars	2 127 389	2 113 679	2 000 954	2 011 906	1 993 835	1 930 682	2 002 456	2 001 089
Vans	350 829	347 071	325 832	339 879	339 052	333 731	350 298	364 070
Buses	240 920	230 643	222 654	240 656	232 166	239 032	246 192	243 052
Lorries	789 822	708 070	702 479	763 163	744 652	777 040	852 411	879 517

Source: VTT – Technical Research Centre of Finland.

b) Fuel consumption and emissions of road transport by automobile type, 1998

Consumption	Fuel consumption		CO		HC		NO_X		Particles	
	t/a	%	t/a	%	t/a	%	t/a	%	t/a	%
Total	3 487 728	100.0	274 790	100.0	45 467	100.0	117 945	100.0	6 742	100.0
Cars	2 001 089	57.4	242 990	88.4	36 314	79.9	68 660	58.2	2 256	33.5
- Diesel	240 030	6.9	3 496	1.3	1 080	2.4	4 598	3.9	1 438	21.3
- With catalyser	725 306	20.8	47 009	17.1	5 412	11.9	6 435	5.5	120	1.8
- Other	1 035 754	29.7	192 485	70.0	29 822	65.6	57 626	48.9	698	10.4
Vans	364 070	10.4	14 619	5.3	2 534	5.6	8 276	7.0	726	10.8
- Diesel	317 093	9.1	3 414	1.2	1 182	2.6	5 683	4.8	702	10.4
- With catalyser	3 873	0.1	295	0.1	25	0.1	44	0.0	0	0.0
- Other	43 104	1.2	10 911	4.0	1 327	2.9	2 549	2.2	24	0.4
Buses	243 052	7.0	5 002	1.8	2 179	4.8	10 818	9.2	930	13.8
Lorries	879 517	25.2	12 179	4.4	4 440	9.8	30 190	25.6	2 830	42.0

Emissions	CO_2		CH_4		N_20		SO_2	
	t/a	%	t/a	%	t/a	%	t/a	%
Total	10 952 732	100.0	2 355	100.0	1 113	100.0	286	100.0
Cars	6 273 583	57.3	1 833	77.8	893	80.3	236	82.7
- Diesel	755 596	6.9	31	1.3	70	6.3	7	2.5
- With catalyser	2 272 626	20.7	452	19.2	707	63.5	94	33.0
- Other	3 245 361	29.6	1 350	57.3	116	10.5	135	47.2
Vans	1 145 380	10.5	71	3.0	72	6.5	16	5.5
- Diesel	998 187	9.1	23	1.0	65	5.9	10	3.3
- With catalyser	12 134	0.1	2	0.1	3	0.3	1	0.2
- Other	135 058	1.2	47	2.0	4	0.3	6	2.0
Buses	765 111	7.0	128	5.4	40	3.6	7	2.6
Lorries	2 768 658	25.3	323	13.7	108	9.7	26	9.3

Table A6.12. **Road traffic accidents, 1980-98**

	1980	1990	1992	1993	1994	1995	1996	1997	1998
Accidents known to police									
- Involving personal injury	6 790	10 175	7 882	6 147	6 245	7 812	7 274	6 980	6 902
- Provided from traffic insurance	80 999	107 553	91 043	81 518	83 748	84 867	81 511	81 168	87 173[2]
Killed									
Number	551	649	601	484	480	441	404	438	400
- Accidents per 100 000 inhabitants	11.5	13.0	12.0	9.5	9.4	8.6	7.9	8.5	7.8
- Accidents per 100 million auto-km	2.1	1.6	1.4	1.2	1.2	1.1	1.0	1.0	0.9
Injured[1]									
Number	8 442	12 758	9 899	7 806	8 080	10 191	9 299	8 957	9 097
- Accidents per 100 000 inhabitants	177	255	196	154	158	199	181	174	176
- Accidents per 100 million auto-km	32	32	23	19	19	24	22	21	20

1. 1995: statistics revised in 1995.
2. Preliminary data.
Source: Motor Insurer's Centre, Statistics Finland.

Table A6.13. **Vessel arrivals in Finnish harbours, foreign traffic, 1980-98**

	1980	1990	1991	1992	1993	1994	1995	1996	1997	1998
All vessels total										
- Number	22 594	26 571	25 734	27 352	28 180	28 849	30 129	28 559	30 650	31 646
- Net-ton (thousand)	58 303	140 864	149 816	149 555	156 405	148 105	166 161	167 378	172 098	177 788
Finnish										
- Number	10 408	10 702	10 013	9 755	10 509	11 039	12 124	12 023	12 710	13 051
- Net-ton (thousand)	33 231	70 282	74 664	73 366	83 588	89 607	106 069	108 878	108 039	112 669
Direct from abroad										
- Number	17 048	19 905	19 503	21 122	21 456	22 432	23 699	22 891	25 203	26 255
- Net-ton (thousand)	44 068	102 500	112 418	119 238	117 003	111 934	127 711	131 338	144 923	148 690
Finnish										
- Number	7 693	8 004	7 766	7 602	7 542	8 443	9 436	9 646	10 914	11 188
- Net-ton (thousand)	24 444	51 977	58 339	60 429	63 608	69 327	83 258	86 826	94 421	96 061

Source: Finnish Maritime Administration.

Table A6.14. **Vessel arrivals, foreign traffic, by type of vessel, 1998**

	Vessels registered in Finland			Vessels registered in other countries			Total		
	No.	Tonnage net	Cargo tonnes	No.	Tonnage net	Cargo tonnes	No.	Tonnage net	Cargo tonnes
Total	13 051	112 669	19 582	18 595	65 119	19 487	31 646	177 788	39 069
Passenger vessels	467	435	0	1 173	1 574	0	1 640	2 009	0
Passenger/car ferries	5 833	88 102	872	5 112	31 491	643	10 945	119 593	1 515
Train ferries	87	466	119	199	1 253	399	286	1 719	518
Cargo ferries	3 397	14 862	2 849	2 990	11 409	2 045	6 387	26 271	4 894
Containers ships	0	0	0	690	2488	679	690	2 488	679
Bulk carriers	325	1 613	3 254	338	2 495	1 995	663	4 108	5 249
Other dry cargo vessels	1 825	2 498	1 157	6 580	10 028	6 881	8 405	12 526	8 038
Tankers	533	3 596	6 911	1 282	4 189	6 200	1 815	7 785	13 111
Other vessels	584	1 097	4 420	231	192	645	815	1 289	5 065

Source: Finnish Maritime Administration.

Table A6.15. **Goods transport on domestic waterways, 1980-98**

a) Million tonnes

	1980	1990	1991	1992	1993	1994	1995	1996	1997	1998
Total, all goods	16.28	12.36	10.46	8.99	8.48	9.78	12.05	12.58	11.85	12.88
Goods transport										
- Total	8.73	8.04	7.05	6.89	6.91	8.49	10.48	11.42	10.44	11.72
- Oil products	5.64	3.83	3.69	4.19	4.11	4.81	4.49	6.00	5.76	4.61
- Other goods	1.98	1.99	1.65	1.44	1.40	1.54	1.73	1.95	1.94	2.64
- Dredged quantities	1.11	2.22	1.71	1.26	1.40	2.14	4.26	3.47	2.74	4.47
Floating										
- Total	7.55	4.32	3.41	2.10	1.57	1.29	1.57	1.16	1.41	1.16
- River floating	1.41	0.66	0.60	-	-	-	-	-	-	-
- Bundle floating	6.14	3.66	2.81	2.10	1.57	1.29	1.57	1.16	1.41	1.16

Source: Finnish Maritime Administration.

b) Million tonne-km

	1980	1990	1991	1992	1993	1994	1995	1996	1997	1998
Total, all goods	5 184	4 032	3 560	3 323	3 383	3 599	3 240	3 649	3 344	3 238
Goods transport										
- Total	3 395	2 981	2 731	2 819	3 029	3 300	2 870	3 365	2 967	2 950
- Oil products	3 064	2 452	2 293	2 411	2 605	2 786	2 340	2 667	2 386	2251
- Other goods	321	519	418	398	414	504	490	659	568	672
- Dredged quantities	10	10	20	10	10	10	40	39	13	27
Floating										
- Total	1 789	1 051	829	504	354	299	370	284	377	288
- River floating	438	244	219	-	-	-	-	-	-	-
- Bundle floating	1 351	807	610	504	354	299	370	284	377	288

Source: Finnish Maritime Administration.

Table A6.16. **Goods transport in international traffic by sea**

a) Imports and exports by sea, thousand tonnes, 1980-98

	1980	1990	1991	1992	1993	1994	1995	1996	1997	1998
Total	49 370	58 872	58 895	59 848	64 436	74 243	71 158	70 289	75 182	76 593
- By Finnish vessels	21 062	20 355	20 147	20 970	25 256	28 882	28 877	29 642	32 183	32 896
- Share %	42.7	34.6	34.2	35.0	39.2	38.9	40.6	42.2	42.8	42.9
Imports										
- Total	31 470	34 825	32 277	32 090	32 560	38 637	37 036	36 944	39 018	39 069
- By Finnish vessels	14 428	13 103	12 146	12 668	15 911	18 114	18 066	18 693	20 158	19 581
- Share %	45.8	37.6	37.6	39.5	48.9	46.9	48.8	50.6	51.7	50.1
Exports										
- Total	17 900	24 047	26 618	27 758	31 876	35 606	34 122	33 345	36 164	37 524
- By Finnish vessels	6 633	7 252	8 001	8 302	9 345	10 768	10 811	10 949	12 025	13 315
- Share %	37.1	30.2	30.1	29.9	29.3	30.2	31.7	32.8	33.3	35.5

Source: Finnish Maritime Administration.

b) Million tonne-km in foreign goods transport, 1985-98

	1985	1990	1991	1992	1993	1994	1995	1996	1997	1998
Total	167 614	145 607	168 064	157 355	169 283	203 390	193 874	194 281	196 232	183 877
- By Finnish vessels	59 715	24 084	26 448	31 992	34 038	38 357	43 690	40 975	36 945	38 796
- Share %	35.6	16.5	15.7	20.3	20.1	18.9	22.5	21.1	18.8	21.1
Imports	.	76 064	87 905	77 708	64 882	75 071	73 947	78 685	78 803	73 654
- By Finnish vessels	.	11 932	14 671	19 834	19 435	22 514	25 130	24 789	22 757	22 950
- Share %	.	15.7	16.7	25.5	30.0	30.0	34.0	31.5	28.9	31.2
Exports	.	69 543	80 159	79 647	104 401	128 319	119 927	115 596	117 429	110 223
- By Finnish vessels	.	12 152	11 777	12 158	14 603	15 843	18 560	16 186	14 188	15 846
- Share %	.	17.5	14.7	15.3	14.0	12.3	15.5	14.0	12.1	14.4

Source: Finnish Maritime Administration.

Table A6.17. **Means of transport imported by sea, 1980-98**

	1980	1990	1992	1993	1994	1995	1996	1997	1998
Total (tonnes)	2 016 541	3 751 518	3 644 380	4 259 517	5 407 275	5 486 438	6 529 560	7 996 700	7 704 730
Cars (No.)		443 678	502 715	458 917	427 295	444 708	445 790	454 949	471 991
Buses (No.)	6 660	14 532	18 241	25 390	19 667	13 590	14 163	15 177	15 950
Lorries									
- Number	59 393	57 508	61 534	81 648	98 138	105 110	106 926	125 011	129 144
- Cargo (tonnes)	851 301	887 303	929 209	1 140 688	1 490 293	1 549 698	1 575 050	1 843 115	1 839 044
Trailers									
- Number	19 275	77 706	73 528	80 914	98 925	108 084	122 972	145 426	152 714
- Cargo (tonnes)	262 198	1 011 499	898 501	1 009 186	1 310 229	1 527 285	1 758 705	2 106 853	2 177 833
Containers $\leq$ 20 foot									
- Number	41 488	64 687	69 996	84 384	93 262	86 560	85 364	102 306	110 554
- Cargo (tonnes)	554 004	851 438	786 215	890 358	1 009 871	979 392	1 077 372	1 315 347	1 327 879
Containers > 20 foot									
- Number	13 775	50 743	57 428	79 695	102 208	111 290	133 113	157 982	135 286
- Cargo (tonnes)	196 062	591 247	587 210	809 245	1 144 659	1 326 430	1 649 846	2 081 328	1 792 290
Other									
- Number	6 703	23 807	25 113	28 021	28 867	27 862	30 645	41 379	37 740
- Cargo (tonnes)	152 976	410 031	443 245	410 040	452 223	463 633	468 587	650 057	567 684

Note: Including cargoes.
Source: Finnish Maritime Administration.

Table A6.18. **Energy consumption and emissions in water transport, 1998**

Consumption	Energy consumption GJ/a	%	CO t/a	%	HC t/a	%	NOx t/a	%
Total	37 467 197	100.0	25 908	100.0	9 704	100.0	65 393	100.0
- Harbours	3 792 250	10.1	501	1.9	188	1.9	6 393	9.8
- Waterways	28 704 002	76.6	2 817	10.9	1 381	14.2	53 135	813
- Free-time boats	2 357 240	6.3	22 140	85.5	7 969	82.1	1 250	1.9
- Fishing and working boats	1 847 550	4.9	394	1.5	130	1.3	3 003	4.6
- Icebreakers	766 156	2.0	56	0.2	37	0.4	1 612	2.5

Emissions	Particles t/a	%	SO_2 t/a	%	CO_2 t/a	%
Total	1 925	100.0	18 201	100.0	2 758 761	100.0
- Harbours	147	7.6	2 158	11.9	282 644	10.2
- Waterways	1 329	69.0	15 654	86.0	2 109 616	76.5
- Free-time boats	339	17.6	69	0.4	172 584	6.3
- Fishing and working boats	64	3.3	105	0.6	138 698	5.0
- Icebreakers	46	2.4	214	1.2	55 221	2.0

Source: Technical Research Centre of Finland.

Table A6.19. **Accidents: water transport**

Shipwrecks, 1993-98

	1993	1994	1995	1996	1997	1998
All shipwrecks, total	87	62	61	49	54	58
Finnish vessels, irrespective of the territory of waters	60	51	39	40	42	46
Foreign vessels on Finnish territory	27	11	22	9	12	12
Stranding or touching						
- Total	37	23	25	27	29	28
- Finnish vessels, irrespective of the territory of waters	22	14	11	25	21	19
- Foreign vessels on Finnish territory	15	9	14	2	8	9
Collision						
- Total	18	6	22	14	12	14
- Finnish vessels, irrespective of the territory of waters	10	4	14	7	8	13
- Foreign vessels on Finnish territory	8	2	8	7	4	1
Fire, explosion						
- Total	2	3	4	3	5	3
- Finnish vessels, irrespective of the territory of waters	2	3	4	3	5	3
- Foreign vessels on Finnish territory	-	-	-	-	-	0
Leaks and damaged cargo						
- Total	4	3	4	1	6	1
- Finnish vessels, irrespective of the territory of waters	4	3	4	1	6	1
- Foreign vessels on Finnish territory	-	-	-	-	-	0
Other accidents						
- Total	26	27	6	4	2	12
- Finnish vessels, irrespective of the territory of waters	22	27	6	4	2	10
- Foreign vessels on Finnish territory	4	-	-	-	-	2

Source: Finnish Maritime Administration.

Table A6.20. **Traffic by Finnish air carriers, 1980-98**

Thousand tonne-km

	1980	1990	1992	1993	1994	1995	1996	1997	1998
Total carriage									
Total	380 257	1 015 836	906 836	937 542	1 055 776	1 160 866	1 226 509[1)]	1 380 207	1 463 456
- Passenger	189 756	859 289	764 347	756 160	839 714	929 915	968 114[1)]	1 061 485	1 166 979
- Freight & mail	52 766	156 547	142 489	181 382	215 992	230 951	258 389[1)]	318 722	296 477
Domestic traffic									
Total	48 250	86 202	77 384	71 638	74 695	79 517	86 234[1]	96 525	110 112
- Passenger	46 109	84 130	75 387	69 492	72 038	76 761	83 550[1]	93 600	107 222
- Freight & mail	2 141	2 072	1 997	2 146	2 557	2 756	2 684[1]	2 925	2 890
International scheduled traffic									
Total	194 272	488 563	458 254	590 409	729 780	910 156	944 890	1 073 045	1 136 888
- Passenger	143 647	347 398	337 070	422 950	526 949	686 237	694 014	763 374	847 124
- Freight & mail	50 625	141 165	121 184	167 459	202 861	223 919	250 876	309 671	289 764
International non-scheduled traffic									
Total	137 735	441 071	371 198	275 495	251301	171 193	195 385[1)]	210 637	216 456
- Passenger	-	427 761	351 890	263 718	240 727	166 917	190 550[1)]	204 511	212 633
- Freight & mail	-	13 310	19 308	11 777	10 574	4 276	4 829[1)]	6 126	3 823

1. Revised figures
Source: Civil Aviation Administration.

Table A6.21. **Carriage of freight and mail at Finnish airports, 1980-98**

Tonnes

	1980	1990	1991	1992	1993	1994	1995	1996	1997	1998
Total										
Mail, loaded and unloaded	8 528	14 294	13 900	16 347	16 361	17 473	18 236	18 724	20 627	22 262
Freight, loaded and unloaded	37 450	70 608	62 353	59 499	65 900	79 784	84 837	90 103	94 618	91 487
Domestic carriage										
Mail, loaded and unloaded	3 258	5 977	6 272	7 555	7 468	7 884	8 031	7 745	8 974	9 445
Freight, loaded and unloaded	12 933	16 110	11 718	10 341	9 081	10 233	10 100	10 058	10 509	9 975
International carriage										
Mail, loaded and unloaded	5 270	8 317	7 628	8 792	8 893	9 589	10 205	10 979	11 653	12 817
Freight, loaded and unloaded	24 517	54 498	50 635	49 158	56 819	69 551	74 737	80 045	84 109	81 512

Source: Civil Aviation Administration.

Table A6.22. **Air transport: energy consumption and emissions**

Consumption, 1998	Energy consumption		CO		HC		NOx	
	GJ/a	%	t/a	%	t/a	%	t/a	%
Total	14 230 323	100.0	3 068	100.0	393	100.0	3 220	100.0
Domestic flights	5 176 598	36.4	446	14.5	154	39.2	1 272	39.5
International flights, departed	4 372 197	30.7	380	12.4	112	28.5	1 422	44.2
International flights, arrived	2 004 230	14.1	256	8.3	69	17.6	317	9.8
Over-flights	2 603 607	18.3	228	7.4	35	8.9	203	6.3
General aviation	73 691	0.5	1 758	57.3	23	5.8	6	0.2

Emissions	Particles		SO_2		CO_2		Pb	
	t/a	%	t/a	%	t/a	%	t/a	%
Total	.	.	263	100.0	1 058 829	100.0	0	0.0
Domestic flights			96	36.6	385 235	36.4	0	0.0
International flights, departed	.	.	81	30.9	325 373	30.7	0	0.0
International flights, arrived	.	.	37	14.2	149 152	14.1	0	0.0
Over-flights	.	.	48	18.4	193 757	18.3	0	0.0
General aviation	.	.	0	0.0	5 313	0.5	1.0	100.0

Source: Civil Aviation Administration.

Table A6.23. **Accidents: air transport**

Accidents involving Finnish aircraft, 1980-98

	1980	1990	1992	1993	1994	1995	1996	1997	1998
Scheduled and non-scheduled traffic									
Aeroplanes	35	49	54	55	54	55	56	55	60
Aircraft hours	83 428	147 500	139 475	134 235	144 710	155 700	165 350	173 000	190 180
Serious aircraft accidents	-	-	-	-	-	-	1	-	-
Aircraft accidents	-	2	-	-	-	-	-	-	-
Killed	-	-	-	-	-	-	1	-	-
Severely injured	-	-	-	-	-	-	-	-	-
General aviation									
Aeroplanes	505	782	776	746	725	711	704	677	671
Aircraft hours	85 201	125 500	101 250	99 925	97 500	92 510	91 970	93 470	88 020
Serious aircraft accidents	3	2	6	3	5	7	3	1	2
Aircraft accidents	19	21	20	18	7	14	9	10	12
Killed	-	2	1	6	-	2	-	-	-
Severely injured	2	1	5	1	1	1	1	2	2
Gliding									
Aeroplanes	305	377	376	364	365	369	369	374	373
Aircraft hours	35 690	36 850	36 750	33 800	32 700	31 700	31 300	34 000	24 700
Serious aircraft accidents	3	1	4	-	2	-	2	-	2
Aircraft accidents	19	19	8	13	11	8	6	6	7
Killed	3	-	-	-	-	-	-	-	-
Severely injured	1	1	4	-	1	-	1	-	2

Source: Civil Aviation Administration.

Annex 7

PERFORMANCE INDICATORS IN JAPAN

Traditional performance indicators

Table A7.1. **Public investment by transportation**

Fiscal year	1993 (JPY billion)	1994 (JPY billion)	1995 (JPY billion)	1995 (%)	1995/93 (%)
Total	17 561	16 144	17 100	100.0	-2.6
Road	15 059	13 989	14 448	84.5	-4.1
Railway	664	615	736	4.3	10.8
Port	1 280	1 125	1 424	8.3	11.3
Airport	558	415	492	2.9	-11.8

Source: Ministry of Land, Infrastructure and Transport.

Table A7.2. **Final energy consumption, 1995**

Million kilo-litres oil equivalent

Total	388
Transport	94
Livelihood	102
Industry	192

Source: Ministry of Economy, Trade and Industry.

Table A7.3. **Final energy consumption, by transport mode, 1995**

10 billion kcal

	Passenger	Freight	Total
Total	51 309	35 795	87 104
Road	42 486	31 973	74 459
Rail	4 213	295	4 508
Sea	1 853	3 000	4 853
Air	2 757	527	3 284

Source: Ministry of Land, Infrastructure and Transport.

Table A7.4. **Final energy consumption, by transport mode and transport volume**

Percentages

	Energy	Transport volume
Passenger		
Total	100.0	100.0
Passenger car	69.0	47.0
Bus	2.0	5.0
Rail	7.0	29.0
Others	22.0	19.0
Freight		
Total	100.0	100.0
Own truck	46.0	13.0
Commercial truck	43.0	40.0
Rail	1.0	4.0
Sea	8.0	43.0
Air	1.0	0.2

Source: Japanese Ministry of Land, Infrastructure and Transport.

Performance indicators in "Comprehensive Programme of Logistics Policies" (CPLP)

CPLP was decided by the Cabinet on 4 April 1997. CPLP includes all logistics policies in Japan, one major set of policies of which are intermodal freight transport policies. CPLP has since been annually reviewed by related ministries and the progress of CPLP has been reported to the Cabinet. As the implementation period of CPLP will finish at the end of FY2001 (*i.e.* the end of March 2002), the nenewed version of CPLP has been decided by the Cabinet in June 2001. Under strong constraints of data collection, it is extremely difficult to evaluate, by using performance indicators, the outcome of implementing CPLP for supply chains as a whole. Hence, the following six performance indicators have been adopted in CPLP, in addition to other traditional performance indicators such as length of improved highways and number of removal of congestion points:

- Performance indicators for urban logistics:
  - Lading rate will be improved to 50%.
  - Average vehicle speed during rush hours will be improved to 25km/h.
- Performance indicator for inter-urban logistics:
  - The portion of the population that can be reached by land transport in a half-day round-trip from sea-terminals will be improved to 90%.
- Performance indicator for international logistics:
  - Processing time for customs clearance will be shortened to around two days.
- Performance indicators for standardisation:

– The use of standardised pallets will be increased to 30%.

– The ratio of unit-loading will be increased to 90%.

Summary statement of the original CPLP

In carrying out the Programme, Japan will set up the following specific targets in each logistic fields; we will make the utmost efforts to realise these targets, contingent on obtaining the necessary co-operation of local public entities and private enterprises.

l. In regard to logistics in the major metropolitan areas, we aim to improve total lading rate to 50% by the beginning of the 21st century by taking measures such as: increasing the ratio of commercial trucks, promoting computerisation and joint-delivery, and reforming commercial practice.

In order to mitigate traffic congestion, we will promote the following measures: increasing traffic capacity, implementation of regional TDM measures, improving efficiency, and promoting logistics systems carried out by private enterprises. We aim to improve, by the beginning of the 21st century, the rush-hour driving speed to 25 km per hour in the densely populated areas of the three major cities.

2. In regard to inter-urban transport, in order to promote the use of coastal shipping transport, we aim to increase to around 90%, by the beginning of the 21st century, the portion of the population that can be reached by land transport in a half-day round-trip from sea-terminals.

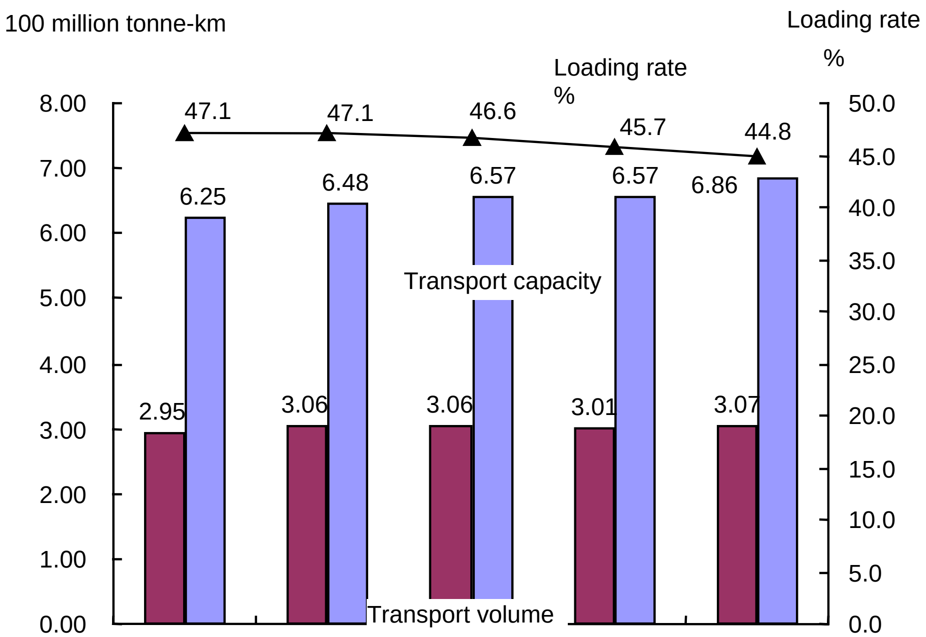
3. In regard to international logistics, we aim at placing, by the year 2001, the level of cost and service related to harbours to the level that is not internationally inferior.

In particular, in regard to cargo containers imported by sea, we aim at shortening, by the year 2001, the time of clearance to around two days (at present it requires four to five days from arrival at the port to departure from the container yard). In addition, we aim to reduce the total domestic transport cost for import/export containers by 30%(compared with the cost if the present situation had continued), by the beginning of the 21st century, by measures such as improving international container terminals.

4. In regard to standardisation, we aim at increasing the present overall palletisation rate (currently around 20%) to around 30% by taking the following measures: increasing unit-loading (to pack, transport, and store in accordance with the unit standard so as to be suitable for mechanised loading and unloading of cargo) ratio to around 90% (currently around 70%), by the year 2001, and promoting the use of pallets to shippers in the manufacturing industry and to the logistics industry.

Note: These targets should be regarded as merely references, due to the limitation of available data, and because improvements depend not only on the government but also on the private sector, whose efforts are indispensable in certain fields.

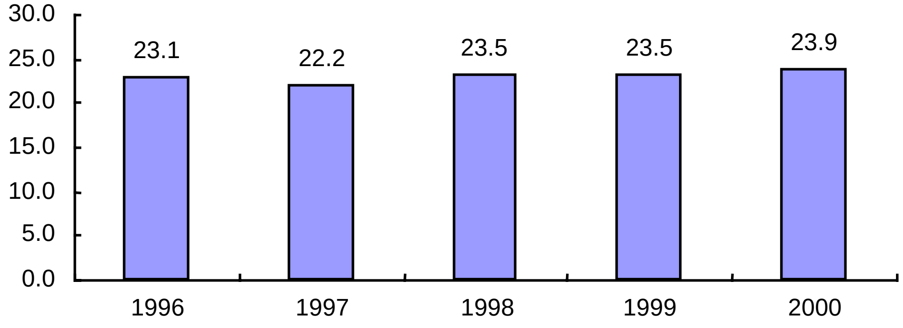
Figure A7.1. **Transport demand, supply and loading rate**



Note: Loading rate is the ratio of the actual goods moved to the maximum tonne-km that would be achievable if the vehicles, whenever loaded, were loaded to their maximum carrying capacity.
Source: Japanese Ministry of Land, Infrastructure and Transport.

Figure A7.2. **Overall palletisation rate**

Percentages



1. Palletisation rate is the rate of palletised volume to the whole palletisable volume.
2. 1996 figure is average of 23 areas of industry. For other years, figures are average of 25 industries.
Source: JILS, Survey report on palletisation.

Annex 8

PERFORMANCE INDICATORS IN THE NETHERLANDS

Proposed indicators

The following tables show indicators which are proposed in the Netherlands by various target groups.

Table A8.1. **Policy makers**

Aggregate performance indicators	• Journey time index (true origin to final destination) • Average cost index • Reliability index
Environmental performance of the different modes/modal combinations	• Emission (NOx, CO_2) • Fuel consumption
Efficiency and use of infrastructure	• Average use of road, inland waterway and rail network • Length of road, inland waterway and rail network • Average travel speed on road, inland waterway and rail network • Growth and growth potential of road, inland waterway and rail network • Congestion / risk • Costs of maintenance and repair of the road, inland waterway and rail network
Safety per mode	• Number of deaths/accidents
External costs (per mode)	• Infrastructure costs • Safety • Noise • Emissions

Table A8.2. **Semi-public organisations**

Terminal efficiency	• Handling time per container • Number of container cranes • TEU per container crane • Movements per hour • Crane-intensity • Movements per crane-hour • Net crane-productivity
Use of space	• Stackable height • Deposit area • Total container area in hectares
Handling cost and revenue	• Cost per container per handling • Cost per container for stacking • Cost for renting the container • Revenue per container
Service level	• Reliability • Facilities (quayage, maximum draught, deposit area, container-cranes) • Average waiting time • Level of technology / EDI • Number and frequency of connections (to other terminals)

Table A8.3. **Shippers**

Relative performance of the intermodal chain	• Total logistic costs (production, sales, collection, storage, transport) • Transit time from true origin to final destination • Reliability • Flexibility • Risk of damage

Table A8.4. **Transport industry and logistic service providers**

Transport company performance	• Return on assets • Return on equity • Trading margin etc.
Degree of utilisation of vehicle	• In volume: measured by payload of weight, pallet numbers and average pallet height • In distance/empty running: measured as the number of miles the vehicle travelled empty and the number of miles the vehicle travelled with only returnable items • In time: measured on hourly basis as one of seven activities (running on the road, rest period, loading or unloading, preloaded and awaiting departure, delayed or otherwise inactive, maintenance and repair, and empty stationary) over a 48-hour period
Schedule adherence and deviations from schedule	• Problem at collection point and/or delivery point • Own company actions • Traffic congestion on major corridors and at border crossings • Equipment breakdown • Lack of personnel • Availability of required infrastructure (terminals, access roads, right-of-way, highways, short-line rail services) • Availability of appropriate equipment at terminals • Operating procedures at ports and terminals
Fuel efficiency	• Measured as km per litre • Measured as ml. fuel needed to move one standard industry pallet 1 km
Relative performance of the intermodal chain	• Timing: transit time, frequency of service and on time reliability • The total logistics costs and service in relation to the level and quality of logistics services • Efficient, seamless transfers between modes • Use of integrated enterprise systems • Compatibility of technology in different global regions • Use of ITS to speed transport, improve connectivity, reduce congestion • High asset utilisation, leading to lower cost of operation, leading to lower freight rates
Harmonisation / regulation	• Harmonised vehicle weights and dimensions • Harmonised safety regulations • Harmonised labour regulations • Immigration policies (leading to such issues as trucking companies not able to hire drivers from other countries during periods of driver shortage) • Conflicting policies between government departments leading to tensions in transportation system

The following series of tables provides information on all modes of freight transport in the Netherlands for the years 1990, 1993, 1995 and 1998. Data has been provided wherever possible although, due to the unavailability of some data, there are inevitably some statistical gaps in the tables.

Table A8.5. **Comparative table of modes of transport, 1998**

Indicators, 1998	Road	Rail	Shipping	Air
Domestic freight moved (million tonne-km)	29 230	848	8 909	-
Domestic freight moved – containers (million tonne-km)	n.a.	n.a.	n.a.	n.a.
International freight moved (million tonne-km)	10 579	3 008	24 941	1.17
International freight moved – containers (million tonne-km)	n.a.	n.a.	n.a.	n.a.
Percentage share of domestic traffic (tonnage)	73	22	26	
Percentage share of international traffic (tonnage)	27	78	74	
Energy consumption and pollution per tonne-km	391	1.4	30	
Reliability	n.a.	n.a.	n.a.	
Price per tonne/km	0.27	0.09	0.04	
Lading factor and degree of utilisation	Int 54.2% Dom. 41.5 %	n.a.	n.a.	

Table A8.6. **Rail freight**

Indicators	1990	1993	1995	1998
Domestic freight moved (million tonne-km)			721	790
Domestic freight lifted (million tonnes)		1994: 4.3	4.3	4.6
Domestic freight moved – containers (million tonne-km)	n.a.	n.a.	n.a.	n.a.
Domestic freight lifted – containers lifted (million tonnes)	1.2	1.7	1.7	1.7
Domestic freight lifted – No. of containers (in loaded TEU)	n.a.	n.a.	1996: 58	69
International freight moved (million tonne-km)			1996: 2 295	3 008
International freight lifted (million tonnes)	n.a.	1994: 13.6	15.2	20.6
International freight moved – containers (million tonne-km)	n.a.	n.a.	n.a.	n.a.
International freight lifted – containers (million tonnes)	1.3	1.4	2.1	3
Percentage share of domestic traffic	n.a.	24%	22%	18%
Percentage share of international traffic	n.a.	76%	78%	82%
Energy consumption & pollution per tonne-km		See following rows		
Fuel intensity (tonne-km per litre)	n.a.	n.a.	74.6	81.5
Energy demand (petajoules)	n.a.	n.a.	1.3	1.4
GHG emissions (grams per tonne-km)	n.a.	n.a.	n.a.	n.a.
GHG emissions (megatonnes) /million kg	n.a.	n.a.	n.a.	n.a.
Carbon dioxide	58	47	44	50
Methane (CH4)	n.a.	n.a.	n.a.	n.a.
Nitrous oxide	1.3	1.0	1.0	1.1
Reliability	n.a.	n.a.	n.a.	n.a.
Price per tonne (NLG/tonne)	3.93	4.25	5.24	
Price per tonne (NLG/tonne-km)	n.a.	n.a.	0.11	0.09
Lading factor and degree of utilisation	n.a.	n.a.	368 tonne/train	390 tonne/train
Accidents	n.a.	n.a.	n.a.	n.a.
Accidents per million train-miles	n.a.	n.a.	n.a.	n.a.

GHG: Greenhouse gas; fuel intensity: total million tonne-km/million litres of fuel; energy demand: petajoules: only diesel traction, passenger transport included.
Source: BER, 1998, VEV, 1998, *Tib-Monito*r April 2000, CBS, *Statistiek van het Goederenvervoer.*

Table A8.7. **Length of national rail, road and inland waterway networks**

Kilometres

Year	Rail	Road	Inland waterway
1990	2 780		4 586
1992		104 831	4 586
1996	2 795	113 419	4 586
1998	2 805	116 093	4 586

Source: CBS, Statistiek van het Goederenvervoer 1998.

Table A8.8. **Growth of rail and road networks in the Netherlands since 1990**

Kilometres

Year	Rail	Year	Road
1990	2 780	1990	
1991		1991	
1992		1992	104 831
1993		1993	
1994		1994	
1995	2 795	1995	
1996	2 795	1996	113 419
1997	2 805	1997	
1998	2 805	1998	116 093

Table A8.9. **Growth of domestic traffic by road, rail and inland water, 1994-98**

Billion tonne-km

Year	Road	Rail	Inland water
1994	26 617	857	6 976
1995	28 010	721	6 930
1996	28 737	778	6 884
1997	28 330	814	8 316
1998	29 230	848	8 909

Table A8.10. **Growth of *total* traffic by road, rail and water, 1994-98**

Billion tonne-km

Year	Road	Rail	Water
1994	9 713	1 949	23 012
1995	10 482	2 295	22 561
1996	10 049	2 385	22 624
1997	10 463	2 621	25 974
1998	10 579	3 008	24 941

Source: Statistiek van het Goederenvervoer 1998.

Annex 9

PERFORMANCE INDICATORS IN THE UNITED KINGDOM

The following series of tables provides information on all modes of freight transport in the United Kingdom for the years 1990, 1993, 1995 and 1998. Data have been provided wherever possible although, due to the unavailability or commercial nature of some data, there are inevitably some statistical gaps in the tables.

Table A9.1. **Comparative table of modes of transport, 1998**

Indicators, 1998	Road	Rail	Shipping	Air
Domestic freight moved (million tonne-km)	155 430	17 400	57 200	n.a.
Domestic freight moved – containers	51.39	n.a.	n.a.	n.a.
International freight moved (million tonne-km)	8 058	n.a.	n.a.	n.a.
International freight moved – containers	n.a.	n.a.	4 035	n.a.
Percentage share of domestic traffic	65	5	23	<1
Percentage share of international traffic	n.a.	1	98 (1995)	1
Energy consumption & pollution per tonne-km	n.a.	Figures only for passenger and freight combined	n.a.	Figures only for passenger and freight combined
Reliability	n.a.	n.a.	n.a.	n.a.
Price per tonne	n.a.	n.a.	n.a.	n.a.
Lading factor and degree of utilisation	0.65 (artic) 0.54 (rigid)	n.a.	n.a.	n.a.

Table A9.2. **Rail freight**

Indicators	1990	1993	1995	1998
Domestic freight moved (billion tonne-km)	15.8	13.8	13.3	17.4
Domestic freight lifted (million tonnes)	138.2	103.2	99.3	97.0
Domestic freight moved – containers	n.a.	n.a.	n.a.	n.a.
Domestic freight lifted – containers	n.a.	n.a.	n.a.	n.a.
Domestic freight lifted – No of containers	n.a.	n.a.	n.a.	n.a.
International freight moved (billion tonne-km)	n.a.	n.a.	n.a.	n.a.
International freight lifted[1] (million tonnes)	<1	<1	1.4	3.1
International freight moved – containers	n.a.	n.a.	n.a.	n.a.
International freight lifted – containers	n.a.	n.a.	n.a.	n.a.
Percentage share of domestic traffic	6	5	5	5
Percentage share of international traffic	<1	<1	<1	1
Energy consumption & pollution per tonne-km	✘	✘	✘	✘
Reliability	n.a.	n.a.	n.a.	n.a.
Price per tonne	n.a.	n.a.	n.a.	n.a.
Lading factor and degree of utilisation	n.a.	n.a.	n.a.	n.a.
Accidents	n.a.	n.a.	n.a.	n.a.

Key: **✘** – figures only available for passenger and freight traffic combined; **n.a.** – not available; **tonnes –** metric tonnes; **international freight lifted** – traffic through the Channel Tunnel (excluding Eurotunnel "shuttle" services); **percentage share of domestic traffic** – total goods lifted by rail expressed as a percentage of all domestic goods lifted; **percentage share of international traffic** – total goods lifted by rail on an international journey expressed as a percentage of all international goods lifted; **lading factor and degree of utilisation** – ratio of the actual goods moved to the maximum tonne-km achievable if the vehicles, whenever loaded, were loaded to their maximum carrying capacity; **accidents** – deaths on the railway cannot be desegregated between freight and passenger companies.

1. Until 1995, a relatively small amount of international rail traffic was carried on the Dover to Dunkirk train ferry operated by Railfreight Distribution. This amount is negligible and the service was discontinued upon opening of the Channel Tunnel.

The rail freight sector in the United Kingdom has undergone radical change over the period in question. Trainload Freight, the freight division of British Rail, was privatised in the early 1990s and there are now two principle rail freight operators in the United Kingdom – EWS and Freightliner. In terms of the data required, in most cases these has simply not been collected; however, since privatisation, the data are subject to commercial confidentiality and, while the operating companies may collect this for their own purposes, they are not released for general consumption. As with all freight modes, the United Kingdom does not calculate figures relating to reliability or price per tonne. The figures given for rail are for financial rather than calendar years; this does not significantly detract from the validity of the figures.

Table A9.3. **Air freight**

Indicators	1990	1993	1995	1998
Domestic freight Moved (tonne-km)	n.a.	n.a.	n.a.	n.a.
Domestic freight moved – containers	n.a.	n.a.	n.a.	n.a.
International freight moved (tonne-km)	n.a.	n.a.	n.a.	n.a.
International freight lifted (thousand tonnes)	1 093	1 276	1 587	1 989
International freight lifted – containers	n.a.	n.a.	n.a.	n.a.
International freight lifted – value (GBP million)	n.a.[1]	n.a.[1]	n.a.[1]	100.22
Domestic freight lifted (thousand tonnes)	50	52	65	50
Total belly-hold (thousand tonnes)	n.a.*	n.a.*	n.a.*	670
Total freighter (thousand tonnes)	n.a.*	n.a.*	n.a.*	1550
Percentage share of domestic traffic	<1	<1	<1	<1
Percentage share of international traffic	<1	<1	1	1
Energy consumption & pollution per tonne-km	✗	✗	✗	✗
Accidents	n.a.	n.a.	n.a.	n.a.
Reliability	n.a.	n.a.	n.a.	n.a.
Price per tonne	n.a.	n.a.	n.a.	n.a.
Lading factor and degree of utilisation	n.a.	n.a.	n.a.	n.a.

Key: ✗ – figures only available for passenger and freight traffic combined; **n.a.** – not available; **tonnes** – metric tonnes, **freight lifted** – weight of goods handled regardless of distance carried, **percentage share of domestic/international traffic** – total goods uplifted (weight of goods handled) by air expressed as a percentage of all domestic/international goods uplifted; **accidents** – figures for accidents involving air freight cannot be separated from passenger figures; **lading factor and degree of utilisation** –ratio of the actual goods moved to the maximum tonne-km achievable if the vehicle, whenever loaded, were loaded to their maximum carrying capacity.

1. Figures are not available for the given years up to 1998, but the United Kingdom can provide figures for "international air freight by value" for 1992: GBP 53.03 million, 1994: GBP 66.76 million and 1996: GBP 94.06 million; "total belly-hold" for 1992: 980 000 tonnes, 1994: 1.23 million tonnes and 1996:1.33 million tonnes; "total freighter" for 1992: 340 000 tonnes, 1994: 460 000 tonnes and 1996: 560 000 tonnes.

The statistical data available for United Kingdom air freight are, as with rail freight, governed by commercial sensitivity and source data not being collected. While the United Kingdom calculates both domestic and international freight moved, air freight is not included in the calculations used to define total UK freight moved due to possible distortions resulting from interlining.

In the United Kingdom, foreign operators carry the majority of international freight. Around 70% of all air freight travels in the belly-hold of passenger aircraft. This link explains why London-Heathrow and London-Gatwick are the dominant UK freight-handling airports. Other UK airports have and are developing freight operations, in particular for major air-freight carriers.

Table A9.4. **Road transport**

Indicators	1990	1993	1995	1998
Domestic freight moved (million tonne-km)	132 968	131 453	146 713	155 430
Domestic freight moved – containers (million tonne-km)	44.04	39.79	50.67	51.39
International freight moved – total (million tonne-km)	5 413	6 098	7 284	8 058
International freight moved – containers[1]	n.a.	n.a.	n.a.	n.a.
Percentage share international traffic	n.a.	n.a.	n.a.	n.a.
HGV mileage intensity (base: 1980 = 100)	99	96	93	93
Tonnes lifted (thousand tonnes)	1 687 000	1 574 708	1 658 409	1 679 434
Tonnes moved (thousand tonne-km)	132 968 864	131 453 034	146 713 580	155 430 806
Average length of haul (kilometres)	79	83	88	93
Average load: rigid (tonnes)	3	3	3	3
Average load: articulated vehicles (tonnes)	10	10	10	10
Empty/light running	29.8	29.1	29.4	27.8
Accidents involving HGVs – fatal and serious casualties	5 100	4 000	3 700	3 500
Lading factor: rigid	0.58	0.55	0.56	0.54
Lading factor: articulated	0.66	0.65	0.66	0.65
Average fuel consumption per tonne-km	22	21	22	23
Average speeds				
Motorways (70 mph speed limit)				
Rigid 2 axles	n.a.	59	59	59
Rigid 3/4 axles	n.a.	57	56	54
All articulated vehicles	n.a.	57	56	55
Dual carriageways (70 mph speed limit)				
Rigid 2 axles	n.a.	55	56	58
Rigid 3/4 axles	n.a.	52	53	53
All articulated vehicles	n.a.	54	55	55
Indicators	1990	1993	1995	1998
Single carriageways (60 mph speed limit)				
Rigid 2 axles	n.a.	42	44	44
Rigid 3/4 axles	n.a.	40	42	42
All articulated vehicles	n.a.	42	45	45
Urban roads (40 mph speed limit)				
Rigid 2 axles	n.a.	n.a.	34	34
Rigid 3/4 axles	n.a.	n.a.	33	34
All articulated vehicles	n.a.	n.a.	31	32
Urban roads (30 mph speed limit)				
Rigid 2 axles	n.a.	n.a.	32	31
Rigid 3/4 axles	n.a.	n.a.	30	30
All articulated vehicles	n.a.	n.a.	30	29

Table A9.4. **Road transport** *(cont'd.)*

Vehicle safety – VI/testing failure rate (%)[2]	21.9	25.5	25.6	25.0
Emission standards (thousand tonnes)				
NO_x	441	n.a.	345	n.a.
PM_{10}	32	n.a.	24	n.a.

Key: **n.a.** – not available; **tonnes** – metric tonnes; **domestic freight moved** – goods moved with an origin and destination within the United Kingdom (expressed in tonne/km = the weight of the load multiplied by the distance it travels); **international goods moved** – goods that raise a customs document with either an origin or destination outside the United Kingdom (expressed in tonne-km); **lading factor** – ratio of the actual goods moved to the maximum tonne-km achievable if the vehicle, whenever loaded, were loaded to their maximum carrying capacity; **accidents involving HGVs** – **fatal and serious casualties** represents approximate figures only; **HGV mileage intensity** – The relationship between the trend in vehicle tonne-km and the growth of GDP; **weight bands** – rigid vehicles: 3.5-36 tonnes, articulated vehicles: 7.5-44 tonnes (70% of articulated vehicles are 36+ tonnes).

1. The IRHS cannot distinguish between swap bodies and containers.

2. The Vehicle Inspectorate (VI) undertakes the enforcement and checking of the HGV fleet in the United Kingdom. The number of annual tests performed on HGVs has remained around 700 000 for the last few years. Of these, approximately 200 000 vehicles record an initial failure. This represents a fall in the failure rate over the past ten years.

Road freight accounts for just over 80% of all goods lifted in the United Kingdom. There are currently around 420 000 licensed HGVs in the United Kingdom; this figure has remained relatively constant for the last few years, although maximum vehicle weight is now 41 tonnes on six axles for general use and 44 tonnes on six axles[25] for journeys to and from a rail head.

The United Kingdom does not collect data on the number of containers moved by road in the United Kingdom, that have been imported or are destined for export. Figures for NOx and PM10 emissions are not available for 1993 and 1998 as the data for HGVs cannot be distinguished from total vehicle emissions. Figures are available for the remaining two years as part of additional work done for the department.

25. The UK Government recently announced that 44 tonnes on six axles would be allowed for domestic use. A date for their introduction is yet to be announced.

Table A9.5. **Maritime freight**

Indicators	1990	1993	1995[1]	1998[1]
Domestic freight moved (billion tonne-km)	55.7	51.2	52.6	57.2
Domestic containerised traffic (thousand units)	n.a.	n.a.	n.a.	n.a.
International freight moved (billion tonne-km)	n.a.	n.a.	n.a.	n.a.
International containerised traffic (thousand units)	2 605	2 879	3 419	4 035
Domestic freight lifted (million tonnes)	172.3	159.3	179.1	176.9
International freight lifted (million tonnes)	319.6	346.9	369.1	391.6
Total international bulk traffic (million tonnes)	222.9	242.0	251.9	257.4
Percentage share of domestic traffic	25	24	23	23
Percentage share of international traffic	n.a.	99	98	n.a.
Total domestic combined transport (thousand units)	1 013	1 272	1 356	1 543
Total international combined transport (thousand units)	2 855	3 082	3 312	3 975
Total coastwise traffic (million tonnes)	122.3	121.5	140.0	144.5
Total unitised short-sea and near-sea traffic (thousand units)	4 141	4 375	4 857	5 669
Total inland water traffic (million tonnes)	6.0	6.4	6.6	4.3
Marine accident figures – deaths and injuries to crew members	600	411	341	361
Marine accident figures – deaths and injuries to passengers	52	135	87	135
Reliability	n.a.	n.a.	n.a.	n.a.
Costs	n.a.	n.a.	n.a.	n.a.

Key: **n.a.** – not available; **domestic traffic** –sum of coastwise and one-port traffic; **bulk traffic** – non-packaged dry and liquid shipments capable of being handled by pipeline, elevator, grab or similar forms of equipment; **containerised traffic** – number of containers (does not include Ro-Ro traffic); **combined transport** – the use of two modes simultaneously (active and passive), including Ro-Ro services; **coastwise shipping –** goods loaded or unloaded at a port in the United Kingdom and transported to or from another UK port; **one-port traffic** – comprises dredged sand and gravel, traffic to off-shore installations, materials for dumping at sea.

1. Figures for 1995 and 1998 include estimates for smaller ports

Table A9.6. **United Kingdom: ship arrivals by type and dead-weight**

Dead-weight (tonnes)	Number of vessels			
	1990	1993	1995	1998
Tankers				
1 – 4 999	17 459	15 961	15 837	13 995
5 000 – 19 999	3 796	4 260	4 602	4 790
20 000 – 99 999	3 450	3 061	3 155	3 081
100 000+	927	692	674	663
Ro-Ro vessels				
1 – 4 999	64 348	64 157	70 433	64 351
5 000 – 19 999	10 578	12 242	17 367	21 549
20 000+	299	333	393	207
Fully cellular container vessels				
1 – 4 999	2 585	1 589	1 706	1 561
5 000 – 19 999	905	1 127	1 376	2 093
20 000+	2 111	2 254	2 635	3 137
Other dry cargo vessels				
1 – 4 999	43 931	34 315	36 428	33 452
5 000 – 19 999	5 630	3 241	3 625	4 295
20 000 – 99 999	2 389	1 505	1 531	1 844
100 000+	539	182	239	293
Total	158 947	144 919	160 001	155 311

Key: **Tonnes** = metric tonnes; **tankers –** includes oil, gas, chemical and other specialised tankers, **Ro-Ro vessels** – passenger and cargo vehicle carrying vessels; **fully cellular container vessels** – vessels that only carry containers; **other dry cargo vessels** – including reefer, general cargo, and single and multi-deck cargo vessels.

Infrastructure: the United Kingdom's five largest ports

The location of the United Kingdom's five largest ports can be seen below:

None of the other indicators are readily available on a port by port basis in the United Kingdom.

In common with other modes the United Kingdom is unable to provide figures for the reliability and costs of maritime freight and port traffic. However, the United Kingdom is able to provide data on all the other indicators.

In terms of movement through UK ports, the majority of tonnage is comprised of bulk traffic. This steadily increased between 1990 and 1998, by an overall increase of 15% to 257.4 million tonnes in 1998. There have been fluctuations within the bulk traffic total; for example, crude oil shipments have risen over the period while other bulk liquid traffic has begun to decline in recent years.

Containerised traffic (units) has increased more significantly over the same period, by 54% to just over 4 million units. This represents a strong growth in container movement, notwithstanding the opening of the Channel Tunnel in 1994.

In terms of combined international and domestic total tonnage, London is the largest port. A major factor of this is the growth in the last few years of traffic through the port of Tilbury.

Table A9.7. **London**

	1990	1993	1995	1998
Total domestic tonnage	26 506	19 811	22 860	19 581
Of which: Bulk	26 481	19 684	22 856	19 557
Container & Ro-Ro	2	2	4	20
Total international tonnage	31 641	31 121	28 502	37 729
Of which: Bulk	22 047	21 733	18 357	23 137
Container & Ro-Ro	6 197	6 537	7 066	11 185
Quayage	n.a.	n.a.	n.a.	n.a.
Draught	n.a.	n.a.	n.a.	n.a.
Total container area	n.a.	n.a.	n.a.	n.a.
No. of cranes	n.a.	n.a.	n.a.	n.a.
TEU per metre quay	n.a.	n.a.	n.a.	n.a.
TEU per hectare	n.a.	n.a.	n.a.	n.a.
Movements per hour	n.a.	n.a.	n.a.	n.a.
Crane intensity	n.a.	n.a.	n.a.	n.a.
Movements per crane hour	n.a.	n.a.	n.a.	n.a.
Crane productivity	n.a.	n.a.	n.a.	n.a.
Accident rate	n.a.	n.a.	n.a.	n.a.
Costs	n.a.	n.a.	n.a.	n.a.
TEU per hour	n.a.	n.a.	n.a.	n.a.
Reliability	n.a.	n.a.	n.a.	n.a.

Table A9.8. **Tees and Hartlepool**

	1990	1993	1995	1998
Total domestic tonnage	7 596	8 174	8 04	11 023
Of which: Bulk	7 577	8 074	8 270	10 955
Container & Ro-RO	0	2	1	3
Total international tonnage	32 651	34 567	37 772	40 430
Of which: Bulk	29 092	29 086	31 006	34 478
Container & Ro-RO	2 031	2 817	4 924	4 455
Quayage	n.a.	n.a.	7 854 m	n.a.
Draught	n.a.	n.a.	1 759 m	n.a.
Total container area	n.a.	n.a.	n.a.	n.a.
No. of cranes	n.a.	n.a.	n.a.	n.a.
TEU per metre quay	n.a.	n.a.	n.a.	n.a.
TEU per hectare	n.a.	n.a.	n.a.	n.a.
Movements per hour	n.a.	n.a.	n.a.	n.a.
Crane intensity	n.a.	n.a.	n.a.	n.a.
Movements per crane hour	n.a.	n.a.	n.a.	n.a.
Crane productivity	n.a.	n.a.	n.a.	n.a.
Accident rate	n.a.	n.a.	n.a.	n.a.
Costs	n.a.	n.a.	n.a.	n.a.
TEU per hour	n.a.	n.a.	n.a.	n.a.
Reliability	n.a.	n.a.	n.a.	n.a.

Table A9.9. **Grimsby and Immingham**

	1990	1993	1995	1998
Total domestic tonnage	6 837	8 085	9 595	9 696
Of which: Bulk	6 827	8 009	9 551	9 661
Container & Ro-Ro	-	-	2	3
Total international tonnage	33 250	33 206	37 195	38 691
Of which: Bulk	25 552	27 005	29 042	28 991
Container & Ro-Ro	5 174	4 925	6 082	7 947
Quayage	n.a.	n.a.	3 803 m[1]	n.a.
Draught	n.a.	n.a.	806 m[1]	n.a.
Total container area	n.a.	n.a.	n.a.	n.a.
No. of cranes	n.a.	n.a.	n.a.	17[2]
TEU per metre quay	n.a.	n.a.	n.a.	n.a.
TEU per hectare	n.a.	n.a.	n.a.	n.a.
Movements per hour	n.a.	n.a.	n.a.	n.a.
Crane intensity	n.a.	n.a.	n.a.	n.a.
Movements per crane hour	n.a.	n.a.	n.a.	n.a.
Crane productivity	n.a.	n.a.	n.a.	n.a.
Accident rate	n.a.	n.a.	n.a.	n.a.
Costs	n.a.	n.a.	n.a.	n.a.
TEU per hour	n.a.	n.a.	n.a.	n.a.
Reliability	n.a.	n.a.	n.a.	n.a.

1.From a report “Supply and Demand in the GB Ports Industry”, by MDS Transmodal. Published in November 1996, this may not reflect the current situation.
2. This data is not collected by DETR. It is sourced from the ABP Web site.

Table A9.10. **Forth**

	1990	1993	1995	1998
Total domestic tonnage	10 709	10 717	14 730	15 690
Of which: Bulk	9 990	10 399	14 388	14 670
Container & Ro-Ro	6	142	332	347
Total international tonnage	14 724	15 658	32 353	28 711
Of which: Bulk	13 147	14 432	29 512	27 154
Container & Ro-Ro	738	677	572	556
Quayage	n.a.	n.a.	1 4816 m[1]	n.a.
Draught	n.a.	n.a.	1 315 m[1]	n.a.
Total container area	n.a.	n.a.	n.a.	n.a.
No. of cranes	n.a.	n.a.	n.a.	n.a.
TEU per metre quay	n.a.	n.a.	n.a.	n.a.
TEU per hectare	n.a.	n.a.	n.a.	n.a.
Movements per hour	n.a.	n.a.	n.a.	n.a.
Crane intensity	n.a.	n.a.	n.a.	n.a.
Movements per crane hour	n.a.	n.a.	n.a.	n.a.
Crane productivity	n.a.	n.a.	n.a.	n.a.
Accident rate	n.a.	n.a.	n.a.	n.a.
Costs	n.a.	n.a.	n.a.	n.a.
TEU per hour	n.a.	n.a.	n.a.	n.a.
Reliability	n.a.	n.a.	n.a.	n.a.

1. From a report "Supply and Demand in the GB Ports Industry", by MDS Transmodal. Published in November 1996, this may not reflect the current situation.

Table A9.11. **Southampton**

	1990	1993	1995	1998
Total domestic tonnage	11 918	10 130	13 177	12 368
Of which: Bulk	11 893	10 099	13 138	12 324
Container and Ro-Ro	-	15	38	44
Total international tonnage	16 931	20 809	19 07	21 891
Of which: Bulk	13 843	16 081	12 869	16 034
Container and Ro-Ro	3 033	4 79	5 967	5 576
Quayage	n.a.	n.a.	6 090 m[1]	8 146 m[2]
Draught	n.a.	n.a.	1 027 m[1]	n.a.
Total container area	n.a.	n.a.	n.a.	n.a.
No cranes	n.a.	n.a.	n.a.	n.a.
TEU per metre quay	n.a.	n.a.	n.a.	n.a.
TEU per hectare	n.a.	n.a.	n.a.	n.a.
Movements per hour	n.a.	n.a.	n.a.	n.a.
Crane intensity	n.a.	n.a.	n.a.	n.a.
Movements per crane hour	n.a.	n.a.	n.a.	n.a.
Crane productivity	n.a.	n.a.	n.a.	n.a.
Accident rate	n.a.	n.a.	n.a.	n.a.
Costs	n.a.	n.a.	n.a.	n.a.
TEU per hour	n.a.	n.a.	n.a.	136*
Reliability	n.a.	n.a.	n.a.	n.a.

1. From a report “Supply and Demand in the GB Ports Industry”, by MDS Transmodal. Published in November 1996, this may not reflect the current situation.
2. This data is not collected by DETR. It is sourced from the ABP Web site.

Corridor studies

There has been only one specific corridor study carried out as part of the EC INSPIRE project. This project is looking at links between Ireland and mainland Europe for unit load cargoes, namely containerised traffic and that moving as Ro-Ro unit. A significant use is made of mainland United Kingdom as a land-bridge for the transhipment of cargoes. The study identifies the size and routes of present flows and estimates the traffic that transits mainland United Kingdom which potentially could move by sea. The final report is now available.

Additional information[26]

From 1995, figures are for the length of the Railtrack network. Since privatisation, Railtrack has been responsible for the ownership and maintenance of the United Kingdom’s railway infrastructure. Rail network figures are for financial years as opposed to calendar years. Figures for the road network include all motorways, trunk roads, principle, class 2 and class 3 roads.

26. All data in this section is sourced from *Transport Statistics Great Britain 1999* (ISBN 0 11 552163 1) GBP 30 from The Stationery Office Publications Centre, PO Box 276, London, SW8 5DT.

The length of the inland waterway network represents the total length of commercial waterways in the United Kingdom.

Table A9.12. **Length of national rail, road and inland waterway networks**

Kilometres

Year	Rail	Road	Inland waterway
1990	16 584	358 034	1 192
1991	16 558	359 966	n.a.
1992	16 528	362 310	n.a.
1993	16 536	364 212	n.a.
1994	16 542	364 966	n.a.
1995	16 666	366 999	1 153
1996	16 666	368 821	n.a.
1997	16 656	369 867	n.a.
1998	16 659	371 603	n.a.

Table A9.13. **Modal share of freight transport**

Billion tonne-km

Year	Road	Rail	Water
1990	136.3	15.8	55.7
1991	130.0	15.3	57.7
1992	126.5	15.5	54.9
1993	134.5	13.8	51.2
1994	143.7	13.0	52.2
1995	149.6	13.3	53.1
1996	153.9	15.1	55.3
1997	157.1	16.9	48.1
1998	159.5	17.4	57.2

Figure A9.1. **Growth of the UK road network, 1990-98**

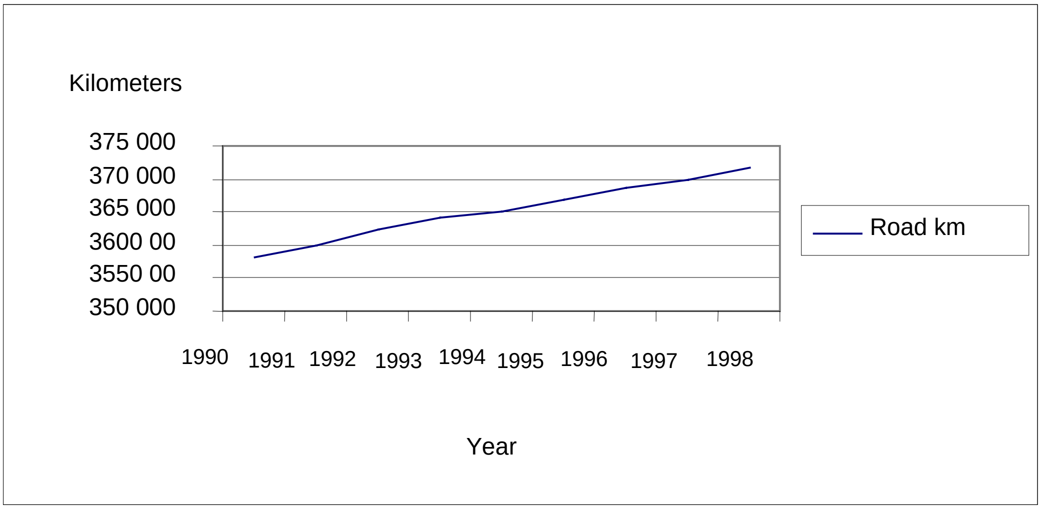
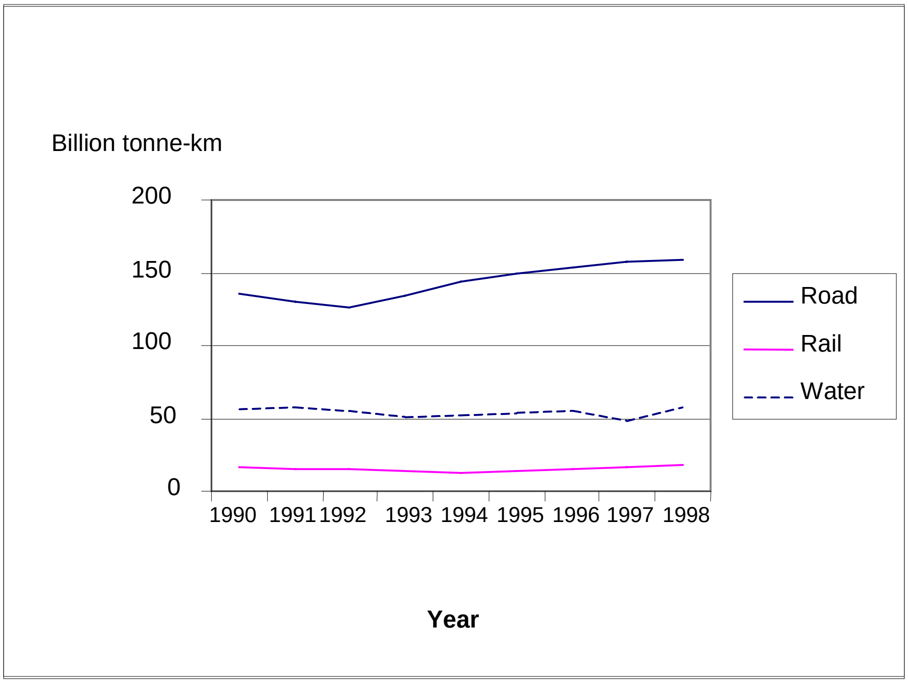


Figure A9.2. **Growth of domestic traffic by road, rail and inland water, 1990-98**



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