Supply Chain Challenges for National Competitiveness through Transport

Executive Summary

The role of transport in economic development has changed considerably in the last century. This report provides a review of the existing practices used for benchmarking and measuring performance of the transport sector and its services at present. The survey shows that most of existing methodologies apply indicators that have been important in the time when transport had a traditional role, but they tend to ignore critical indicators that are important for measuring the role of transport services in modern supply chains.

Several gaps in the existing literature and practice are identified. Firstly, existing approaches are either aimed at the micro-level and measure firm or sector specific aspects of transport, or they consider the macro-level with focus on global cross-country measures of competitiveness. What is missing then? First, we do not have internationally accepted approaches that focus on the national or meso-level considerations. Secondly, most of the existing methods focus on supply driven indicators that describe the physical characteristics of the transport system (like km of roads). The use of indicators describing the operational performance of transport services is increasing, but the considerations of the important sustainable and administrative aspects of transport systems are missing. Thirdly, a number of methodological gaps in the existing assessment models are identified, including the balanced use of quantitative and qualitative data.

This audit report therefore shows that there is a need for the development of a common methodology that will be able to measure the contribution of transport services to national competitiveness and assist nations in benchmarking performance of their transport systems.

I.Background

Objective

Traditional methodologies for benchmarking and measuring performance of the transport sector are based on physical supply driven indicators. As logistics and supply chains are becoming increasingly complex, it is questionable whether these methodologies are able to capture the true performance and contribution of the transport sector to the efficient functioning of supply chains and thus to increase economic competitiveness of a nation. This project aims at developing a methodological tool for benchmarking performance of transport and logistics systems as well as the contribution of transport to national competitiveness.

Process

The Working Party on Transport Trends and Economics (WP.5) approved the secretariat's proposal to launch this project at its twenty-first session in September 2008. The Inland Transport Committee confirmed this decision at its seventy-first session in February 2009. The project outline was discussed at the twenty-second meeting of WP. 5 in September 2009. The first step in the proposed outline of the project was a Round Table which the secretariat organised in December 2009. Following on the feedback from the Round Table, the secretariat proposed a new timeline for the project which was approved by WP.5 at its twenty-third session in

September 2010. According to this timeline the next step was the development of an audit report on the existing methodologies.

This document
This document - prepared by the secretariat - builds on the results of earlier UNECE papers, the roundtable of 2009 and incorporates findings of the in-house research carried out since the last ITC.

It is organized as follows: the aspects of modern supply chains are presented by a case study in section 2; section 3 provides definitions and the theoretical background for the development of the role of transport, and section 4 provides an evaluation of the existing methodologies. The gap analysis is presented in section 5 and section 6 concludes this paper.

Outlook
Following the finalization of the audit report, the UNECE secretariat in close cooperation with a Task Force consisting of interested countries and international organisations will

a/ review the relevance and the messages of the currently available indicators about how the UNECE countries' transport sector contributes to national competitiveness.
b/ prepare the necessary analytical background and draft proposal of the methodology. The outline methodology will be presented with pilot data to the WP.5 and the new methodology will be launched by the Inland Transport Committee at its session in 2013.

II. Introduction: Modern supply chains

The theoretical background and development of supply chains has been presented in a number of previous background documents (see Informal document No. 10, 71st session of the ITC). At this point it is useful to consider a case study of a modern supply chain in order to understand the micro-level dynamics and gain some real-world insights before turning to the theoretical descriptions and the evaluation of existing methodologies.

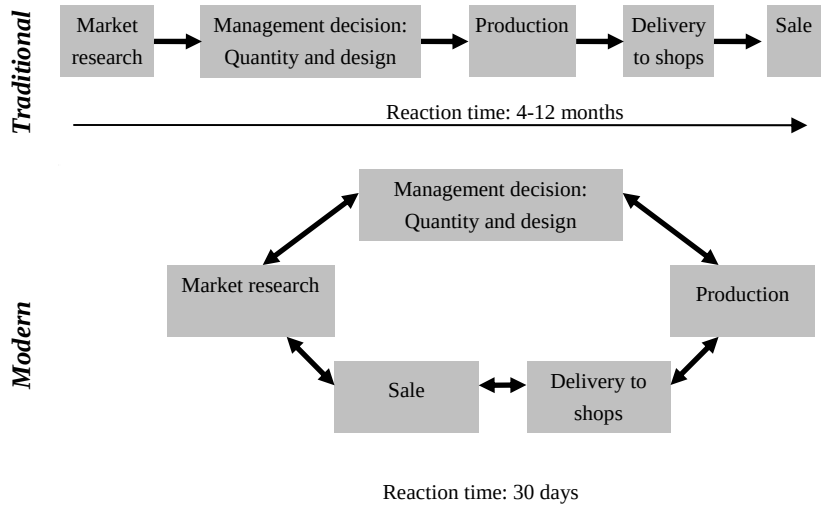
The example provided here (based on Dutta (2002)) concerns the Spanish retail company Zara which was founded in 1975 in Spain and is currently presented in 73 countries worldwide. About half of the sold goods are manufactured in Spain, about one-quarter in the rest of Europe and the remaining part in Asia and the rest of the world (Thoney-Barletta and Hartman, 2005). In 2009 the company had a revenue of 7.071 billion USD.

Based on the study by Dutta (2002) the difference between a traditional and a modern supply chain can be illustrated by the case of Zara. Box 2.1 shows a simplified example of a modern and traditional supply chain. By reducing the reaction time, the company is able to keep inventories at a minimum and therefore reduce the costs of unsold goods. Production decisions are made in reaction to the demand. This low reaction time sets new standards for the transport role in the process:

- Speed: Goods and information have to move fast.
- Flexibility: Quantity, type and route are decided on short notice.
- Reliability: Goods have to be delivered with certainty!
- Track and trace: It important to know what is where and when.

This example clarifies that the role of transport in modern supply chains is not only limited to the existence of physical infrastructure, but also depends on the quality of transport services as presented above.

Box 2.1 Modern and traditional supply chains



Based on a case study of the firm Zara (Dutta, 2002)

III. Definitions and Theory

3.1: Definitions

In this section the definitions of the used terms are provided. These definitions are of major importance in identifying the role of transport systems in the modern, complex supply chains, and understanding them is a prerequisite for knowing how to adequately measure the role of transport.

Definition I: Supply Chain

There is no single best definition of the term supply chain. Mentzer et al (2001) review a number of definitions and based on these define a supply chain as:

> *"a set of three or more entities (organizations or individuals) directly involved in the upstream and downstream flows of products, services, finances, and/or information from a source to a customer"* (Mentzer et al, 2001).

It is in other words a system where a product is transferred from a supplier to the end consumer via organizations, people, technology and information. The following quote supports and confirms the validity of this definition:

> *A network of connected and interdependent organizations mutually and co-operatively working together to control, manage and improve the flow of materials and information from suppliers to end users.* (Formulation by J. Aitken, presented in Christopher (2005)).

When the term Supply Chain (Management) was introduced in the 1980s, critics called it a new description of logistics. However, as emphasized by Mentzer et al (2001): *"logistics is <u>one of the functions</u> contained within supply chain management"*. At this point it is interesting to refer to the *Terms and Glossary* of the

Council of Supply Chain Management Professionals. The two relevant formulations are presented in table 1.1.

Table 3.1 Definitions by the Council of Supply Chain Management Professionals

Logistics	"The process of planning, implementing, and controlling procedures for **the efficient and effective transportation and storage of goods** including services, and related information from the point of origin to the point of consumption for the requirements. This definition includes inbound, outbound, internal, and external movements."
Supply Chain	1) Starting with unprocessed raw materials and ending with the final customer using the finished goods, the supply chain links many companies together. 2) The material and informational interchanges in the logistical process stretching from acquisition of raw materials to delivery of finished products to the end user. All vendors, service providers and customers are links in the supply chain."

Source: Council of Supply Chain Management Professionals (2010)

Definition II: Logistics

There is thus a link between supply chain and logistics. Based on the definitions from table 3.1 logistics is *the part of supply chain management that* deals with the *transportation and storage of goods and information*. This formulation is also applied by The Council of Logistics Management:

> *"Logistics is that part of the supply chain process that plans, implements, and controls the efficient flow and storage of goods, services, and related information from the point of origin to the point of consumption in order to meet customers' requirements"*

Based on the definitions of supply chains and logistics, the role of logistics can be divided into the transportation and the storage of goods. It consists of the planning, implementation and the control of these tasks.

Definition III: Transport

A definition of transport may seem superfluous; however it does provide us with an anchor point which is important in making the distinction between transport, logistics and supply chains.

> *Transport is to carry, move or convey from one place to another*

Definition IV: National Competitiveness

To understand the term competitiveness, it useful to take point of departure at the micro-level. Competitiveness is a firm's ability to compete, grow and be profitable (Martin et al, 2006). There is a wide agreement about the term at this level, but when taking competitiveness to a macro-level, i.e. nations, the definitions and agreements are lacking:

> *"there is no agreed definition of national competitiveness either within or across the academic disciplines[. . .] The concept is essentially normative"* (Thompson 2003)

As there is no single definition of competitiveness, it is useful to evaluate a number of definitions and identify their commonalities. Table 3.2 provides an overview of definitions from a number of well-known institutions. A common approach in the first three definitions is description of an environment, which consists of institutions, policies and factors which affects the competitiveness.

Table 3.2 Definitions of National competitiveness

Institution	*Definition*
International Institute for Management Development (IMD)	World Competitiveness is a field of economic theory, which analyzes the facts and policies that shape the ability of a nation to create and maintain an environment that sustains more value creation for its enterprises and more prosperity for its people. (IMD, 2009)
Global Country Forecast	[...] a business rankings model, which measures and ranks 82 countries on the quality of their overall business environment (EIU, 2010)
World Competitiveness Report	"the set of institutions, policies, and factors that determine the level of productivity of a country (World Economic Forum, 2009)
OECD	the degree to which an economy can under free and fair market conditions, produce goods and services which meet the test of international markets, while simultaneously maintaining and expanding the real incomes of its people over the longer run." OECD (1992, p. 237)

Academic disagreement

There is a dispute about the use of the term national competitiveness. The most famous critique of the term is by the Nobel Laureate Paul Krugman, who stated that "competitiveness is a meaningless word when applied to national economies" (Krugman, 1994). Krugman disagrees with the link from micro to macro level, due to the fact that:

> *"when we say a cooperation that is uncompetitive, we mean that its market position is unsustainable – that unless it improves its performance, it will cease to exist. Countries, on the other hand, do not go out of business"* (Krugman, 1994).

The discussion is essentially a question of policy-makers' objective and how national or regional prosperity and wealth is measured. Following the critique by Krugman, a strand of literature evolved especially in the academic field of regional science. For instance Camagni (2002) concludes that:

> *"Location territories, on the other hand, are not just the passive objects of location decisions by firms, but communities made up of economic subjects which act in their own interest by trying to keep or attract firms. […] In a globalising economy, territories and not just firms increasingly find themselves in competition with each other."* (Camagni, 2002).

A policy-maker will thus seek to provide the optimal "business environment" in order to attract firms and investment and thus achieve economic development, employment, stability and the well-being of the nation's citizens. One aspect of the environment is the quality of the transport infrastructure and its ability to perform in global supply chain systems. Finally the term competitiveness can be linked to productivity. Krugman (1994) claims that *"our competitive problem is really a domestic productivity problem"*, and Michael Porter – a famous proponent of the term national competitiveness states that:

> *"Competitiveness remains a concept that is not well understood, despite widespread acceptance of its importance. To understand competitiveness, the starting point must be the sources of a nation's prosperity. A nation's standard of living is determined by the productivity of its economy, which is measured by the value of goods and services produced per unit of the nation's human, capital and natural resources. Productivity depends both on the value of a nation's products and services, measured by the prices they can command in open markets, and the efficiency with which they can be produced. True competitiveness then, is measured by productivity. Productivity allows a nation to support high wages, a strong currency and attractive returns to capital, and with them a high standard of living."* (Porter and Ketels, 2003)

3.1 Theory

The role of transport in the production process

The role of transport has changed considerably over the last century. Traditionally the role of transport was seen as independent from the production process and transport services were provided by separate companies which only dealt with the movement of a good from *A* to *B*. The concept of logistics has its origin in military use and was launched in World War II. Before that *Production was the main part of the managers concerned, and industry logistics was once regarded as "necessary evil"* (Tseng et al, 2005). According to Tseng et al (2005) between one to two thirds of the logistics costs are spend on transportation. Today:

> *"the role that transportation plays in logistics system is more complex than carrying goods for the proprietors. Its complexity can take effect only through highly quality management. By means of well-handled transport systems, goods could be sent to the right place at right time in order to satisfy customers' demands. It brings efficacy, and also it builds a bridge between producers and consumers. Therefore, transportation is the base of efficiency and economy in business logistics and expands other functions of logistics system. In addition, a good transport system performing in logistics activities brings benefits not only to service quality but also to company competitiveness."* (Tseng et al, 2005).

The role of transport has thus evolved from being the "necessary evil" to be an integrative element of the supply chain.

The traditional role

The role of transport in the period "before logistics" can be defined as traditional. Transportation was regarded as a separate function and what mattered was the existence of transport links. In other words, in its traditional role, the physical attributes of transport sector in the form of rail, road, maritime and air infrastructure were of major importance.

The post 1950 role

Logistics became more and more developed and applied in the period after 1950. The concept evolved especially in the 1970s when the volatile energy prices and increasing globalization increased the role of transport for businesses. It was not only relevant whether there is a physical connection, but also how fast a good could be moved, at what price and with what reliability. One can say that an operational dimension was added.

The modern role

Today competition is global and telecommunications make immediate information sharing possible. These trends put the transport sector under increased pressure to

lower the costs and provide fast and reliable service. However, at the same time security, safety and environmental concerns are rising and are vital parts of supply chains. Firms can track the movement of goods globally in real-time. In these modern supply chains, the administrative and sustainable dimensions have been added.

The role of transport has thus evolved from only providing a physical connection between A and B to incorporating operational, administrative and sustainability concerns now. This development can be related to the case of Zara presented in section 2. The company operates almost without any inventory. Goods are produced following demand and the distance from supplier to end consumer in time must therefore be minimized. As the process involves several steps, this implies that flexibility, reliability, speed and the availability of intelligent transport systems has become crucial. Moreover goods have to cross borders smoothly which requires harmonized administrative standards for documentation, customs clearance and information sharing. In the light of terrorist threats and increasing environmental concerns, security and sustainability issues matter for both the direct transport process but also for the value of the end good for the final consumer.

Table 3.3 summarizes the development of the role of transport. It shows how this has affected the development of the important measurement indicators.

Table 3.3. Simplified description of the role of transport

	Traditional	*Post 1950*	*Modern*
Role of transport	Transport is separated from production- it is an external business.	Transport is (the most important part) of the logistics system.	Transport is an element of the supply chain.
Important aspects of transport	Existence of transport connections.	+ Speed of movement, reliability and transport costs.	+ Safety, environmental sustainability and administrative efficiency.
Indicators	Infrastructure density and transport connections.	Congestion, timeliness and transport rates.	Intermodal connectivity, accident rate, risk of crime, border crossing efficiency, availability of ITS.
Dimension	Physical	+ Operational	+ Sustainable and Administrative

Economic Theory:

Why is the supply chain performance important for policy makers?

Neo-Classical: Growth depends on factor endowments.

In the mid 20th century the neo-classical growth models – also known as exogenous growth models – were developed. The neoclassical growth models (For example the Solow model (Solow, 1956)) predict that national productivity differences exist, because nations differ in their factor endowments. Technical assumptions in these models lead to the conclusion that poor nations at some point will catch-up with wealthy nations because the marginal return to a factor is diminishing and investment will happen where the return is highest. At some point economies will equalize in their factor endowments and the marginal return and productivity will converge.

New-Growth Theory: Growth depends on investment in human capital and R & D.

In the 1980s the new growth theory – also known as the endogenous growth theory - evolved as a response to the critique of the neo-classical growth theory. The crucial

difference between these theories is that policy interventions can impact long-run growth rates in the endogenous growth theory. The models are based on utility-maximizing households and profit-maximizing firms (i.e. micro foundation) and human capital and technological development is seen as major determinants of economic growth.

New Economic Theory: Role of clustering forces on spatial distribution of economic activity.

The new economic growth models evolved about two decades ago. Paul Krugman is one of the founding fathers of this range of models in which the spatial distribution of economic activity is explained by the degree of agglomeration which on the other hand depends on *transport costs* (Krugman, 1991). In the unrealistic case that transport costs are zero, location of firms is irrelevant as they can serve all markets and receive inputs from all markets at no costs. If transport costs are very high, firms will have to locate in all nations in order to be able to serve each market. But if transport costs are neither zero nor very high, the firm can choose to locate in a *core* and serve the *periphery* from the core. This theory is very relevant both in explaining and understanding why nations today *compete* - they want to be the *core* with high economic activity and enjoy agglomeration spill-over effects. Table 3.4 is a reproduction of table 1 in Gardiner et al. (2004) and summarizes the discussed theories.

Table 3.4 Three perspectives on national productivity growth.

Theory	*Explanation of national productivity differences*	*Evolution of national productivity differences*
Neoclassical Growth Theory	National differences in productivity due to different factor endowments, and especially differences in capital/labour ratios and technology.	Assumes constant returns to scale; diminishing returns to factors of production; free factor mobility and geographical diffusion of technology, so that low-productivity nation should catch up with high productivity ones, i.e. national convergence in productivity.
Endogenous Growth Theory	National differences in productivity due to differences in capital/labour ratios, knowledge base and the proportion of the workforce in knowledge-producing industries	Implications for national productivity evolutions depend on the extent to which low-technology national catch up with high-technology nations, and this on the degree of geographical diffusion of technology and knowledge, and flows of knowledge workers. The more knowledge/ technology spillovers are localized, and the more knowledge workers move to leading technology nations, the more productivity differences between nations will persist or even widen
'New Economic Geography' models	Spatial agglomeration/ specialization/ clustering are key sources of externalities and increasing returns (labour, knowledge spill-overs, specialist suppliers, etc.) that give local firms higher productivity	Economic integration (trade, factor flows) increases the tendency to spatial agglomeration and specialization of economic activity, leading to 'core–periphery' equilibriums and persistent national differences in productivity

Source: Reproduced from Gardiner et al. (2004)

Initially, economic centres were created in nations that had a natural advantage. This was due their geographical position or natural resources endowments. Transport connections were built to connect all markets and were setting a limit for economic development. However, as the world has become interconnected and transport costs have declined, the centres of economic activity are no longer determined by the natural advantage, but rather by the opportunities for firms to engage optimally in global supply chains. Transport is no longer constraining economic development, as most connections are developed. Instead it is enabling and promoting faster economic development. Reliable, fast and low cost transport delivery is now crucial for the location of firms.

Table 3.5 shows how these theories relate to empirical trends. It is however at this point important to stress that none of the theories is superior and they each have their advantages. Also, there is no clear consensus that any of the models fit better with the empirical trends than the others. This description however only covers a few models and explains the basic ideas behind these.

Table 3.5 The evolvement of the role of transport in economic development.

Theory	*Empirical trends*	*Role of Transport*
"Classical" growth models	Productivity growth is seen in nations where investments in factors are high, i.e. physical and human capital.	**Transport connects** nations that are attractive due to their natural characteristics, i.e. resource endowments or geographical location.
'New Economic Geography' models	Economic activity is concentrated in agglomerations.	**Transport determines** the economic centers. Agglomerations are created in nations that are well connected and where supply chains perform best.

Nations compete by attracting firms and investments. The attractiveness of a certain location depends on the business environment, which sets the boundaries for the supply chain performance as well as the ability of a country which depends on the effectiveness of the logistics and especially the transport sector.

Measuring the role of transport: how should it be done?

Before describing the optimal measurement of infrastructure some methodological issues need to be considered. Development of the role of infrastructure has not only affected what should be included, but also how it should be included. Measuring the quality of the transport sector performance in its traditional role only requires description of its physical dimension with characteristics which can be typically described by quantitative metrics, for example density and quality. Operational dimension can also be described by quantitative indicators, for example by vehicle density on roads (congestion), average delays and breakdown frequency. However, sustainable and administrative dimensions are difficult to measure by quantitative means and will typically be described by qualitative and subjective measurements. It is however beneficial if all four dimensions are measured by both qualitative indicators and quantitative metrics. Regarding the physical dimension, a well functioning infrastructure system not only depends on the quantity and quality, but also on whether the roads and railways are located in strategically good positions. This information can be obtained by a subjective assessment of transport users and operators.

A second methodological recommendation on the optimal measurement is related to the aggregation of indicators by weights. As described above, a number of dimensions and a number of indicators for each dimension should be included. This raises a new question on how these approaches should be aggregated. It is important to carefully consider whether all indicators and whether all four dimensions, physical, operational, administrative and sustainable should receive the same weight or different weights. Countries differ in their demographic, geographic and economic characteristics. For example, land-locked countries have special requirements for inland transport connections. Moreover, the dominant sector, the existence of natural resources and the political situation in the country and neighboring countries affect what aspects of transport are important. It is therefore beneficial if all dimensions are included, but that the benchmarking systems uses weights on each dimension depending on the individual characteristics of a country. In a less developed country with missing infrastructure connections, the physical dimension may be weighted higher than the other three dimensions. In a developed country with problems of congestions, concerns for environmental sustainability and border crossings obstacles, but with a well developed infrastructure network, a higher weight may be put on the operational, sustainable and administrative indicators. It is important that the benchmarking methodology considers these issues and carefully develops a systematic approach for the aggregation of indicators and dimensions.

The third and last methodological recommendation considers the aggregation methodology. The benchmarking based on the four different dimensions with both qualitative and quantitative indicators implies a complex aggregation task. There is no first-best solution to this issue. The most common approach is to use averages of ranks which is controversial as ordinal numbers receive cardinal importance. A second approach is to use factor analysis, but this methodology depends very much on the applied specifications and weights. It is therefore recommended that any assessment present benchmarking results based on several approaches, to confirm their robustness.

The overall result can be summarized by the following four results and the graphical illustration in figure 3.1

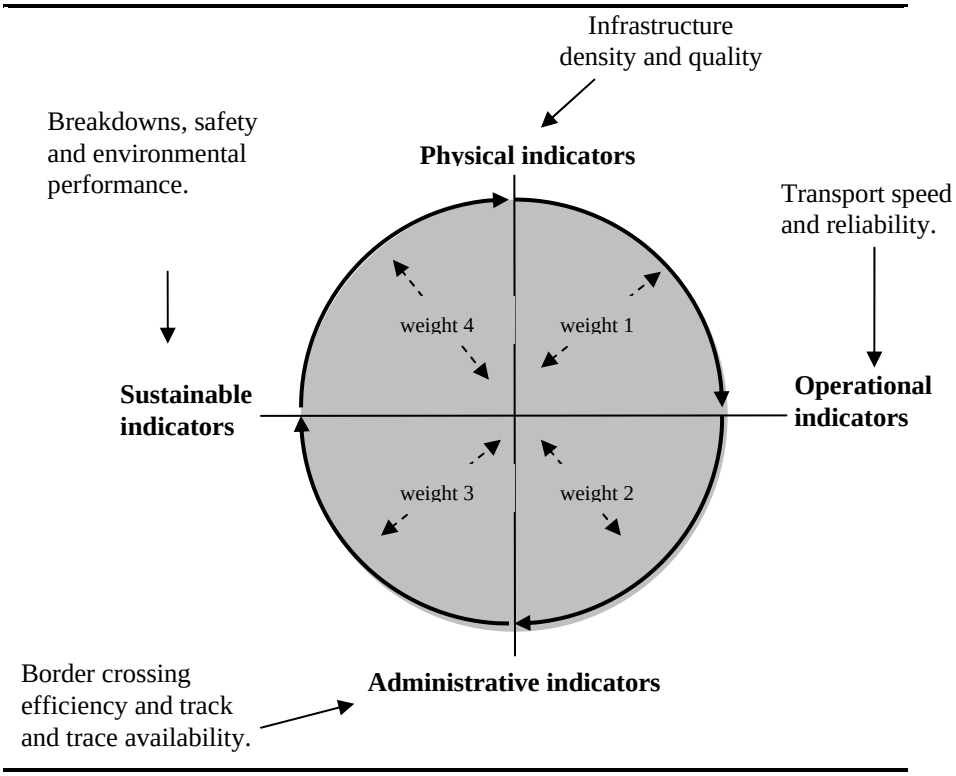
RESULT 1 Measurement of the performance of the transport sector should include all four dimensions of modern supply chains: 1) physical, 2) operational, 3) administrative and 4) sustainable.

RESULT 2 The four dimensions of transport should be weighted according to the individual characteristics of a country.

RESULT 3 Quantitative and qualitative indicators should be used for all four dimensions.

RESULT 4 Benchmarking results from several aggregations methods should be presented.

Figure 3.1 Measurement of transport



IV. Empirics: Applied Measurement Methods

Having defined the elements for the optimal measurement of the role of transport in supply chains and its impact on competitiveness, it is now appropriate to analyse the existing literature and evaluate how transport is actually evaluated. This review includes studies which, to some extent, assess the transport system. In most cases transport system will be just one element in a broader evaluation of specific national features. The motivation for evaluations is driven by the desire to compare over time and/or across countries. This then allows policy makers to follow the progress and at the same time these results can be used as marketing instruments towards firms and investors. Rogerson (1999) investigated why benchmarking and ranking of cities has become so popular. He concludes that:

> *"The representation of the complexity which is urban living by a single value and rank is appealing in an era when politicians, media and public work with simple headlines. But by so doing, such ratings are open to challenge for offering simplicity at the expense of reflecting the multiple facets of a locality." (Rogerson, 1999)*

This quote indicates the importance of the gap analysis. As Rogerson states, the single value – stating the rank of the specific country/region/city – is getting increasingly important, but how can all the aspects be presented in one single value? Statistical instruments and a lot of expertise are going into development of the best aggregation method of all the aspects of an economy. Before one starts to deal with the methodology for aggregation of the multiple features of an economy, it is important to consider whether the measurement is appropriate. This empirical section will provide an insight in how these ranking and benchmarking studies have

chosen to measure transport. If the measurement is not right, the final value will not be right and the information that is communicated through the single ranking value will be wrong and misleading.

Structure: The evaluation of the existing approaches will have the following structure. A distinction between private and non-private sector measurements has been made. For each study a *brief description* in which the measurement is introduced is provided, followed by a *quick facts* section where some results and methodologies are summarized. Following this, the type of indicators related to transport and the role of transport in supply chains is analysed. For each study a plot of the performance of the benchmarking system is provided by plotting the resulting ranking with the GNI per capita rank. This is however only meant to provide some visual illustration, because i) it is not the objective of the studies to predict the GNI per capita and ii) studies vary considerably in the number of variables included, the aggregation methodology and the objective.

3.1 Non-private sector approaches

The first group of empirical studies that is considered are the public sector approaches. These are typically publication rankings and measurements of international organisations such as the World Bank, OECD and the United Nations.

3.1.1 The World Bank Logistics Performance Index (LPI)

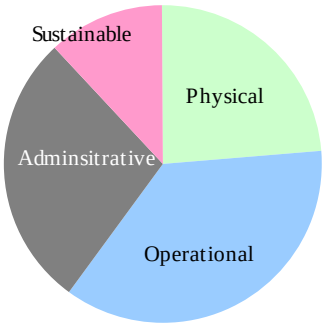
Brief description

The World Bank has created a benchmarking system that on a country level evaluates the logistics performance based on a worldwide survey of operators. A web based questionnaire is distributed to these operators in 130 countries and it includes questions about the respondent's home country as well as eight other countries. It measures both the domestic and international performance of the logistics supply chain.

Quick facts

The LPI is published by the World Bank Group. It has been published two times so far, once in 2007 and once in 2010. The objective is to measure the logistics performance of the 155 countries based on a subjective questionnaire that is send to transport professionals. All used data is "soft" data. The reports and rankings are freely available on the website of the World Bank. In 2010 study the best performing country was Germany, while Singapore was second and Sweden third. The worst performing countries were Somalia, Eritrea and Sierra Leone.

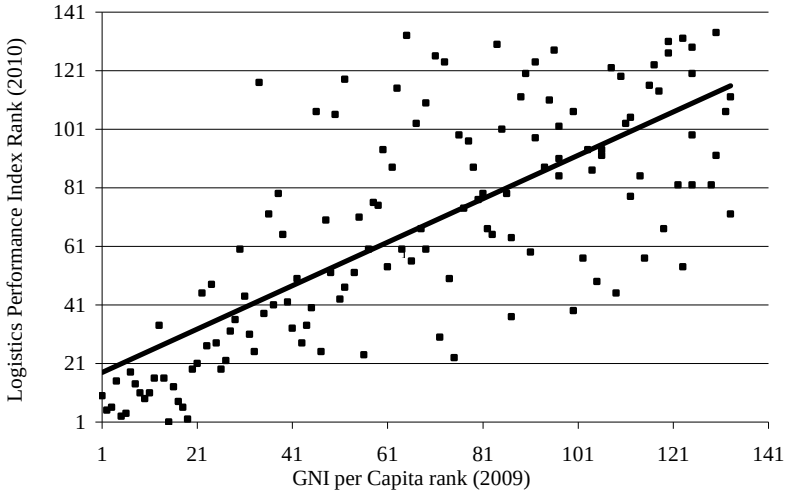
Indicators



In the most recent study 25 indicators related to the transport system were included.

The only indicator of the physical quality is related to the quality of infrastructure. Six operational indicators are included; these are timeliness, operational logistics, delay frequency, time, costs and inspection methodology. Five administrative measurements are included: efficiency of the clearing processes, ease of arranging shipments, competences and quality of service, track and trace facilities, number of authorities involved. Finally three sustainability measurements are included: security, frequency of criminal activities to cargo and informal payments.

Figure 4.1 Performance of The World Bank Doing Business Index



Source: World Bank Logistics Performance Index and The World Bank

Performance

Figure 3.1 shows how the ranking of the countries with respect to the logistics performance produced by the World Bank is correlated with the rank in GDP per capita. The R^2 of the fitted line is 55 indicating a relatively good performance especially when considering that the LPI rank is based on transport logistics data. There are other sectors, such that education and innovation that affect the productivity and prosperity of a region. Figure 41 therefore shows the close relationship between the performance of transport system and economic development.

4.1.2 The World Bank Doing Business Index

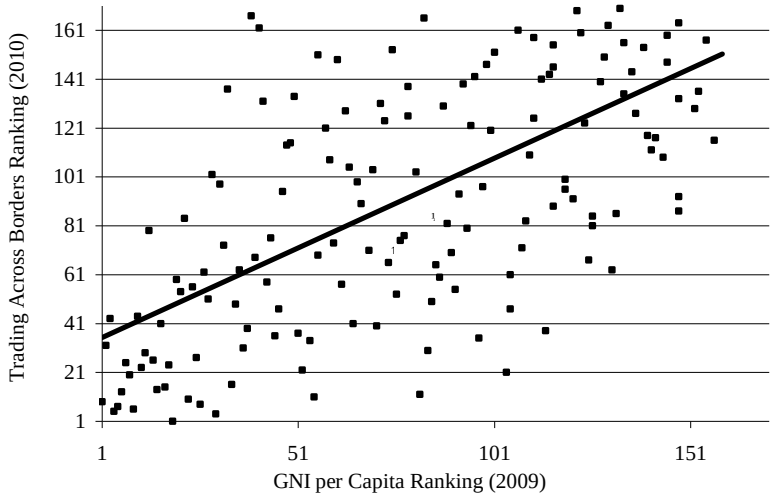
Brief description

The World Banks *Doing Business* study was launched in 2002. It provides a quantitative measure of the ease of doing business by considering aspects such as regulations, trading across borders, access to credit and paying taxes. The ranking is therefore based on information from laws and regulations as well as indicators on the efficiency of the business environment. The study is focused on small and medium sized firms and considers nine dimensions: 1) Starting a business, 2) dealing with construction permits, 3) registering property, 4) getting credit, 5) protecting investors, 6) paying taxes, 7) trading across borders, 8) enforcing contracts and 9) closing a business. Logistics is included in the seventh pillar.

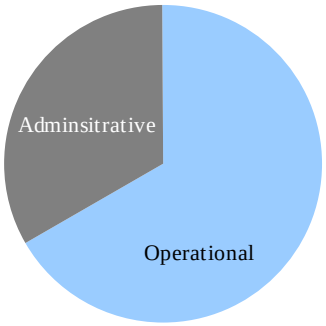
Quick facts

The Doing Business index is being published annually since 2003 by the World Bank. It considers 183 countries and is based on qualitative and quantitative data. Among qualitative data is information on regulations. Information is obtained from a questionnaire with more then 8,000 respondents. Aggregation is carried out by means of simple averaging of the percentile rankings. In the most recent study the best performing country is Singapore, Hong Kong and New Zealand. The three worst performing countries are Chad, Central African Republic and Burundi.

Figure 4.2 Performance of The World Bank Doing Business Index



Source: World Bank Doing Business Index and The World Bank



Indicators

The Doing Business Index considers three transport related indicators, of which two relate to operational characteristics in form of estimated transport costs and transport time for imports and exports. The last indicator considers the number of documents needed for imports and exports and thus considers the administrative characteristics of the logistics system.

Performance

The trading across borders rank is plotted with the rank in GNI per capita in figure 4.2. The R^2 of the fitted linear relationship is around 40, which is relatively good considering the limited number of variables used (compared to for instance figure 4.1).

4.1.3 European Commission: EU Regional Competitiveness Index

Brief description

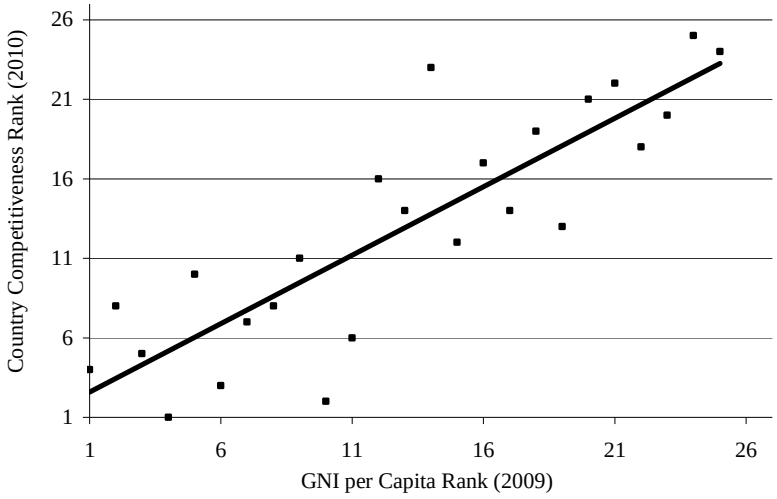
The EU Regional Competitiveness Index is a joint project between DG Joint Research Centre and DG Regional Policy with the goal to measure competitiveness at a regional level (NUTS2) within the EU. It considers 69 indicators from 11 different aspects of which one is infrastructure. It is worth noting that the EU regional competitiveness is highly inspired by the WEF Global Competitiveness Report.

Quick f acts

The competitiveness index covers the EU27 on a NUTS[i] 2 level whenever possible. Both macro and micro data is used, and all data relating to logistics is hard data. Aggregation is carried out with a simple averaging of percentile rankings. On a country level the best performing countries are 1) Netherlands, 2) Denmark and 3) Finland, while the worst performing countries are 25) Malta, 26) Bulgaria and 27) Romania. On a regional level, the Utrecht region in The Netherlands is ranked

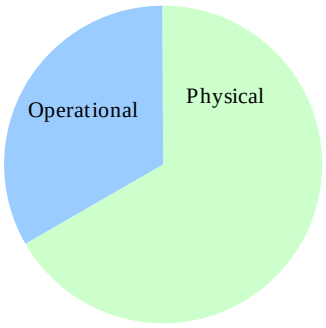
highest among the 268 regions, ahead of the Copenhagen area in Denmark and North-Holland.

Figure 4.3 Performance of The EU Regional Competitiveness Index



Source: The EU Regional Competitiveness Index and The World Bank

Indicators



The nine pillars included in the competitiveness index are 1) Institutions, 2) Macroeconomic stability, 3) Infrastructure, 4) Health, 5) Primary Education 6) Higher Education, 7) Labour Market Efficiency, 8) Market size and 9) Technological readiness, 10) Business sophistication and 11) Innovation. Within sector pillar 3, three variables are used. These cover the motorway density, railway density and the number of passenger flights that are accessible within 90 minutes drive.

Performance

The overall country competitiveness rank of the EU Regional Competitiveness Index is plotted with the GNI per capita rank in figure 4.3. The R^2 of the fitted line is 74 indicating a good fit. It has unfortunately not been possible to obtain the ranking within the infrastructure pillar.

4.2 Private sector approaches

The market of private sector benchmarking studies has been expanding within the last decades. The approaches are very heterogeneous ranking from qualitative evaluations such as the Lisbon Scorecard to technically advanced methods such as the Global Competitiveness Report. At this point it is important to notice that this does not imply that the advanced methodology is superior to a qualitative or simple quantitative evaluation. Several private sector studies are carried out in cooperation with universities, such as the The Global Competitiveness Report from the World Economic Forum.

4.2.1. The Global Competitiveness Report.

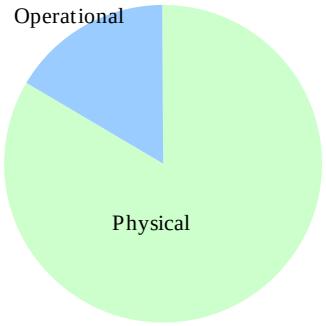
Brief Description

The World Economic Forum annually publishes a ranking of countries in the Global Competitiveness Report. The objective is to measure competitiveness based on a broad set of indicators.

Quick facts

The Global Competitiveness Report is one of the oldest and most popular benchmarking reports. It focuses on measuring the competitiveness of 139 countries world wide based on both macro and micro data, and quantitative and qualitative data. Most of the information is based on their own survey. The three best performing countries in the 2010-2011 study are Switzerland, ahead of Sweden and Singapore; the worst performing countries are Burundi, Angola and Chad.

Indicators

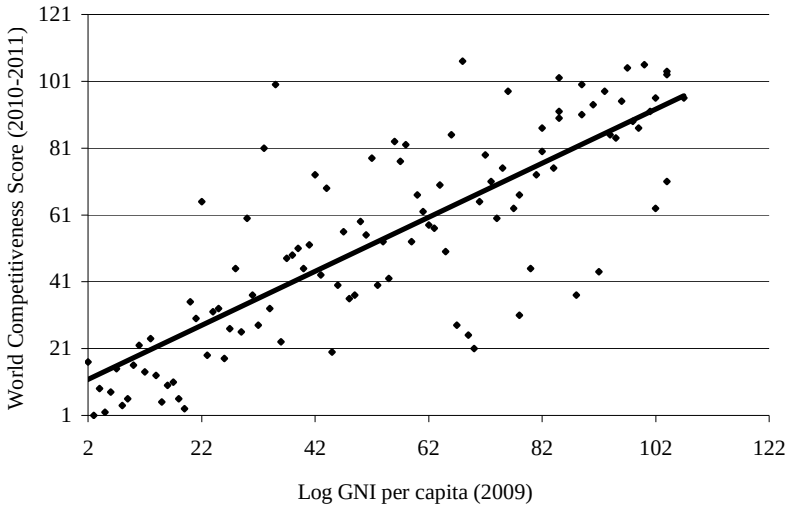


The Global Competitiveness Report measures the competitiveness based on a set of 12 pillars: 1) Institutions, 2) Infrastructure, 3) Macroeconomic Environment, 4) Health and primary education, 5) Higher education, 6) Goods market efficiency, 7) Labor market efficiency, 8) Financial market development, 9) Technological Readiness, 10) Market size, 11) Business sophistication and 12) Innovation. Within element 2) six indicators are used, of which five are related to the quality of infrastructure: quality of overall infrastructure, quality of roads, quality of railroad infrastructure, quality of port infrastructure and quality of air transport infrastructure. The only operational indicator is the number of airline seat-kilometers that are available.

Performance.

Figure 4.4 plots the country rank in the Global Competitiveness Report with the GNI per capita rank. The estimated linear relationship has an R^2 of about 65, indicating a relatively good fit. However considering that this is based on 105 individual indicators covering the 12 aspects of the economy mentioned above, the fit is not impressive. Note however that fitting with the GNI per Capita Rank is not a target of any of these studies.

Figure 4.4 Performance of The Global Competitiveness Report



Source: WEF and The World Bank

4.2.2 World Competitiveness Index

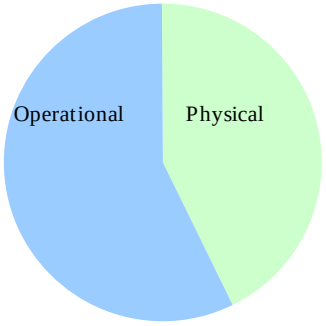
Brief Description

The International Institute for Management Development (IMD) publishes the World Competitiveness Index annually and has done so since 1989. It ranks 58 countries worldwide based on four main factors (Economic performance, Government Efficiency, Business Efficiency and Infrastructure) and 20 sub-factors.

Quick facts

The World Competitiveness index applies a mixture of macro-data and questionnaire data to create one dimensional ranking of countries' competitiveness. The index is published annually and in 2010 edition Singapore scored best leaving the second place to Hong Kong and placing the United States third. The lowest ranked countries are Croatia, Ukraine and Venezuela.

Indicators

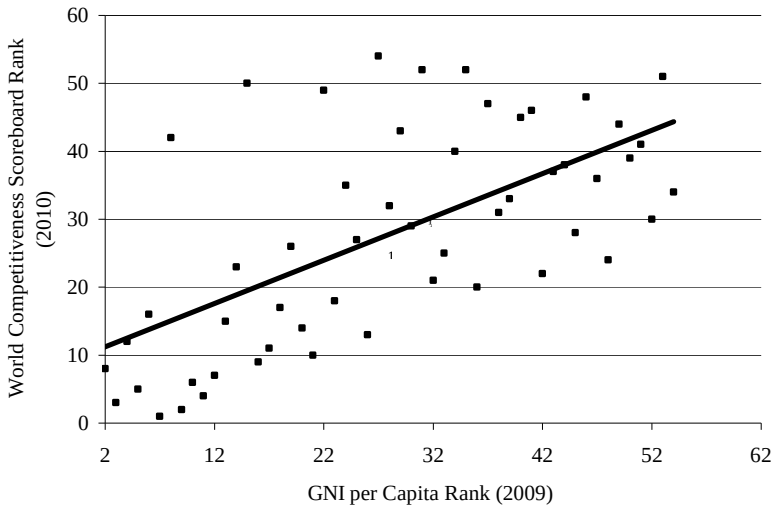


Within the infrastructure dimension, three indicators of the physical performance of the transport infrastructure are included: 1) density of rail infrastructure, 2) density of road Infrastructure, and 3) quality of air transport. The remaining four indicators related to transport infrastructure indicate the operational performance: 1) gasoline prices, 2) water transportation (meeting business requirements), 3) distribution infrastructure efficiency and 4) maintenance and development of infrastructure.

Performance

The performance of the World Competitiveness Index is evaluated by its correlation with the GNI per capita ranking in figure 4.5. An R^2 of about 40 is very low considering the number of indicators included (327 criteria are included).

Figure 4.5 Performance of The World Competitiveness Index



Source: The World Competitiveness Index and The World Bank

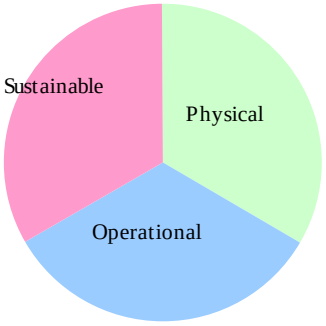
3.2.3 Lisbon Scorecard

Brief Description

The think-thank Centre for European Reform (CER) evaluates the EU countries performance with respect to the Lisbon targets. The measurement is based on EU's shortlist of structural indicators with respect to economic, social and environmental aspects. The scorecard is based on the performance with respect to innovation, liberalization (including transport), enterprise, employment and social inclusion and sustainable development.

Quick facts

The Lisbon Scorecard is based on a qualitative assessment of aspects of the Lisbon Strategy of the European Union. It has been published annually since 2000 and includes a mixture of hard and soft data. In the most recent evaluation, Sweden leads the list ahead of Austria and Denmark. At the bottom Bulgaria is placed 25th, Romania 26th and Malta 27th.



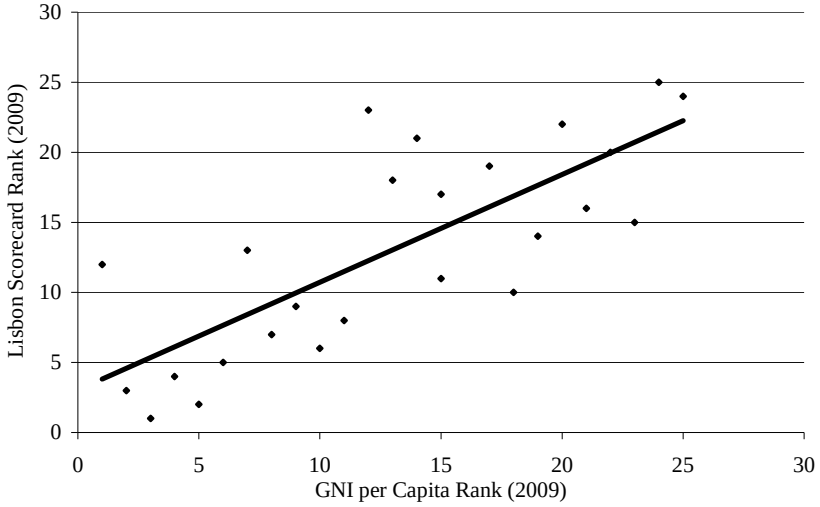
Indicators

With respect to the logistics performance three indicators included in the Lisbon Scorecard are relevant. Firstly the physical characteristics are described by the availability of transport connections, the operational quality is evaluated by the efficiency of the transport sector and finally the environmental sustainability of the transport sector is assessed.

Performance

In contrast to the majority of studies, the aggregation is carried out through a qualitative assessment. The ranking is plotted against the ranking of the GNI per Capita Rank in figure 4.6.

Figure 4.6 Performance of The Lisbon Scorecard



Source: The Lisbon Scorecard and The World Bank

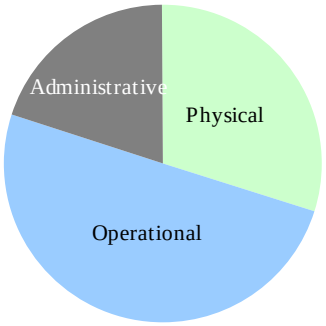
4.2.4 Holland International Distribution Council

Brief Description

The Buck Consultants International benchmarked the Dutch logistics locations against foreign counterparts in 2004 and again in 2007 for the Holland international Distribution Council (NDL/HIDC).

Quick facts

The Holland International Distribution Council evaluates the logistics performance of selected regions in the Netherlands, Germany, Ireland, France and Belgium. This study has been published twice so far and is based on mainly hard data from regional and national statistics, Eurostat, IMD, Watson Wyatt and ILO. The best performing region is Venlo ahead of Rotterdam and Tilburg (All three are cities in the Netherlands)



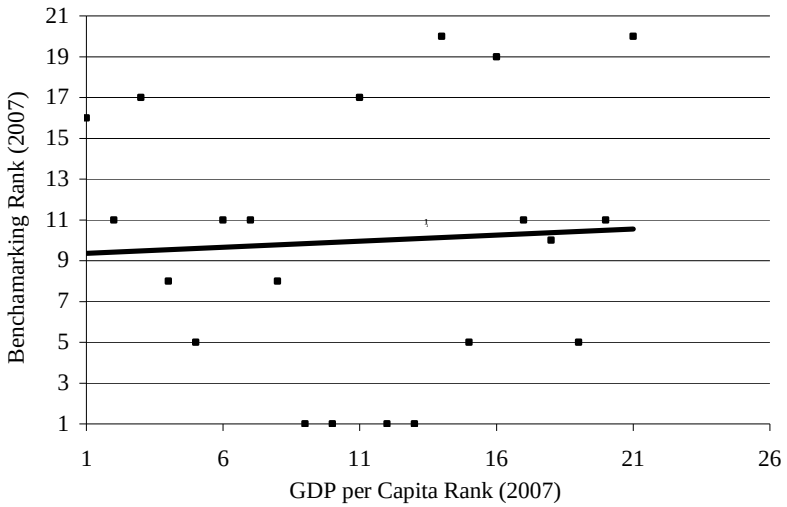
Indicators

With respect to logistics, six measures of the physical quality have been included: 1) proximity to integrator hubs, 2) proximity to airports, 3) proximity to seaports, 4) highway connections, 5) congestion and 6) proximity to markets. The study includes ten operational measures: 1) inbound transport costs, 2) in-transit inventory carrying costs, 3) facility costs, 4) labour costs, 5) replenishment costs, 6) outbound transport costs, 7) fiscal costs, 8) quality of labour, 9) availability of 3 party logistics providers and 10) availability of multimodal transport. Finally four indicators of the administrative performance of the logistics sector are included: 1) labour regulations, 2) time to obtain licenses/rulings, 3) business orientation customs and 4) administrative burden.

Performance

Since the study was carried in selected regions only, it has been difficult to obtain exact information on the GDP per capita. Figure 4.7 provides a plot of the regional rank against the GDP per capita rank, based on information from Eurostat. Since it has not been possible to obtain information on GDP per capita for the exact same region, the GDP per capita of the region at a more aggregated level has been used instead. This may also be the reason for the low relationship between the rankings.

Figure 4.7 Performance of the Holland International Distribution Council



Source: The Holland International Distribution Council and Eurostat

4.2.5 BVL: "Logistik Indikator"

Brief Description

The institute for World Economics at the University of Kiel calculates a logistics indicator in cooperation with the German Logistics Association. The indicator is calculated quarterly, based on a survey of 100 German logistics suppliers and 100 German logistics buyers (firms). The questionnaire asks for the current situation and the outlook.

Operational

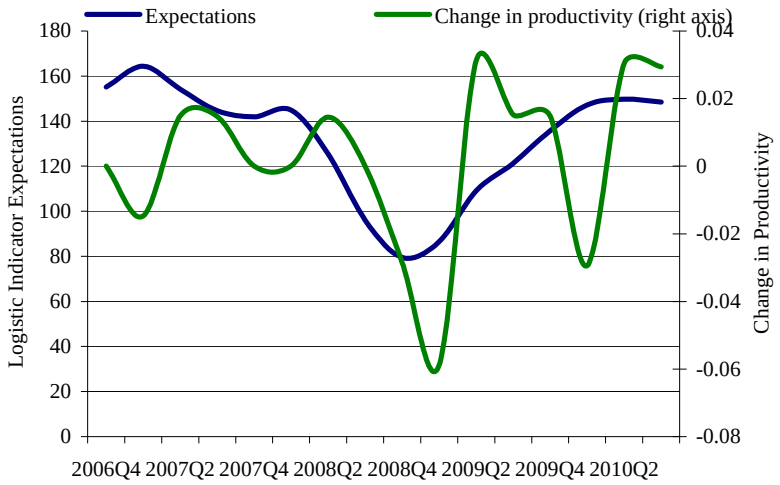
Quick facts

The Logistic Indicator is published quarterly since 2006. It provides an idea of logistic buyers and suppliers expectation of the forthcoming quarter. It is based on purely subjective data and does not compare regions, but is rather used to predict variation over time. The questionnaire includes 20 questions.

Performance

To evaluate the performance of the Logistic Indicator, the predictions (from the previous quarter) and the actual development of the economy are shown in figure 4.8. The blue curve shows the Logistic Indicator expectations and the green curve shows the change in BNP per capita (a rough measure of productivity). Despite the fact that the blue bar only is aiming to predict the development of the logistics sector, a close correlation is seen.

Figure 4.8 Performance of the German Logistics Indicator



Source: Kiel Institute for World Economics and The World Bank

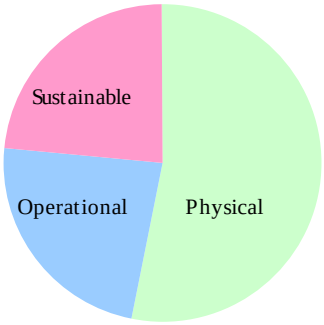
4.2.6 United States: Transportation Performance Index

Brief Description

Under the scope of the U.S. Chamber of Commerce's initiative "Let's Rebuild America" a project was carried out to measure the performance of the U.S. infrastructure and its ability to meet the demands of the nation. The idea is to create an index that incorporates the demand and not only the supply of infrastructure. The first version of the index was published in 2010.

Quick facts

The index was first published in 2010 and covers transport, energy, broadband and water infrastructure on both State level and to some extent also metropolitan areas and nationally over time. It is possible to get sub-scores for only the transport sector. Many sources are used, including the Bureau of Transportation Statistics. All data in relation to transport infrastructure is hard data. The best performing state in the Transportation Index is North Dakota, South Dakota is second, and Nebraska is third. The worst performing area according to this index is the District of Columbia.



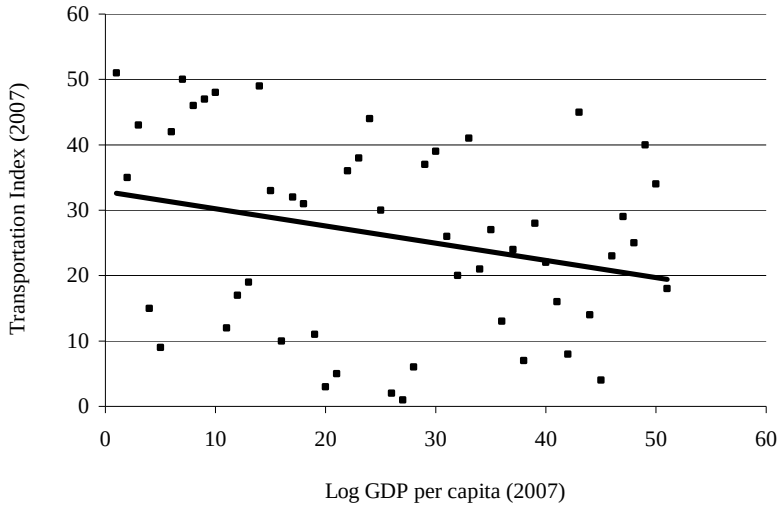
Indicators

With respect to transport infrastructure 21 indicators are included. Nine of those consider the physical quality: 1) highway density, 2) transit density, 3) airport access, 4) rail density, 5) waterway density, 6) port access, 7) intermodal connectivity, 8) road quality, and 9) bridge integrity. Four indicators consider the operational performance: 1) air congestion, 2) road congestion, 3) transit utilization, 4) rail utilization. Four indicators are used to measure the sustainability and safety measures: 1) transit (mainly public transport) safety, 2) rail safety, 3) air safety and 4) highway safety.

Performance

To evaluate the performance of the U.S. Infrastructure Index, the rank within the index with the GDP per Capita rank is plotted in figure 3.9. Surprisingly there is a negative relationship, which seems doubtful. However the District of Columbia was placed last in this index, and is the wealthiest area measured in GDP per capita. This puzzle was also noted by the U.S. Chamber of Commerce.

Figure 4.9 Performance of The U.S. Infrastructure Index



Source: The U.S. Infrastructure Index

Note that the fitted line has a negative slope, which is in contrast to the expected. This may be a result of the choice of indicators used. Many of the applied operational measures will have a poor performance value in regions with high activity. For instance congestion.

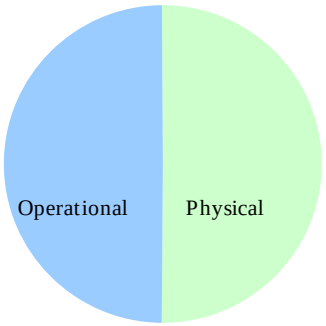
4.2.7 The European Competitiveness Index

Brief Description

The Robert Huggins Associates European Competitiveness Index evaluates the competitiveness of the European regions. A composite index is created based on three pillars: creativity, economic performance and infrastructure and capital. This implies that the economic performance is a part of the index and therefore the good fit of figure 3.6 is not surprising.

Quick facts

The European Competitiveness Index has been published twice so far (2004 and 2006) and covers Europe on a NUTS1 level. It applies hard data mainly on a macro-level from National Statistical Offices and Eurostat in order to compose a measurement of competitiveness.



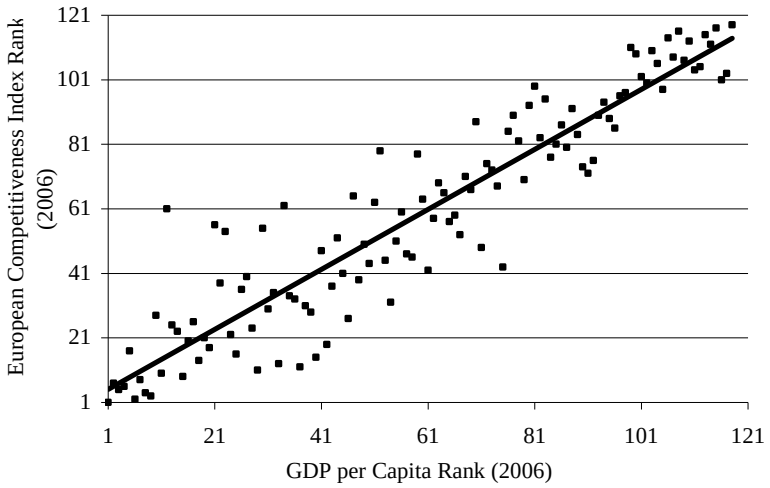
Indicator

Six indicators with relation to logistics performance are included. The motorway density is measured both with respect to number of vehicles and area size. Rail density measured in track length per area is included as well as air freight and air passengers (dis)embarked relative to the population size. Finally the number of vehicles per inhabitants is used as well.

Performance

The relationship between the index rank and the GDP per capita rank is shown in figure 4.10. The fit of the linear trend is stunningly good as seen by the R^2 value of 86. This is however not surprising, as the index even includes a measure of GDP per capita. In that sense it is rather surprising that the fit is not better.

Figure 4.10 Performance of European Competitiveness Index



Source: Robert Huggins Associates

4.2.8 Eurochambres Atlas of Regional Competitiveness

Brief Description

The Atlas of Regional Competitiveness is developed by Eurochambres, which is the European Association of Chambers of Commerce and Industry. The Atlas consists of a description of a number of aspects and the performance of each region with respect to this aspect as well as a number of best practices.

Quick facts

The Eurochambres Atlas of regional competitiveness evaluates 268 NUTS2 regions in the EU27. The Atlas of Regional Competitiveness measures the economic performance of regions in the EU based on six indicators: 1) economic performance, 2) employment, 3) training and lifelong learning, 4) R&D and innovation, 5) transport and energy and 6) internationalization. However no absolute ranking system is developed.

Operational

Indicators.

Among the used indicators two are related to the logistics performance: 1) air freight transport and 2) maritime freight transport.

Performance

As the Eurochambers Atlas of Regional Competitiveness does not rank the countries it has not been possible to compare the score with the GDP per capita or similar indicators of economic development.

4.2.8 Economist Intelligence Unit's Ranking of Business environments

Brief Description

The weekly magazine *The Economist* publishes a number of annual rankings with various focuses. One of these rankings is the Business Environment ranking. It is based on information from The Economists Country Forecast and compares 82 countries worldwide. The 91 used indicators are divided into 10 separate categories.

Quick facts

About half of the indicators are based on quantitative metrics. The benchmark is also based on predictions by the Economists Intelligent Unit. The indicators are aggregated using the average within each category. The Economist discusses the use of weighted vs. equal-weight averaging system. Results are presented using the latter approach. The three best performing countries in the most recent study are Singapore, Finland and Denmark; the three worst performing countries are Cuba, Venezuela and Angola.

Physical

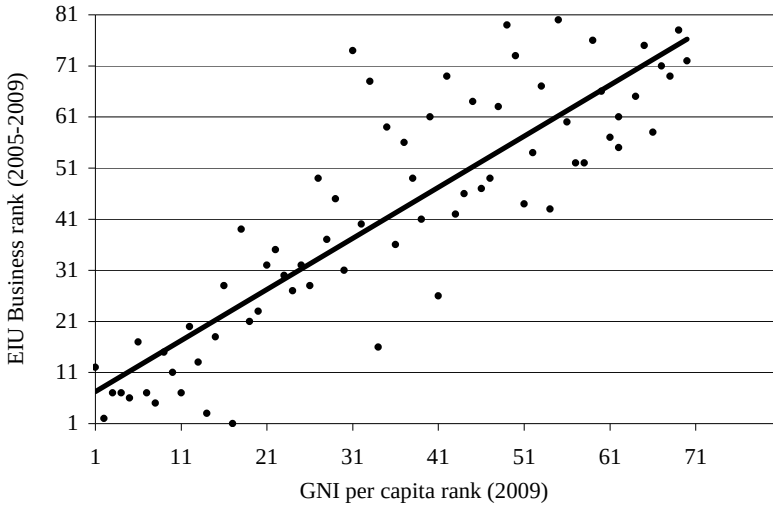
Indicators

Five variables that are included in this benchmarking study are related to logistics. There are three qualitative measures that based on a questionnaire evaluates the quality of road, rail and air transport and two quantitative or hard data variables, in form of the road and rail density.

Performance.

The Business environment ranking of EIU is compared to the GNI per capita rank in figure 4.11. A good linear fit is obtained with an R^2 of 75. However, it is important to keep in mind that the indicator is based on variables covering the entire economy.

Figure 4.11 Performance of Economist Intelligence Unit's Ranking of Business environments



Source: Economist Intelligence Unit and The World Bank

4.2.9 The Performance Measurement Group: Supply Chain Benchmark

Brief Description

The Performance Measurement Group (PMG) offers a supply chain benchmark for individual companies that wish to be compared against peer companies. The evaluation is based on the so called Supply-Chain Operations Reference (SCOR) model. It is a commercial product which is carried out following demand from individual customers and takes approximately 6-10 weeks.

Quick facts

Today the PMG has a database consisting of more than 1,000 supply chains from more than 750 firms. It combines quantitative and qualitative indicators. Due to confidentiality considerations scores, metrics and results are not publicly available.

Indicators

According to the publicly available information more than 95 quantitative indicators and 250 qualitative indicators are used in the assessment. Only a partial list of indicators is available. These cover the operational, administrative and sustainable dimensions.

Performance

The Supply Chain Benchmark evaluates firms and benchmark firms against peers. Data is not publicly available.

4.1.10 Supply Chain Operations Reference Model (SCOR)

Brief description

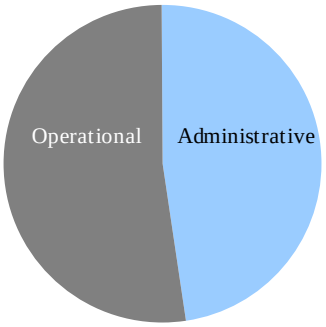
The international organization the Supply Chain Council has developed a model called the Supply Chain Operations Reference Model (SCOR) which is based on the Supply Chain Councils view of modern supply chains. The SCOR model benchmarks the performance of companies supply chain in comparison to similar companies. The model was developed by the management consulting firm PRTM.

Quick facts
The idea to develop a standardized methodology to measure supply chain performance came in 1996 and the first version was launched that year. The model is based on five distinct management processes: 1) *Plan* (i.e. processes dealing with adjusting supply and demand), 2) *Source* (i.e. processes that procure the supply and demand), 3) *Make* (i.e. processes that develop the good into its final stage), 4) *Deliver* (process dealing with the delivery of the final goods) and 5) *Return* (i.e. processes dealing with the return of goods). The model is a commercial product and detailed information is not publicly available.

Indicators
The SCOR model applies more than 150 indicators. Among the used metrics are: *Perfect Order Fulfillment, Order Fulfillment Cycle Time, Upside Supply Chain Flexibility, Upside Supply Chain Adaptability, Downside Supply Chain Adaptability, Supply Chain Management Cost, Costs of Goods Sold, Cash-to-Cash Cycle Time, Return on Supply Chain Fixed Assets and Return on Working Capital.*

Performance
The SCOR model evaluates firms and benchmark firms against peers. Data is not publicly available.

4.1.11 Supply Chain Balanced Scorecard Metrics



Brief Description
The company Balanced Scorecard Designer (www.strategy2act.com) has developed a tool for measuring a firms supply chain performance. The tool is an excel document in which firms can enter a number of metrics and a score is then produced.

Quick facts
This type of performance management is available in many forms and is a type of balance scorecard. It is a commercial product, but free trial excel sheets are available.

Indicators
The excel sheet includes 19 indicators of which two relate to warehousing, two relate to manufacturing, four relate to transportation, five to customer satisfaction and six to financial performance. The user sets the weight to each category and a score in percentage is calculated based on the users' assessment of the individual factors.

Performance
The benchmarking system is not evaluated against other firms, and merely provides a score.

4.2.12 LOG4SMEs

Brief Description
LOG4SME focuses on the logistics performance of small and medium sized enterprises in the automotive sector. It is a project that involves the University of Bergamo (Italy), the Fraunhofer-Institut für Produktionstechnik und Automatisierung (Germany) and Széchenyi István Egyetem (Hungary). The aim of the project is to give small and medium sized enterprises within the automotive industry an instrument to benchmark the logistics performance against regional and industry levels.

Quick facts
The final report was published in 2006 and covers three regions: 1) Baden Württemberg, a Federal state in the south-west of Germany. 2) Lombardy in the north of Italy and 3) West Pannon in the western part of Hungary. The project group conducted a survey among companies in these regions. The outline of the questionnaire and analysis was based on three levels: 1) The level of firm complexity, 2) Drivers and 3) Questions.

Indicators
The survey covered 48 companies which were analysed with respect to their position in the supply chain and managerial complexity. It is however not clear exactly which questions have been used.

Performance
Firms are evaluated according to their managerial practices and the level of complexity.

4.1.14 Logistics and Supply Chain Management (SCM) Key Performance Indicators (KPI) Analysis
Brief Description
Industry Canada in cooperation with Supply Chain and Logistics Association of Canada (SCL) have developed a number of sector specific supply chain performance reports. Among the included sectors are the automotive industry, aerospace, manufacturing and the pharmaceutical sector. Additionally one general United States/Canada perspective was published.

Quick facts
The report covers four sectors (manufacturing (raw/finished), wholesale and retail) and provides a comparison between U.S. and Canadian firms. One of the results is that logistics outsourcing is more expensive in the U.S. than in Canada in both the manufacturing and retail sectors. The study also shows that inventory turns have increased significantly over the last two decades in both the U.S. and Canada. Furthermore Canada lags behind in efficiency in three out of four sectors evaluated.

Indicators
The main indicators used are just-in-time performance and supply chain costs. No ranking is provided, but sectors are compared as well as the situation in the U.S. in comparison to the situation in Canada.

Performance
Not applicable.

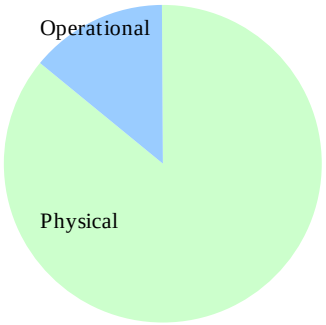
4.3. National Initiatives
National initiatives are generally undertaken in order to deal with the development of national logistics master plans – for the transportation sector or the promotion of countries as logistics hubs for multinational companies. National initiatives have not been focused on ranking or comparing countries regarding logistics indicators or their logistics companies' efficiencies, but are mainly dealing with the formulation of a long-term strategy for the transportation and logistics sector as they recognize its importance to their national economies and competitiveness. The following are brief descriptions of various national initiatives in the field of logistics and transportation.

4.3.1 The regional Competitiveness Index of Croatia

Brief Description

Both quantitative and qualitative indicators are included and the measurement is inspired by World Economic Forum and IMD.

Quick facts



The study covers the 21 NUTS3 regions of Croatia and has been published once. It is based on mainly hard-data on a macro-level. Data is obtained from the National Statistical Office and Eurostat.

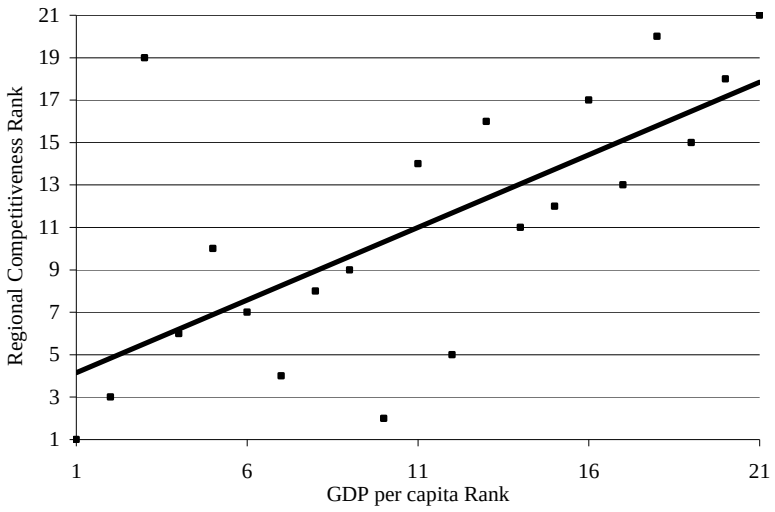
Indicators

Seven indicators that somehow relates to the logistics performance are included in the study. Six consider the physical quality: 1) measuring the road density (State, country and local roads), 2) total infrastructure quality, 3) quality of railways, 4) quality of ports and water transport, 5) level of development of air transport, and 6)overseas air transport,. One indicator is used to measure the operational performance: vehicles per capita (passenger and cargo).

Performance

Figure 4.12 shows a plot of the regional competitiveness index rank and the GDP per capita rank. The fit is relatively good, but the R^2 of the plotted line is only 47, which is low compared to the number of variables included.

Figure 4.12 Regional Competitiveness Index of Croatia

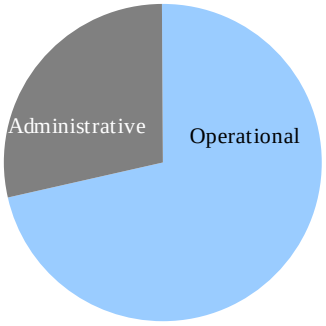


Source: Regional Competitiveness Index of Croatia

4.3.2 Logistics Friendliness Index – Finland

Brief description

The logistics friendliness index aims at providing a systematic approach to the evaluation of the performance of the logistics sector. This first study was carried out in 2003 to 2004 by means of an internet based survey addressing 3,300 international freight forwarders.



Quick facts

A significant correlation between national income and a country's 'logistics friendliness' was found in this approach. The higher the per capita income is, the 'friendlier' the country is from the point of view of logistics. The study showed that a highly developed logistic environment might be seen as problematic if transport costs are high owing to such factors as long distances and high overheads.

Indicators

The internet based survey asked each respondent to evaluate the logistics of nine countries according to the following seven aspects: 1) transport time, 2) timeliness of shipments, 3) international freight costs, 4) domestic collection and delivery costs, 5) customs procedures, 6) professionalism in freight forwarding and 7) overall evaluation

Performance

Not available

4.4 Evaluation of approaches

The quality of an indicator depends on many factors, for instance what the objective of the measurement is. A competitiveness performance measure will naturally better predict regional productivity levels than a pure transport indicator simply because a competitiveness indicator considers more aspects of the economy.

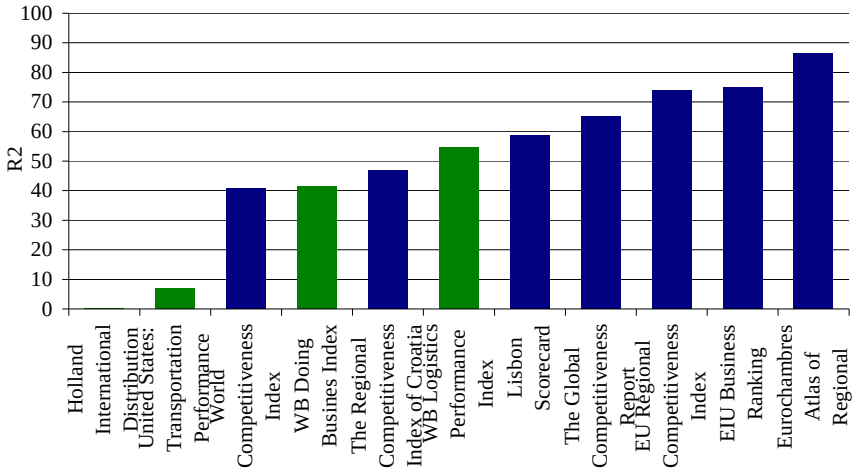
This review should provide an overview of the existing assessment methods based on methodology and coverage. These aspects will be further evaluated in the next section. However it is useful to summarize the evaluated indicators. From table 4.1 a first gap can be identified in terms of the very dominant private sector. The World Bank is the most dominant institution from the public sector side.

4.4.1 Benchmarking and productivity

It was discussed in section 3, that a good measurable approximation for competitiveness is productivity. In the discussion of the individual benchmarking systems, whenever possible, the benchmarking rank has been plotted against the rank in income per capita. The idea is to use income per capita as an approximation for productivity. Optimally it should be production per employed person, but due to lack of available data and for simplification, income per capita has been chosen. It must be emphasized, that the studies not necessarily aim at predicting income per capita, and that R^2 is a poor measurement of fit, which for instance does not consider how many variables are included. Nevertheless the figures shown and the summary provided in figure 4.13 provide some indication.

The blue bars in the chart denote the studies where the ranking was based on several aspects of the economy with the aim to summarize competitiveness. The green bars indicate studies where the benchmark rank was only measured on transport, logistics or supply chain indicators. It is important to recall that R^2 is a simplistic indicator of the fit and the chart is only meant as an indication. It is no surprise that measures of total competitiveness are typically better in predicting the rank in income per capita. However, note that the World Banks LPI has a score above 50. Roughly speaking by using only logistics relevant indicators, it is possible to predict more than 50% of the variation in income per capita. ***This does indicate that supply chain quality is important for national competitiveness***. However the direction of causality is not clear. It might still be, that supply chain quality is high because the nation is wealthy, and not vice versa.

Figure 4.13 Measurement of fit of the indicator rank against income per capita rank.



Source: UNECE Research. Note for green bars the indicator plotted is only related to transport logistics or supply chains. For blue bars the indicator covers competitiveness in general.

Bearing in mind that the objective of this review is to assess how the existing approaches measure the contribution of transport to competitiveness, figure 4.13 reveals some interesting insights. The World Bank's LPI is doing reasonably well in predicting differences in national productivity, despite the fact that only transport related issues are included. This benchmarking method is one of the few studies that apply indicators from all four dimensions, physical, operational, administrative and sustainable. ***This therefore indicates that if the performance of transport is measured appropriately, the contribution of transport to national competitiveness increases to a substantive level***.

Table 4.1 provides a list of the 19 studies evaluated. Of these, four studies will not be included in the following quantitative evaluation due to lack of data, they will however be included in the qualitative evaluations. About half of the evaluated studies focus on supply chains but as the next section will show these studies focus on an intra-sector or even intra-firm scale.

Table 4.1 Included studies

	Title	*Author*	*Classification*	*Focus*
Included and evaluated	4.1.1 Logistics Performance Index	The World Bank	Public	Logistics
	4.1.2 Doing Business Index	The World Bank	Public	Business Environment
	4.1.3 EU Regional Competitiveness Index	European Commission	Public	Competitiveness
	4.2.1 The Global Competitiveness Report	World economic Forum	Private	Competitiveness
	4.2.2 World Competitiveness Index	IMD	Private	Competitiveness
	4.2.3 Lisbon Scorecard	CER	Private	Lisbon Strategy
	4.2.4 Holland International Distribution Council		Private	Logistics
	4.2.4 BVL: Logistik Indikator	University of Kiel	Private/Public	Logistics
	4.2.5 United States: Transportation Performance Index	U.S. Chamber of Commerce	Private	Infrastructure
	4.2.7 The European Competitiveness Index	Robert Huggins Associates	Private	Competitiveness
	4.2.8 Eurochambres Atlas of Regional Competitiveness	The Chamber House	Private	Competitiveness
	4.3.1 The Regional Competitiveness Index of Croatia	The National Competitiveness Council	Private/Public	Competitiveness
	4.2.12 Supply Chain Balanced Scorecard Metrics	-	Private	SCM
	4.2.14 SCAR	Logistics Bureau	Private	SCM
Included, but not quantitatively evaluated	4.3.2 Logistics Friendliness, Finland		Public	Logistics
	4.2.9 Supply Chain Benchmark	PMG	Private	SCM
	4.2.10 Supply Chain Operations Reference Model	Supply Chain Council	Private	SCM
	4.2.11 LOG4SMEs	-	Private	Logistics
	4.2.12 Supply Chain and Logistics Canada	-	Private	SCM

4.5 Academic approaches on the measurement of infrastructure

Before turning to the gap evaluation a sample of academic studies is briefly considered. The point of departure in identification of academic studies was "Transport Investment and Economic Development" by Banister and Berechman (2000). As an additional constraint, only studies that consider the relationship between public infrastructure and economic development were reviewed. This implies that a number of studies consider infrastructure in a wider aspect than transport, and in addition to transport include buildings, parks, water, gas and sewer infrastructure.

Measurement types

A sample of 144 empirical studies was reviewed. The studies fall into four groups with regard to the measurement of infrastructure.

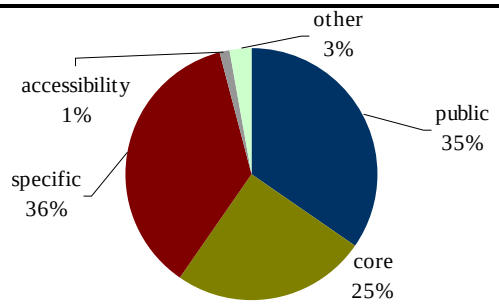
I.) Studies that include all **public** infrastructure in the measurement.
This is the most aggregated measurement of infrastructure seen in literature and includes transport infrastructure as well as buildings, parks, water, gas and sewer infrastructure. In these approaches infrastructure is measured by its value based on investments adjusted for depreciation. This approach is seen in for example in Aschauer (1989b), Duffy-Deno and Eberts (1991b) Bajo-Rubio and Sosvilla-Rivero (1993), Crihfield and Panggabean (1996)).

II.) Studies that include all **core** public infrastructure in the measurement.
Core infrastructure consists of transport infrastructure (road, rail, airports, waterways) as well as gas, water and sewer infrastructure. This measurement approach is also mostly based on the investments in this type of infrastructure and therefore quantified by the estimated value of the existing infrastructure (e.g. Aschauer (1989a), Berndt and Hansson (1992), Munnell (1990) Conrad and Seitz (1994), Paul et al. (2004)).

III.) Studies that measure one **specific** element of infrastructure
A number of studies also consider only one specific aspect of infrastructure. The infrastructure is either considered by its estimated value (as above) or by its physical attributes, for example, the length of roads, rail tracks or waterways. This methodology is seen for example in Blum (1982), Baltagi and Pinnoi (1995), Boarnet (1998)). Some studies use specific features of infrastructure for operational characteristics, i.e. the degree of congestion.

IV.) Studies that measure infrastructure by **accessibility** measures
Some newer studies measure infrastructure quality by measuring the accessibility. The latter is typically measured by how many interactions can be accessed within a defined time limit. This approach is seen in Ozbay and Berechman (2006), Johansson (2007))

Figure 4.15 Measurement methods in academic literature

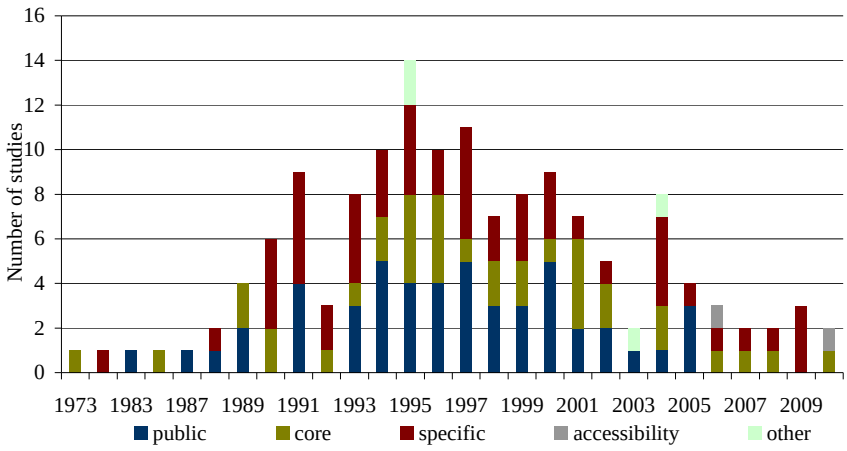


Source: UNECE Research. Note: 144 studies evaluated.

The distribution of methodology is shown in figure 4.14. Of the 144 evaluated studies 50 evaluate infrastructure by the value of all public infrastructure, 36 apply the value of core infrastructure as a measurement, and 52 evaluate a specific aspect of infrastructure, while only two evaluate accessibility, and the “other” group consist of four studies. A second grouping of studies can be made depending on whether studies measured infrastructure by value. This is the case for all studies in the first two groups but also for a number of studies in the third group and in the “other” group. In total 83% of the studies considered use a monetary measure of infrastructure.

Figure 4.15 shows the distribution of measurement type in the 144 evaluated academic studies. The studies have been divided into the four groups above and one additional "other" group. There is however slight indication of increased popularity of accessibility measures in recent years, while the most aggregated group "public" has been used less in the last decade. It is important to remember that the objective of the individual studies may differ from our objective. However, only studies that considered the impact of transport infrastructure on economic development have been included.

Figure 4.15 Measurement methods in academic literature by year of publication



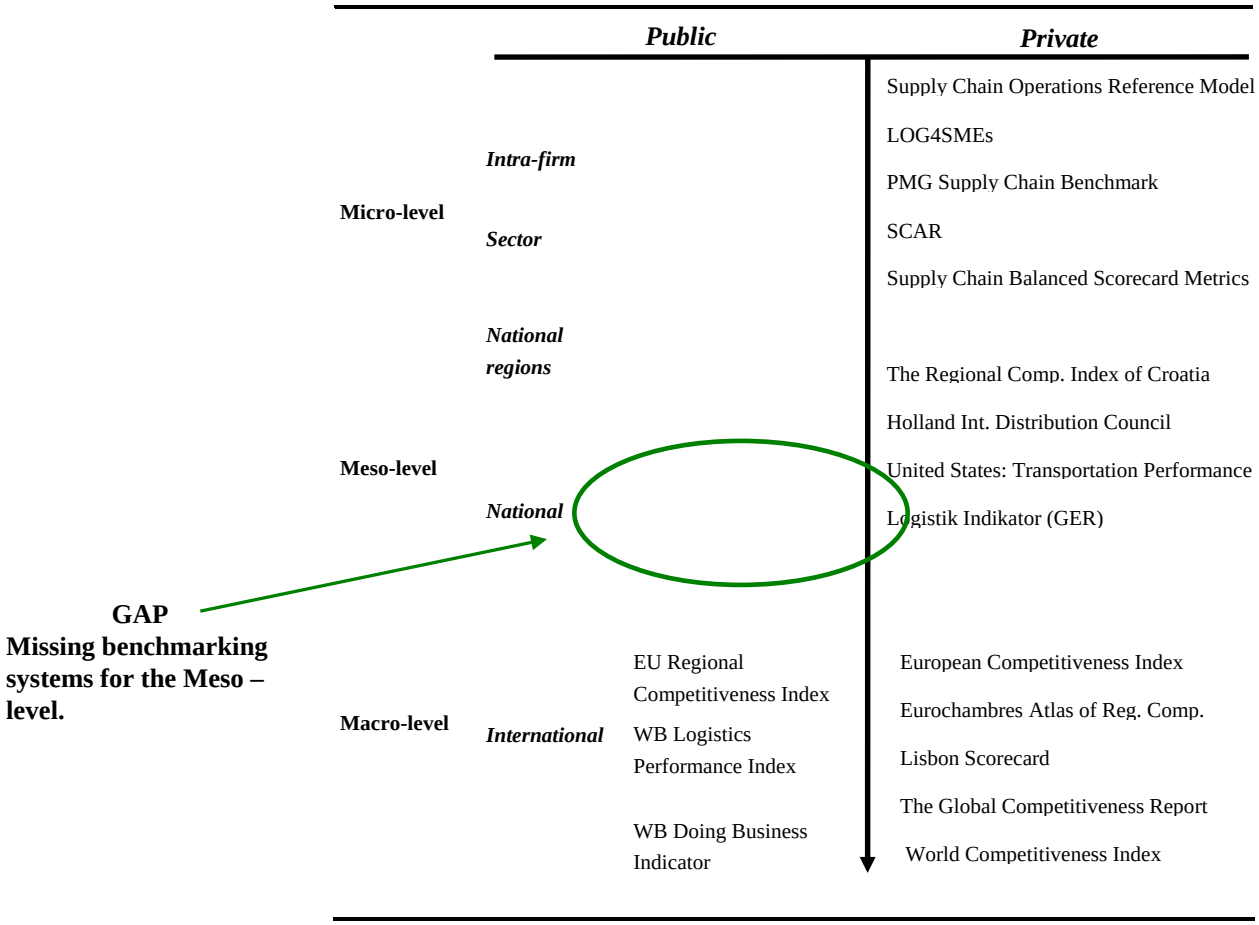
Source: UNECE Research. Note: 144 studies evaluated.

V. Gap analysis

5.1. Geographic dimension of evaluation

A first distinction to be made is the scale of evaluation - the geographical or institutional area which the measurement covers. The review of the empirical studies in the previous section showed that measurement approaches are very heterogeneous in terms of the scale of coverage. It seems reasonable to take approach going from the total micro-level - within firms- to the total macro level – worldwide cross-country comparisons. Figure 5.1 organizes the evaluated studies according to this scale. The World Bank's Doing Business Indicator is the most global measurement as it covers 183 countries worldwide, while the LPI covers 155 countries. For the private sector the Global Competitiveness Report of the World Economic Forum is the top-scorer with 139 countries worldwide.

Figure 5.1 Geographic Coverage of measurements



The micro indicators, however relevant for single companies, are difficult to aggregate to the supply chain level. The macro indicators reflecting the efficiency of supply chains tend to be focused on particular concern in isolation, rather than on a comprehensive review of all supply chain aspects, which are of interest to policy makers. ***Therefore, there is a need to develop a multi-criteria assessment system at a meso-level for conducting a comparative evaluation of transport services in different countries which will cover total transport costs, quality of transport services, and impacts on socio-economic factors***.

Gap identification

Studies measuring infrastructure performance cover the entire range from an intra-firm scale to an international cross-country comparison. Figure 5.1 shows that while the private sector approaches are found within all dimensions, the public sector measurements are focused on geographical areas, i.e. national regions but mostly countries. Figure 5.1 clearly reveals a gap, because there are no public sector approaches on intra-firm or intra-sector level. This gap also indicates that numerous intra-firm and sector performance measures are clear indicator of the importance the private sector attaches to increased efficiency, rationalization and cost factors as the elements of competitiveness. It is also evident that public sector institutions need to provide a comparable tool for national economies to evaluate their logistic performance and contribution to competitiveness.

5.2. Methodological approach

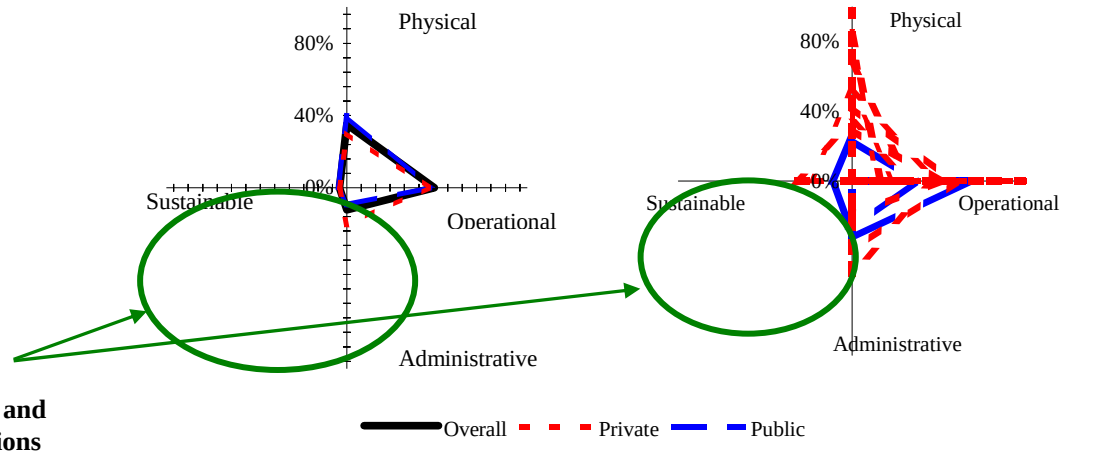
The studies differ considerably with respect to the applied data source, aggregation methodology and choice of indicators. The choice of indicators is critical as it is crucial for appropriate measurement of transport. However, if the data sources used are of low quality or do not include enough dimensions, the right choice of variables will not matter. Likewise, if the aggregation methodology gives the author control of the outcome, the measurement cannot be trusted. The following section will evaluate the studies with respect to these three methodology dimensions.

5.2.1 Choice of Indicators

Four dimensions of transport were derived for the optimal measurement of its role in modern supply chains and its importance for national competitiveness. These dimensions – physical, operational, administrative and sustainable – should all be considered and included in the appropriate measurement. This does however not imply that they all have to have the same weight or the same number of variables.

Figure 5.2 Covered dimensions of transport in modern supply chains

Figure 5.2.1 Average *5.2.1 Actual*



GAP
The administrative and sustainable dimensions are widely ignored.

This distinction was also applied in the presentation of the existing measurement methods in section 4. Figure 5.2.1 presents the average distribution of indicators while figure 5.2.2 includes all studies. Both charts show that measurement approaches tend to focus on measures of the physical and operational characteristics of transport. Few studies consider sustainability (safety, security and environment) or administrative factors (track and trace facilities, burden of clearance procedure). Especially the public sector studies (blue lines) have paid very little attention to sustainability aspects. Figure 5.2.2 also reveals that some measurement methods concentrate only on the physical or operational dimensions. There is no study that has an evenly distributed choice of indicators, but that may not be desirable. The World Bank Logistics Indicator is the only approach that covers all dimensions.

GAP
Indicators are typically supply driven.

Traditional measurements of transport by its physical attributes also have the disadvantage of being supply driven. They therefore rather provide the answer to the question “what is there?” than to the more relevant question “does it meet demand?”. For the competitiveness of a firm it is not relevant how many roads, railways or airports there are available, what is relevant is how fast goods can be delivered, how reliable is delivery and how much does it cost. There is a link between the existing supply and the performance, but it is important to make distinction that for competitiveness, what matters is the performance in terms of how well the demand for service is met. This fact has been seen in most of the evaluated studies. For instance the Global Competitiveness report uses indicators on “the quality of roads”, “quality of railroad

infrastructure", etc. The World Competitiveness Index uses "density of rail infrastructure", "density of road infrastructure". There is however some indication that the studies are beginning to include more demand driven indicators. For example the World Competitiveness Index uses an indicator on whether water transportation "meets businesses requirements".

5.2.2 Data source

The type of data is analysed keeping the distribution of indicators in mind. A first distinction is made between hard and soft data. Hard data is objective data from statistical databases typically presented in quantitative terms. Soft data is subjective and typically obtained through questionnaires. For an appropriate measurement it is important to consider both these types as they can provide different information about the same characteristics. A physical measure of transport infrastructure could for instance be the density of roads. This can be evaluated with hard data by a measure of the total length of road infrastructure and the total area size. A second approach is to ask transport users (buyers and providers) to assess the quality of road infrastructure. By using both hard and soft data one could obtain a more complete and realistic picture of roads in this case. Some elements can however only be evaluated by one type of data, and for some aspects it is advisable to give a higher weight to one type of data.

Figure 5.3 shows the types of data used in the studies evaluated in section 4. At a first glance the distribution is fairly even, as seen from figure 5.3.2. For the private sector approaches the distribution is almost fifty-fifty, while for the public sector approaches soft data is used more (67%).

Figure 5.3 Data Type distribution, share of hard data

Figure 5.3.1 By indicator

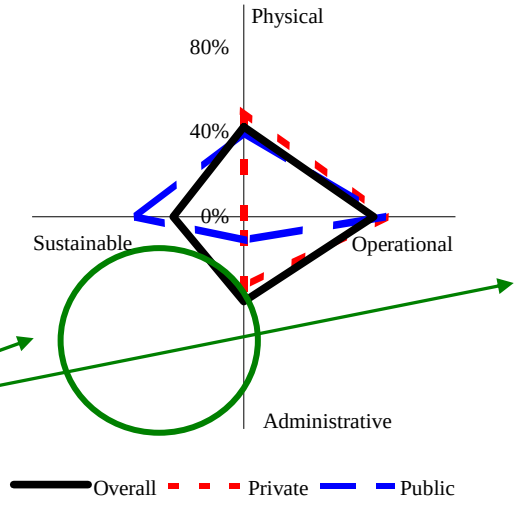
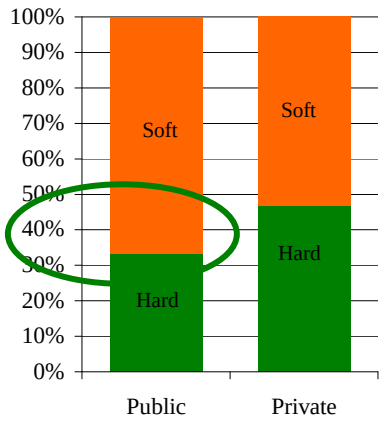


Figure 5.3.2 Total share of hard data



GAP
The use of soft and hard data is unbalanced.

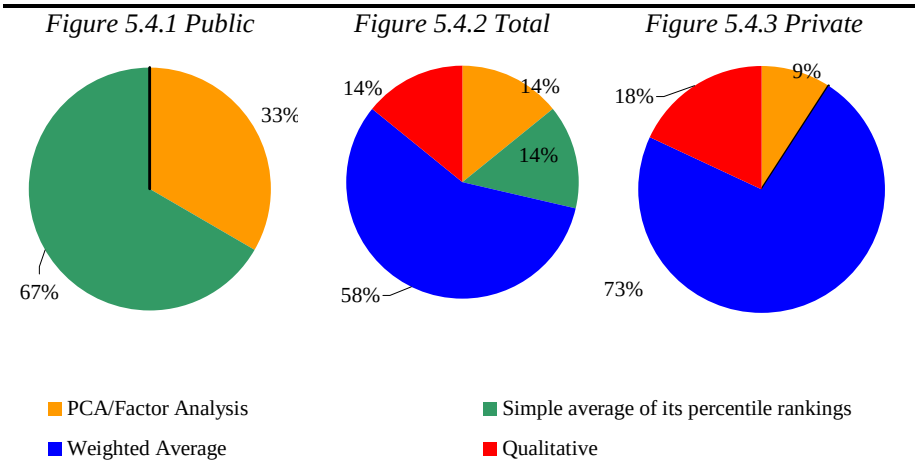
Gap identification

Section 5.2.1 shows that the sustainable and administrative dimensions are more or less overlooked by all kinds of approaches. The measurement methods tend to focus on operational and physical measures of the transport infrastructure. Section 5.2.2 revealed that overall distribution between hard and soft measures is more or less even. On average the operational dimension and physical dimensions are relatively balanced in the public sector studies, but the administrative and sustainable dimensions are dominated by soft data variables. A first gap identified is therefore a measurement that includes all dimensions evenly and applies an evenly distributed share of soft and hard data.

5.2.3 Aggregation Methodology

Combining data is not straightforward, especially not when one needs to combine qualitative and quantitative data types and variables that measure very different aspects. Studies considered in this review have applied very different measurement methods which can have an impact on the outcome. The methodology in the evaluated studies fall into four groups: 1) factor analysis, 2) simple averaging, 3) weighted averaging and 4) qualitative assessment. Factor analysis is a common methodology for decreasing the dimension of a dataset. The idea is that variation in a set of variables reflects the variation in one single unobserved variable. There is no first best solution to the aggregation methodology and this evaluation is not intended to conclude the best approach but rather to shed more light on the applied methodology.

Figure 5.4 Aggregation methodology



Note that none of the public sector approaches have applied weighted averaging or qualitative assessments; while private evaluations tend to avoid simple averaging. Overall, a weighted averaging tends to be the most popular methodology. Several studies mention that they compared their results with results obtained using other methodologies, which gave similar conclusions.

Gap identification

Regarding methodology, it is difficult to identify a gap, but it is remarkable that none of the public sector approaches have applied qualitative or weighted average approach. In future studies it would be beneficial if rankings and measurements based on various approaches also would be presented. The methodology used for identifying weights for averaging varies considerably within studies. It will not be argued here which methodology is superior, but instead it is recommended that future studies precisely and clearly explain how the weights are obtained, since this is lacking in many of the evaluated studies.

5.3 SWOT analysis

Using the SWOT analysis (**S**trengths, **W**eaknesses, **O**pportunities and **T**hreats), existing methodologies could be further evaluated. The analysis, shown in figure 5.5 shows that there is gap concerning the existence of evaluation tools that assess transports contribution to countries competitiveness based on transport's new role as a part of global supply chains. The majority of public sector approaches treat

transport as a separate element in the economy or as a part of the logistics sector but without evaluating its importance for the competitiveness. In other words, the available benchmarking systems that treat transport as an integrated element of logistics or supply chain only provide a benchmark for the logistics sector and do not consider the importance for competitiveness. The available commercial indicators treat transport as an element of supply chain but mainly based on intra-firm or intra-sector characteristics. There is therefore a need for the development of an integrated assessment tool that will assess transport's supply chain challenges and its contribution to countries competitiveness.

Figure 5.5 SWOT analysis of the existing transport benchmarking systems

Strengths	***Weaknesses***
✓ Based on easy accessible and comparable indicators.	× No common methodologies, definitions or terminology applied.
✓ High degree of transparency in most systems.	× Country specific characteristics are ignored (land-locked, Islands, etc.)
✓ The role of transport is treated as an integral part of logistics services.	× Sector specific needs are not considered.
✓ The importance of transport and infrastructure for economic development is clearly visible.	× Commercial benchmarking systems of supply chains exist, but they focus on intra-firm characteristics.
	× In public sector approaches, transport is evaluated as a separate element of the economy and typically not as an integrated part of global supply chains
	× No evaluation of the impact of transport on national competitiveness.
Opportunities	***Threats***
✓ Basis for development of flexible, dynamic and efficient evaluation tools has been created.	× The role of transport in global supply chains and the importance for competitiveness is being underestimated.
✓ New benchmarking treat transport as an integrated part of logistics.	× Inaccurate measurement of the quality of transport in global supply chains.
	× Inaccurate measurement and may lead to wrong policy decisions about the importance of transport for national development.

5.4 Gap identification

The findings of the gap analysis are now summarized in order to identify the overall gaps. Firstly, regarding coverage it was shown in section 5.1 that there is a gap at the Meso-level. There are cross-regional/national measurements of logistics available

from both the private and public sector. However only one international public sector study that concentrates on logistics or transport performance has been identified.

GAP 1: There is no meso-level benchmarking system with a supply chain focus.

In section 5.2 it was shown that for both the private and non-private sector, the measurements of the logistics sector are focused on measures of the physical and operational infrastructure quality. The public sector approaches almost all ignore the sustainability dimension. The administrative dimension is also ignored by almost all studies. Of all the evaluated studies, only the World Bank LPI considers all four dimensions. At this point, it important to repeat that one cannot claim that all dimensions should be included to the same extent. It is however important to take all dimension into consideration and avoid that they are not included. It seems more appropriate to apply weights after inclusion of all indicators than before.

GAP 2: The administrative and sustainable dimension is widely ignored in measurements of the role of transport.

The quality of the data is obviously important for getting an appropriate measurement. It has been shown that, overall, the balance between hard and soft data is good; however within studies this is not the case. The best balance is obtained by The World Competitiveness Index, in which 43% of the indicators are obtained from soft data. Only two other studies use a mix of soft and hard data.

GAP 3: Within studies balance between hard and soft data is poor.

Regarding methodology, the most used aggregations methods are averaging or factor analysis. It is often seen that these two methods give very similar results. This is also noted by a couple of studies. None of the studies however present results from various methodologies.

GAP 4: Presentation of ranking outcomes with alternative aggregation methods is missing.

None of the evaluated studies considered country specific-dimension weights based on a sound theoretical framework. The weights were typically identical across countries, which is beneficial when countries want to compare against peer economies. However this may not give the true picture of what the quality of the countries transport sector.

GAP 5: None of the studies used apply country-specific dimension weights that for example accounts for the special needs of land-locked countries.

An evaluation of 144 empirical scientific studies dealing with the causal relationship between transport infrastructure and economic development showed that measurement of transport varies considerably, and is widely based on very simplified methods. Only very few studies consider accessibility measures, and none of the studies considered all four dimensions of transport and its role in modern supply chains.

GAP 6: The measurement methodology in academic studies is mostly based on either a monetary estimate of the value of public capital or by only considering the physical attribute of one aspect of infrastructure.

Table 5.1 summarizes the results of the overall gap analysis. It shows that the World Banks LPI is the study that is closest to explaining the desired objective. However this study has some major limitations, it is mostly based on qualitative data from a questionnaire, and inclusion of the third and fourth dimension is relatively weak.

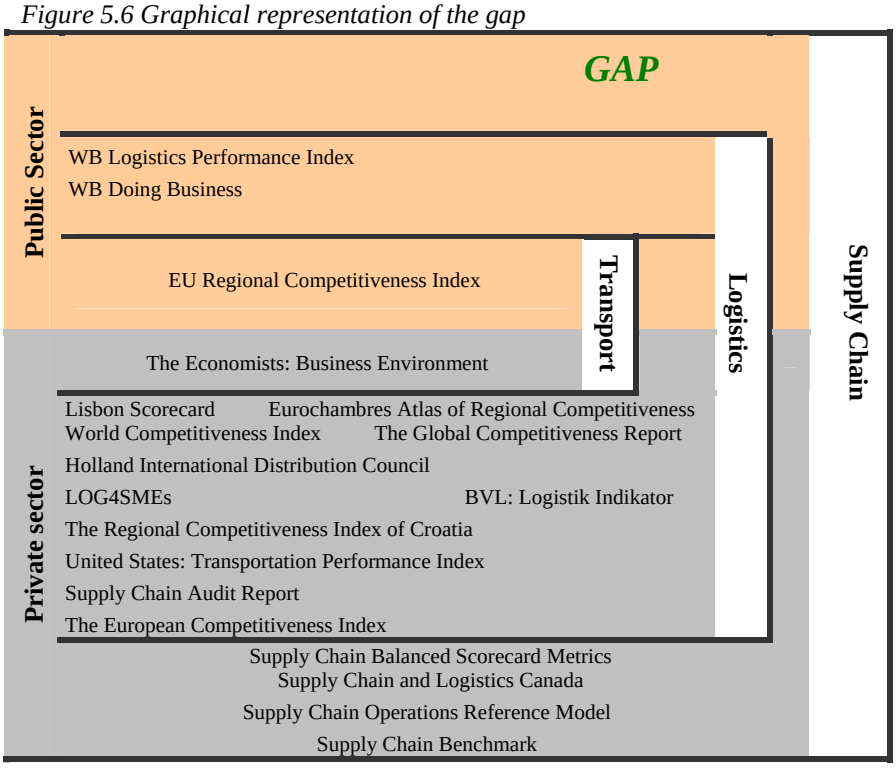
Table 5.1 Gap Analysis Summary

Gap	Almost there
International comparison of national supply chain performance.	*The World Banks Logistics Index is measuring the logistics performance of countries Worldwide. It is the only international study focusing on this sector but it does achieve to fully integrate all elements of a supply chain.*
Consider all four dimensions of the logistics performance.	*The World Bank Logistics Performance Index includes indicators for all dimensions, but the sustainability dimension is thin.*
Balanced use of data	*The World Competitiveness Index is close to being balanced with 43% soft data. Only two other studies (Holland International Distribution Council and The Regional Competitiveness Index of Croatia) include both types of data.*
Use of sector and country specific weights.	*None of the studies used applied weights based a consistent framework.*
Thorough presentation of robustness the results.	*None, a couple of studies state that the robustness was checked. The Economist provides a thorough discussion of drawbacks and disadvantages of existing aggregation methods.*

Based on the indicators used in the measurement it is possible to classify the approaches in three groups according to how transport is treated. Figure 5.6 illustrates the outcome of this analysis. It important to highlight, that some private sector supply chain studies are focus on intra-firm or intra-sector approach dimensions, so that some of the more traditional measures are excluded. These studies do – to some extent – ignore the physical dimension of infrastructure. This is with good reasons as these studies are aimed at firms and sectors in order to assist them in the benchmarking of their competitiveness. Firms and sectors cannot directly affect the physical dimensions of infrastructure, and this dimension is out of their control and therefore less relevant.

Figure 5.6 reveals a gap in the supply chain treatment from the public sector. The World Bank Logistics Index is relatively close, but as the name indicates, the transport system is evaluated from a logistics dimension.

Figure 5.6 Graphical representation of the gap



VI. Conclusion: The way forward

Overall objective: Measure the contribution of transport to national competitiveness

As the Round Table concluded, there is a need to audit the existing and, if necessary develop a common methodology for the measurement of the contribution of transport to national competitiveness. This audit report provides the next step by assessing the existing methods.

The role of transport has developed

The role of transport in modern supply chains was discussed in section 3. Four dimensions of transport were defined which have to be accounted for in order to obtain a full measurement of the quality of the transport performance. The first dimension considers physical attributes. Regarding the traditional role of transport it was sufficient to measure the quality of transport infrastructure by the length and quality. The second dimension was added during the development of logistics after 1950 considers operational characteristics, such as speed, costs and reliability. The third and fourth dimensions - sustainability and administrative characteristics, have to be added in order to adequately reflect the role of transport in modern supply chains. How each of these dimensions are weighted and aggregated will depend on the country specific characteristics. For instance, land-locked and mountainous countries have very different demands compared to, for example, island states.

The existing approaches

This audit report has summarized existing methods of benchmarking the quality of transport sector. Insights from a sample of 144 empirical scientific studies dealing

with the causal relationship between transport infrastructure and economic development were also included. Six major gaps in the existing approaches were identified. Thus, any future methodology should incorporate all four dimensions of transport, include both quantitative and qualitative data, and provide robust checks of the applied methodology.

National action plans for the logistics markets

Need for national initiatives

A number of countries has already embarked upon establishing long-term master plans and started to formulate strategic action plans concerning the development of their national logistics markets. A growing number of national administrations have realized the importance of logistics and supply chain markets for enhanced competitiveness of their national economies and their potential contribution to economic development. Thus, the objective to develop common methodology and tool for evaluating transport sector's role in supply chains and the challenges they pose is very relevant and timely.

Example: Germany's Master Plan for Freight Transport and Logistics

In order to preserve the functionality and the efficiency of the overall transport system, the German Government has developed a plan with the objective to ensure that the different functions for freight transport, logistics hubs and gateways, transit, supply, distribution and servicing are all carried out in an integrated manner for economic, social and ecological sustainability. For this purpose investment policy, regulatory and innovation policy instruments are incorporated. Integrated transport policies, in turn, should bring about an overall enhanced efficiency through the optimization of transport infrastructure and better linking of all transport modes, well trained staff, the use of innovative logistics strategies and new technologies, more efficient and resource–conserving process organization of the transport chain and, unlocking capacity reserves in the shipping and rail sectors.

The core objectives of the German Master Plan are: the "Road map" to enhance the competitiveness of the logistics industry and logistics locations in Germany; the plan of action for the optimum design, funding and use of the freight transport system; the contribution to economic and structural change and sustainable development; as well as greater public perception of the economic significance of freight transport and logistics. Main target groups are shippers, carriers, logistic companies, associations, authorities as well as final consumers. The methodology selected for the Master Plan was developed by the Federal Ministry of Transport which coordinated a "structured dialogue" between network management experts. This dialogue, carried over a series of workshops resulted in 27 proposals which range from infrastructure measures (widening of federal highways; nationwide, multi-scale coordinated strategy and planning for the development of infrastructure; and optimal linking of ports and their hinterland) to proposals regarding enforcement of social regulations relating to driving and rest times, efficient use of road infrastructure through better traffic management and traffic information data, etc.

The way forward: Develop a common methodology

Realizing that a growing number of national governments are becoming aware of the importance of transport on the performance of logistics and supply markets and their impact on competitiveness, it seems timely to develop a common methodology that will assist countries in measuring and benchmarking performance of their transport services and their contribution to national competitiveness. The benefits to member Governments of such a multi-criteria assessment methodology could be manifold. Above all, policy makers need to have at their disposal an effective and consistent methodology for the optimal assessment of the transportation market. Governments, other stakeholders and users will benefit from the application of such a methodology in several ways. Common concepts and consistent use of standardized indicators and parameters would produce information and critical elements for analytical work as well as necessary tools to facilitate the evaluation and international comparisons of

the transport sector's role in supply chains, and the challenges which their development impose on transport markets.

The use of tools based on a logically based structure will help the assessment of supply chain challenges for transport and provide the opportunity to better understand transport's role in global supply chains; more accurately assess its contribution to countries' competitiveness; contribute to development of an integrated strategy for a country supply chain market; provide tools for obtaining information and measuring the level of integration of different transport modes; create additional value-added by using results for further analysis and assessment of a country's capacity as logistics or transit hub; and benchmark performance of a particular country against other countries based on objective and identical parameters. It will further be possible to use such a methodology to assess the degree of technology penetration in transport networks and supply chain markets, and, for example, assess the capacity of different supply chains sub-markets.

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[i] NUTS is an abbreviation for *nomenclature d'unités territoriales statistiques*/ Nomenclature of Territorial Units for Statistics. As a guideline, a NUTS 1 level covers a population area between 3 and 7 million. A NUTS 2 level covers a population area between 800 000 and 3 million.