



# Logistics Development Strategies and Performance Measurement



Roundtable Report

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Roundtable Report



## **The International Transport Forum**

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International Transport Forum  
2, rue André Pascal  
F-75775 Paris Cedex 16  
[contact@itf-oecd.org](mailto:contact@itf-oecd.org)  
[www.itf-oecd.org](http://www.itf-oecd.org)

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## Executive summary

### Objectives

Logistics performance is a strong determinant of national income and is the result of actions from a wide array of private and public actors. Understanding and decomposing the components of logistics performance is fundamental to improving the efficiency of transport systems and the quality of regulation of trade and transport. The roundtable meeting was convened to improve understanding of logistics performance and logistics measurement and exchange experience in developing indicators and comparable methods of assessment internationally.

The roundtable was hosted at the Mexican Institute of Transportation and focused on discussion of four input papers. The first examined the potential for applying performance measurement in the design and implementation of public policy, identifying appropriate metrics and the potential for misuse of key performance indicators. The remaining papers and presentations examined practical application of indicators from different perspectives. Paper two outlined the use of the Logistics Performance Index (LPI) developed for the World Bank in driving improvement in trade logistics with a case study of Turkey. Paper three reviewed the use of supply chain performance measurement in Latin America. Paper four set out a performance measurement methodology for intermodal corridors. Participants also contributed presentations on port performance, on relating public investment in transport infrastructure to logistics performance and on the development of a national observatory for freight transport and logistics in Mexico.

### Findings

Policy makers are interested in logistics performance indicators primarily because of the potential for improved transport services to promote economic development. Strategies for development of the logistics sector have been adopted in many countries, especially where trade accounts for a major part of economic activity, however causality from intervention to outcome can be difficult to demonstrate. Performance indicators can play a key role in guiding policy, quantifying objectives and measuring progress. The fluidity indicators developed to support Canada's Gateways Initiative are one example. Performance indicators are also effective in drawing political attention to the importance of a sometimes invisible sector. The Inter-American Development Bank's programs to develop logistics performance indicators for Latin American countries have had a significant impact.

Key performance indicators are open to misunderstanding and misuse in this sector as much as any other. The most prominent of indicators, the World Bank's LPI, is so successful that Ministers regularly cite results in public addresses, at least when they provide a favourable result. The roundtable examined how careful use of the index can drive improvement. But the results can also be used to draw spurious conclusions by those less familiar with the methodology employed. This happens most often in relation to modal split and the performance of rail transport. The LPI is simply not designed to measure anything but aggregate results across all modes. Similarly, the highly effective indicators developed for Canadian Gateways are not sufficiently disaggregated to provide information, for example, to guide the choice of

shippers between port terminal operators. Different policy objectives require different indicators and transport and logistics businesses are likely to require more disaggregated data than government.

Data quality and availability problems often make ideal indicators difficult to produce. Nevertheless, headline aggregate indicators such as the World Bank's LPI can be used to great effect. This was illustrated at the roundtable by a case study of Turkey where, combined with information on the organisation and reform of local services, the LPI is being used to drive improvement of customs services to meet ambitious national objectives for increasing trade.

The discussions at the Roundtable were directed at informing any public sector organisation considering the development or improvement of their logistics performance indicators. Several recommendations flow from the discussion and are summarised below. Discussions also addressed issues particularly relevant to the establishment of a dedicated logistics observatory in Mexico. The conclusions on that point are summarised in more detail in the report *Logistics Strategy and Performance Management: Mexico's National Observatory for Transport and Logistics, ITF 2015* [http://www.internationaltransportforum.org/Pub/pdf/15CSPA\\_MexicoLogistics.pdf](http://www.internationaltransportforum.org/Pub/pdf/15CSPA_MexicoLogistics.pdf).

## **Recommendations**

### ***Select performance indicators carefully according to purpose and control for exogenous constraints***

Indicators of transport intensity are better used for comparing performance over time for the same entity than for comparing performance between countries unless carefully controlled for differences relating to geography, overall level of economic development and the composition of trade. Composition should be considered in terms of both industry shares and the transport modes using a given piece of infrastructure or deployed within a nation. Supply chains differ greatly across sectors with their particular operation typically determining the efficiency aspects of most interest. Reliability is crucial, for example, in the shipping of automotive parts whilst bulk commodity shippers are more interested in unit costs.

### ***Identify causality by using sufficiently granular data when relating investment to growth***

Potential issues of causality also need to be addressed in the assessment of transport policies and investments. Whilst investment in transport infrastructure and better logistics fosters economic development, development also tends to drive improved logistics practices. Measuring performance at a sufficient level of detail to be able to relate changes to specific interventions is the way to overcome this potential defect of high level performance indicators.

### ***Support key performance indicators with text outlining key industry trends and characteristics to minimise the risks of being misrepresentation***

When indicators are used to benchmark performance internationally and especially when a sector has undergone significant restructuring a narrative text should accompany key performance indicators relating change in the indicators to changes in the organisation of the industry and changes in the economic environment in which the industry operates. Explanations for change should be proffered; short term disruptions need to be identified and separated from longer term trends in performance.

### ***Use indicators of modal split with particular care***

Only where markets are actually contestable by alternative modes can split reflect efficiency and competitiveness. Contestability may be precluded by simple absence of infrastructure (rail lines for example), prohibitive distance from terminals and loading facilities or by the type of commodity to be

carried. A low overall modal share for rail for example may have little or nothing to do with the efficiency of rail services or with the success or failure of government policies; and a high rail share may reflect a large amount of heavy bulk freight in the overall commodity mix or very long distances between markets rather than particularly efficient performance.

***Measure the performance of customs and inspections services as these are critical to trade-driven growth***

The importance of improving customs services is reflected in the Bali Ministerial Declaration on trade facilitation and there is a strong statistical relationship between improved customs procedures and reduced logistics costs. All customs authorities should monitor performance continuously, in terms of delay in the release of goods, and publish the results regularly. Inspection services at borders – customs, phytosanitary, veterinary, narcotics, and security – should be coordinated as far as possible to optimise the location and timing of inspections. Identifying exactly where delays arise is important and indicators monitoring performance have to be disaggregated to pinpoint friction points.

***New observatories should carefully focus resources on their intended audiences***

A new observatory should first clearly define its intended audience as well as its scope and limitations. Data collection and indicator scopes should be tightly focused in the initial phase so that processes and credibility can be established. As initial objectives are achieved, the mission should be expanded to encompass a broader range of indicators and analysis.

***Private sector involvement in developing indicators should be sought***

Gaining access to private sector data is generally a pre-requisite for developing performance indicators. The private sector's insights are also crucial for to ensure the developed indicators are relevant and appropriate. Participation needs to be broadly based to ensure the nuance across sub-sectors and supply chains is adequately reflected in the raw data and the indicators developed. Care must be taken to ensure that individual companies (or infrastructure) cannot be identified in the published information.

***Public sector involvement should be broadly based***

Relevant data and knowledge is likely to reside in parts of government that do not directly deal with the transport sector. Such agencies should be engaged early in the development of indicators to simplify data collection and to ensure this cross sector knowledge is incorporated early.



## Chapter 1. Summary of discussions

Stephen Perkins, International Transport Forum, Paris

This chapter provides a summary of the Roundtable discussion on *Logistics development strategies and performance management*. It examines how careful use of indicators can drive improvement in performance, making recommendations for public sector organisations developing logistics performance indicators. This includes case study material on the establishment of dedicated logistics observatories in Mexico and Chile.

## Logistics Strategy and Performance Measurement

### Introduction

Logistics performance is a strong determinant of national income. Understanding and decomposing the components of logistics performance is fundamental to improving the efficiency of logistics systems and prioritising investments in transport infrastructure. Policy makers concerned with national logistics strategy need a basis for comparing national performance across time and against international peers. Such information would include the main drivers of logistics performance, indicators of the cost, and quality of logistics service, as well as indicators to measure the impact of regulatory and fiscal change in the sector on economic performance and industrial development.

A sound and comprehensive set of national performance indicators is therefore an important underpinning for high level policy dialogue on the development of the transport and logistics sector. Whilst governments have developed strategies for the logistics sector in many countries, the data available for measuring performance is often far from perfect and some of the indicators developed can be misleading if used without essential contextual narrative. The Roundtable meeting was convened to improve understanding of logistics performance and logistics measurement, and to exchange experience in developing indicators and comparable methods of assessment internationally.

The Roundtable focused on discussion of four input papers and three additional presentations over a two-day conference held at the Mexican Institute of Transportation (IMT) in Queretaro, Mexico on 9th and 10th March, 2015. This summary provides a brief overview of the paper topics and a summary of the discussions, highlighting the key points debated. The four papers presented were as follows:

- *Performance Measurement in Transport: Its Contribution to the Design of Public Policy*; Alan McKinnon, Kuhne Logistics University, Germany;
- *Logistics Performance Index and Drivers of Logistics Performance*; Lauri Ojala, Turku School of Economics, Finland and Dilay Celebi, Istanbul Technical University, Turkey;
- *Supply Chain Performance Measurement in Latin America*, Gaston Cedillo University of Nuevo Leon, Mexico; and
- *Performance Measurement for Intermodal Corridors: A Methodological Approach*, Carlos Martner, IMT.

The three additional presentations were:

- *National Performance Indicator Observatory on Freight Transport and Logistics*, José San Martín Romero, Director General, IMT;
- *Port Performance Thoughts to Share*, Mary R. Brooks, Dalhousie University, Halifax, Canada; and
- *Measuring Public Investment in Transport Infrastructure and Logistics Indicators for Efficient Investment*, Sissi De La Peña, Sissi De La Peña Mendoza, Office of the President of the Government of Mexico.

All of the papers and presentations are available on the ITF website.<sup>1</sup>

## Performance measurement for freight transport and its use in the design of public policy

The paper prepared for the Roundtable by Alan McKinnon provides an overview of the main types of freight performance metrics, or key performance indicators (KPIs), relevant to freight transport policy interventions. It reviews the availability of freight and logistics data and describes a typology for the main areas of performance measurement with examples of indicators covering intensity of transport and logistics usage (freight intensity), modal choice and diversity, operational efficiency, service quality, environmental and safety impacts and economic development.

The report summarises problems and constraints for compiling freight performance statistics – principally a lack of existing data. In light of this, the report proposes practical KPIs based on data that is likely to be more readily available. Nevertheless, a range of issues arise in the interpretation of KPIs, even where they are developed from high quality data:

- the use of various utilisation indicators in assessing performance;
- the relation between transport intensity and economic development;
- appropriate use of indicators of modal split and factors that may influence modal split that are not related to performance;
- ways that the same KPIs may need to be interpreted for different market segments; and
- the relationships between indicators of safety from a public policy versus private operators' perspectives.

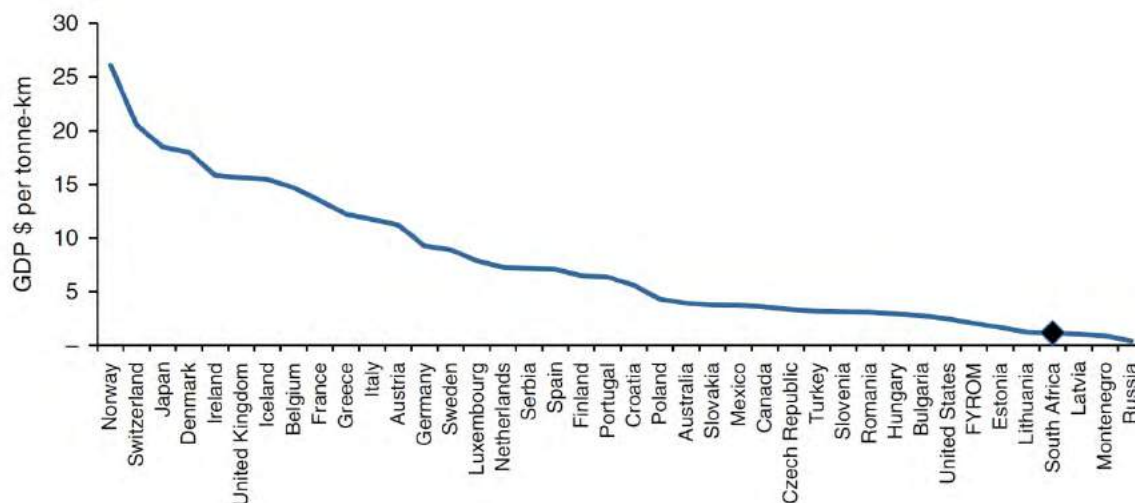
### *Utilisation and intensity indicators*

When using mass or volumetric indicators to infer information about productivity or utilisation it is essential to first understand the mix of commodities being transported, especially in comparing different regions or countries. The composition can change over time, as a country transitions from a predominantly agricultural and extractive (bulk) to a more manufacturing oriented industrial base. Even in specific trade lanes, the mix of commodities can affect the measurements of volume, density and tonnages moved.

There was much discussion at the Roundtable on transport intensity and the value or otherwise of using this metric to compare countries or benchmark performance. Transport intensity (or freight transport intensity) provides an indicator of how much freight activity “contributes” to the overall economy (or, alternatively, how much is required to achieve a given level of output). It is typically measured in terms of freight transported per unit of economic output (GDP) or, inversely, GDP per tonne-kilometre transported (Figure 1.1). But the interpretation of these indicators is highly dependent on the type of economy and the geographical characteristics of the country. Issues also arise for the use of such indicators to describe larger or more economically or geographically diverse countries with more specialised regional economies. Topographic conditions and transport network density can also influence this measure when comparing different regions of the same country. So, unless controlled for these factors, comparisons of transport intensity are better indicators of performance over time for the same entity than for the comparative analysis illustrated in comparing performance between countries (Figure 1.1), where differences relate to geography, sectoral mix and overall economic development more than efficiency or other factors specific to freight transport.



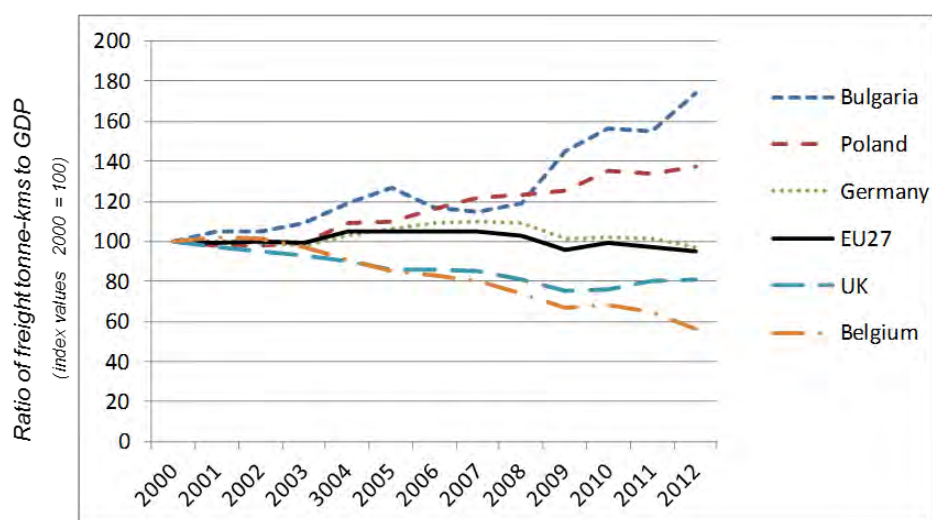
Figure 1.1. Freight transport intensity



Source: Havenga and Simpson, 2014

Transport intensity can change over time. There has been a “de-coupling” of freight transport intensity from GDP in many developed countries as they move to a more service-based economic structure and to production of higher value-to-volume ratios of manufactured goods (Figure 1.2 (which inverts the scale from Figure 1.1)). But intensity can rise as well as fall, such as in the Eastern European countries where, following steep declines with restructuring in the 1990s, there has been an increase in freight transport intensity since 2000. There may be a number of structural factors influencing aggregate indicators based on GDP, with factors affecting trade that extend beyond the realm of logistics. Regional trade integration for example has been an important factor as the European Union deepens and expands its single market. At the same time the efficiency of customs procedures and logistics costs can be contributing factors.

Figure 1.2. Trends in European freight transport intensity



Source: McKinnon, 2015

### ***Mode split and market diversity***

A particular caution was given over the use of indicators of mode split, used most frequently for tracking policy for diverting transport from one mode to another. Modal split indicators need to be interpreted carefully. Among the most relevant issues is the “contestability” of traffic in a trade corridor. For example, moving cargoes from highway to rail modes may depend on a number of factors not necessarily included in high-level mode split measurements. First is the availability of competitive modes; in many cases, rail service may not be accessible (sidings, terminals, etc.) or available (rail lines may not be near enough to provide services even if investments in terminals and loading facilities could be made). Second, mode split and choice needs to be carefully assessed based on the commodities involved and the markets served. Finally, the economics of transport, which can be markedly different when evaluating bulk, manufactured or containerised shipments may significantly favour one mode over another.

These factors imply that understanding the markets and trade lane characteristics of a commodity as well as the requirements and economics of shippers is important when assessing changes in mode shares measured in aggregate over time for a particular country, or when comparing national-level modal shares. Factors such as shipper preferences, density of production/consumption nodes, and practices in each economic sector can influence both the aggregate split of modes and the speed with which transition between modes may take place. In some countries, policy makers are not focused so much on measuring mode split as how infrastructure investments influence the costs of providing services by mode and the relative returns on public investment. This should be the ultimate focus.

### ***Environment and safety indicators***

Environment and safety are key policy areas where aggregate indicators are often required by policy makers and private companies alike. There are indicators of safety and environmental performance that are relevant only to private companies, such as equipment condition, fuel usage and operating costs (directly and indirectly influenced by emissions requirements), and indicators of safety tied to regulatory as well as operating cost factors (e.g., inspections and certifications for equipment and drivers).

Voluntary as well as mandated reporting of information from private companies can be important to policy making, especially in areas where operationally-based information is needed. Incentives for reporting this kind of information can be created by providing industry with access to public data, suitably aggregated to mask commercially sensitive information. This applies to performance benchmarks for a sector in relation for example to “green certification”. Providing information that allows companies to assess their competitive performance can be helpful in fostering compliance and in collecting information voluntarily that might otherwise be difficult or expensive to obtain.<sup>2</sup>

### ***Logistics performance and economic development***

Policy makers are interested in logistics performance indicators primarily because of the potential for improved logistics performance to promote economic development. The Bali Ministerial Declaration on trade facilitation (Bali Package)<sup>3</sup>, for example, is supported by work that found a strong statistical relationship between improved customs procedures and reduced logistics costs. The importance of the performance of the customs and related inspection services, including coordination between the services to optimise the location and timing of inspections, was underlined at the roundtable.

At the same time, while improving logistics is good for development, development is also something that drives improved logistics practices and a more sophisticated, more specialised and diverse logistics sector delivering higher added value. In Mexico, it was noted that there are important

differences between the north and south of the country, not just in the demands put on the logistics system (agricultural products in the south, manufactured products in the north for example) but in the sophistication of the logistics industry. The quality of rail, road and logistics infrastructure is perhaps more relevant in delineating the effective boundary of influence of the integrated North American Free Trade Agreement (NAFTA) economic area than the southern border of Mexico, as noted by *The Economist* in an article in 2015<sup>4</sup>. The frontier takes an irregular path around parts of the northern and central states, the Valle de Mexico to the ports of Lazaro Cardenas in the west and Veracruz in the east.

Roundtable participants noted that developed countries typically have highly developed freight infrastructure, while developing countries may have less dense networks, older legacy systems or mismatched logistics services from the perspective of current industry logistics demands versus available freight transport infrastructure. To provide indicators that get the right kinds of information to policy makers there are important questions and design issues that need to be worked out so that indicators being reported do not produce distorted results. One example cited was the measurement of logistics costs as a percentage of GDP. For most developed countries, the goal is to assess infrastructure performance with the objective of reducing logistics expenditures as a percentage of GDP. However, in some countries where the objective is to focus on providing logistics services, like Dubai or Panama, the objective may be to see the percentage of GDP attributable to logistics services increase over time. There may be other indicators of logistics expenditure and trends that merit monitoring to assess the success of public policy.

Many companies evaluate logistics performance to assess where they should invest. A range of factors are usually considered, including productivity and quality of service. While measurements are made for this, these are usually more detailed than would be relevant for national policy indicators.

The resilience of logistics is increasingly important to businesses as production becomes more specialised and supply chains lengthen. Managing the risks associated with these more complicated supply chains involves balancing the potential costs of disruption against cost savings from scale and specialisation. Resilience can be improved at the cost of holding additional stocks and building duplication and redundancy into supply chains. Capturing these trade-offs in logistics indicators is not straightforward. Key risk management strategies include contingency planning and good lines of communication between suppliers along the chain, built on the trust and common language that comes with regular contact, so that responses to disruption are fast and appropriate. Leading industrial firms require suppliers to agree to resilience management strategies and these are subject to certification by ISO-type standards. The prevalence or otherwise of such agreements could be the basis for developing indicators of resilience in the logistics systems of specific industries (McKinnon, 2014).

Reducing delivery variability is an important aspect of logistics reliability. However, there are many factors that influence this over and above the condition of infrastructure and administrative practices. These include such privately controlled factors as inventory management practices, equipment utilisation and private investments in logistics planning and capital. Customs practices and procedures at the border are important, but there are multiple agencies responsible for various clearances, processing and related certifications needed to expedite border crossing clearance. This includes the capacity and expertise to prepare customs documentation by private shippers and service providers as well as the ability to process documentation they provide by governmental agencies. Indicators might be developed to monitor performance in many of these detailed areas; which such indicators will be of most use to driving improvement will depend on the country and sector under investigation.

Changing trends in globalisation may require reinterpretation of traditional performance indicators and benchmarks. After decades of increasing globalisation of supply chains, trends in production in a

growing number of industry sectors are changing. There is more regionalisation as the costs and complexities of global logistics have begun to overwhelm the efficiencies of global supply chains. Mexico has benefitted from the inward investment that has accompanied the ‘nearshoring’ trend among US businesses. New indicators may be required to capture the effect accurately and understand the key factors over and above labour costs in preventing any reversal.

### **The World Bank’s Logistics Performance Index and drivers of logistics performance**

The World Bank’s Logistics Performance Index (LPI) is widely used to highlight the efficiency of the national logistics industry in relation to other countries. The annual rankings receive widespread press coverage and are often cited by Ministers and other policy makers. Despite some limitations to robustness of the results given the methodology employed and discussed below, the index has proved very useful in drawing the attention of policy makers to this important but sometimes invisible sector.

#### ***Approach***

The LPI is based on surveys of port operators, shippers and freight forwarders, producing a composite index reflecting responses to the questionnaire. Because of the nature of those surveyed, the LPI is oriented toward assessing the transport of manufactured goods rather than bulk commodities, and more applicable to higher-value goods. It measures perceptions rather than physical indicators of performance. The index covers six aspects of logistics performance:

- customs, efficiency of the customs clearance process;
- infrastructure, quality of trade and transport-related infrastructure;
- international shipments, ease of arranging competitively priced shipments;
- logistics quality, competence and quality of logistics services;
- tracking and tracing, ability to track and trace consignments;
- timeliness, frequency with which shipments reach the consignee within the scheduled or expected time.

#### ***Strengths and limitations***

The index uses ratings from interviewees outside of the country for which the LPI is calculated to avoid bias from users who might try to portray their countries services in a more favourable light. Modal bias could, however, arise from a highly skewed set of mainly road users answering questionnaires, distorting the picture for other modes. Participants at the roundtable thought results for rail should only be based on surveys of rail users and it was noted that for this reason the World Bank deliberately does not develop mode-specific LPIs, unlike the World Economic Forum. Some participants felt that since the LPI is more of a perception-based index than an actual measurement of performance, it might be unwise to focus too much attention from policy makers on LPI results rather than more objective indicators of logistics system performance. For instance, the composition of outside country interviewees may change from wave to wave of the LPI, and for countries dealing with a limited number of forwarders these compositional changes could influence scores. Some participants wondered whether it was possible that some “gaming” of the index might be occurring – especially for those countries where there are a limited number of out-of-country respondents.

Lauri Ojalla reported that his team had tested for the existence of bias among different groups of respondents. In Finland, the team mirrored the LPI survey and found that own-county respondents tended

to rate their countries lower than international respondents. The opposite happened in less developed countries, where forwarders tend to rate their countries higher in overall perception than the standard LPI. The team also found that there is a difference in how port operators, shippers and forwarders respond to questions in the LPI. They also found that many forwarders were inconsistent in the way they complied with requirements from one country to another.

Constructing a perception index can be challenging. In the case of Mexico, a similar approach to surveying was attempted. There were challenges finding the range of forwarders and agents needed to get a good cross-section of mode-specific information. In-country forwarders were primarily focused on air cargo, while forwarders in the US and Canada formed a broader cross-section of modal specialists. They also only found consignees and shipping line representatives to represent marine shipping in Mexico. Customs brokers typically only dealt with sea trade. The designers of the survey concluded that they needed to have more information about how responses differ based on the type of respondent. They also noted that the experiences of forwarders grew and broadened over time, so that more experienced and broadly focused service providers often had a better perspective on the quality of logistics services than those with a single focus or who were less experienced.

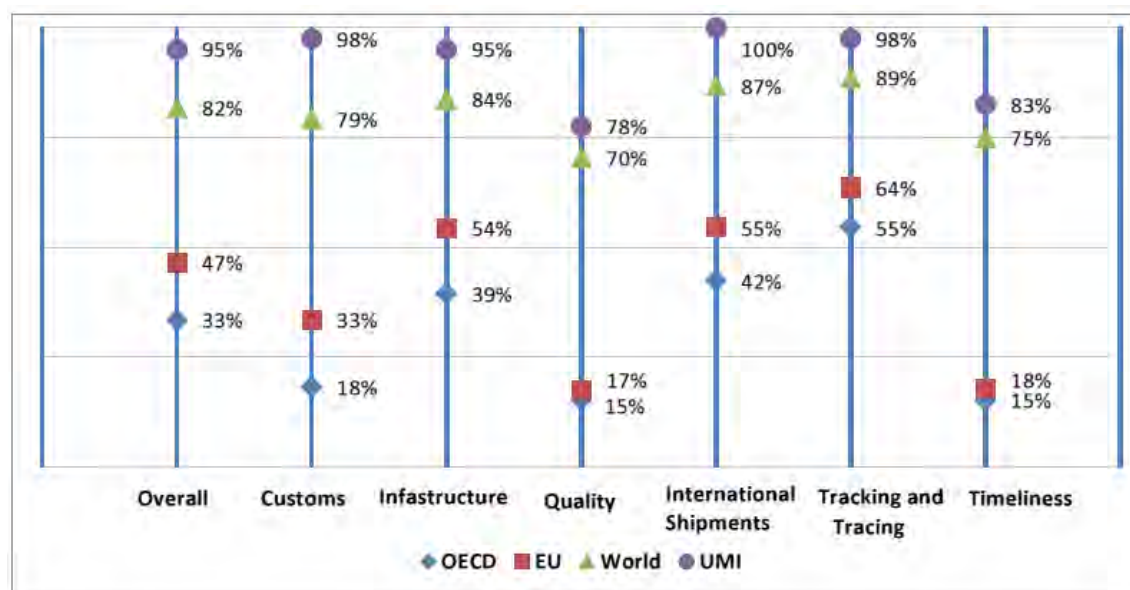
The robustness of the survey can be checked with statistical methods, but the statistics have to be viewed with caution. For instance, many of the former Soviet republics trade quite easily with each other but outside countries find trading difficult. This trading bloc effect can potentially bias results if not controlled for. There may be other competitiveness issues that can influence or bias results. All of this should be considered when interpreting the LPI and because the index is based on perceptions, and the elasticities computed from LPIs need to be interpreted with particular caution. However, the LPI does represent a stand-alone survey that has many dimensions, and it does seem to correlate well with other types of indices as noted in the paper.

### ***Applying the LPI***

The objective of the paper prepared for the roundtable meeting was not so much to discuss the limitations of the index as to examine how the LPI can be used to assess the success of policy initiatives. This requires information on the operating environment for transport and logistics companies at the national level and a case study of Turkey was developed to show the potential.

A review of LPI rankings comparing Turkey to the average for approximately 41 other upper-middle income countries is summarised in Figure 1.3. Other comparisons to world-wide averages and OECD countries as well as Germany, which has one of the higher overall LPIs, showed that Turkey had a relatively high rating and compared favourably with other upper middle income countries.

Figure 1.3 Turkey's percentile LPI rankings compared to other country groups



Note: Upper-middle income (UMI) n=41; World n=160, OECD n=34, EU n=28.

Source: Arvis, et al. 2014

The relationship between LPI scores and GDP growth were examined referencing studies (Korinek and Sourdin, 2011) where the elasticities between LPI scores and GDP growth rates had been computed. It was noted that for a 10% increase in the overall LPI score, exports typically increase by 69% or more and imports increase by an average of 54%. By examining the scores of other upper middle income (UMI) countries, like Malaysia, it was estimated that by attaining equivalent scores, Turkey could boost imports by 14% and exports by 18%. Likewise, by reaching the average LPI score for high-income OECD countries imports and exports could increase by 31% and 40%, respectively. Based on relationships like these, Turkey's export expansion program is intended to triple exports. The government therefore intends to track LPI scores both to assess changes in global position and track progress in underlying factors that may influence such gains.

Year on year tracking of Turkey's overall LPI score and its six components provides important insights into Turkey's trade performance and the factors that have influenced the increase in its overall score. The three factors that influenced score improvements from 2010 to 2014 included improved customs clearance, improved infrastructure quality and tracking and tracing capabilities. Two indicators for which Turkey was not performing well included the ease of arranging international shipments and the timeliness of shipments reaching destinations (a measure of supply chain reliability). The presentation carefully decomposed several factors that heavily influenced these indicators and identified areas where these weaknesses could be further diagnosed.

Discussion focused on the need to carefully analyse factors that contribute to the indicators in the LPI, as suggested in the paper. Using the LPI as a starting point, it is important to "drill down" into factors that contribute to a particular score. This may be an entirely different set of factors for one country compared to another. This applies to elements as diverse as the composition of the trucking fleet and the type of pre-clearance information available. It might be useful to develop country-specific LPI type surveys or surveys specific to the conditions under which trade is conducted. While the LPI may be

a reasonable tool for overall comparisons it may not always be the best option, or at least sufficient, for use in informing policy makers.

### Case study: Mexico's cross-border and domestic freight

Much of the discussion of Mexico's logistics sector has focused on international trade. However, Mexico needs to be concerned about domestic logistics requirements, too. Especially if GDP growth not tied to trade is to be encouraged. Transportation and trade in agricultural commodities from the South may require an entirely different set of indicators and sensitivities to metropolitan trade in Central Mexico.

#### *Automotive supply chain clusters*

In recent years, Mexico's industrial base has expanded and specialised in inputs to production that stretches across North America. At the same time, key economic clusters are emerging. Nearshoring and regionalisation of supply chains within North America has accelerated development of these clusters. Wage and production costs as well as logistics system reliability have been important factors. A supply chain cluster has three basic features: 1) physical proximity; 2) common processes, activities, products and services used in different supply chains by firms in the cluster; and 3) collaborative relations between providers. Figure 1.4 identifies the main logistics centres in Mexico. These support trade corridors and relationships throughout the NAFTA region, particularly in the automotive industry.

Figure 1.4. Logistics centres in Mexico



Source: Sistema Nacional de Plataformas Logísticas (SNPL), SCT, SE and IDB, [http://logisticsportal.iadb.org/sites/default/files/presentacion\\_sistema\\_nacional\\_de\\_plataformas\\_logisticas.pdf](http://logisticsportal.iadb.org/sites/default/files/presentacion_sistema_nacional_de_plataformas_logisticas.pdf)

Figure 1.5 shows trade corridors running from clusters in Mexico throughout the US and into Canada for the automotive industry. Within Mexico, there is a set of automotive clusters in northern Mexico, central Mexico and the Mexico City-Toluca-Puebla area. There are also electronics clusters in the centre of Mexico and on the Californian border and an emerging aerospace cluster in central Mexico.

Figure 1.5. **Automotive production and trade in the Detroit-Mexico corridor**



Source: Brookings analysis of Economic Development Research Group. Data: Moody's Analytics, INEGI, Statistics Canada.

The success of the automotive sector in Mexico and the assembly processes on which the industry is based relies on cross-border rail transport in bonded containers that reduces or eliminates stops for inspection at the border. This may not be a model that other industries will emulate; modal dependence is very industry-specific. For example, the Mexican Silicon Valley industries are almost 100% dependent in trucking whereas the automotive sector can carry as much as 60% of its stock on rail cars between manufacturing plants.

These observations underscore the need for performance indicators to be specified by sector. If not, differences across sectors can pose problems for interpreting performance indicators and their relevance for the economy.

However, metrics for the performance of intermodal supply chains in Mexico currently tend to be rather specific to the automotive sector. For instance, automotive manufacturers measure reliability in terms of hours whereas other industries with different inventory management and production requirements may be content to measure reliability in terms of days. This is especially true of bulk commodities shipped by rail.

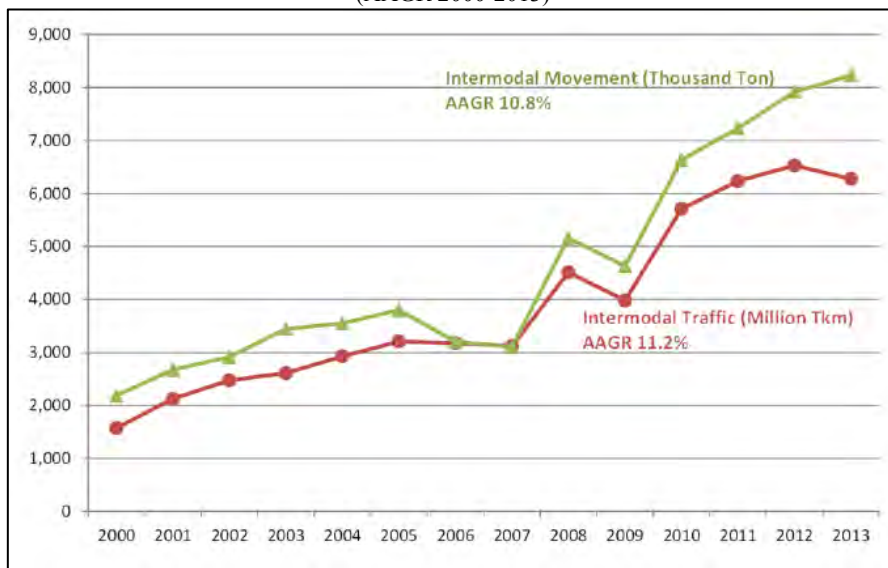
### ***Looking beyond the automotive sector: rail and intermodal***

There is a need for improved quality and quantity of performance indicators that cover rail and intermodal freight. The growth of intermodal container movements has been rapid in Mexico. Whether



measured by total tonnage or by tonne kilometres, average growth rates have exceeded 10% since 2000 (see Figure 1.6). This growth continued through the global economic downturn in 2008-09 and has accelerated since then. Intermodal moves from ports and across the US/Mexican border have been the primary source of the sustained growth in traffic, with growth in rail carriage of maritime containers exceeding growth in truck carriage of maritime containers (when measured in tonne-kilometres).

Figure 1.6. **Growth of rail-truck intermodal traffic in tonnes and tonne-km**  
(AAGR 2000-2013)



Source: IMT based on DGTFM-SCT data, Martner, 2015

The geographic distribution of rail intermodal moves in Mexico has been modelled by IMT (Figure 1.7), with the highest volumes from the two west coast ports of Manzanillo and Lazaro Cardenas inland to the Metropolitan Area of Mexico City and Central Mexico, and along the north-south corridor from Central Mexican to Monterrey/Salttillo and to the US border. The modelling also shows the emerging Veracruz to Mexico City market. These estimates are based on assignment models developed by IMT and identify three high-density corridors in the country.

Figure 1.7. Intermodal corridors in Mexico (tonnage)



Source: IMT based on DGTfM-SCT data, Martner, 2015

Although these first approximations of traffic flow and intermodal corridors are interesting and provide a good overview of logistics patterns, the data and information used to assess these flows is not consistent or collected regularly. Therefore, the work of the new National Observatory (see below) will be important in refining the data used in the models and also providing better, more frequent information on intermodal connections and intermodal system performance.

### Port performance and what to measure

In general, data for major port operations has been relatively easy to acquire as most ports monitor common aspects of their operations. Port operators have an incentive to provide relevant statistics, at least where they compete for cargo carriers and terminal service providers. Indicators commonly available for ports include anchorage and port dwell times, container throughput, and terminal performance by terminal type for vessel loading and unloading times.

### Canada's fluidity index

In Canada, the government has focused on providing a vision for trade gateways, developing indicators to highlight the performance of their ports and hinterland corridor intermodal services. This has resulted in development of a 'fluidity' index focused on port operation metrics such as vessel turnaround time, vessel turnaround time per container, number of vessel calls, vessel size distributions, cargo dwell time and port productivity indicators (Table 1.1). Indicators distinguish between types of

operations (e.g., bulk versus liner services) and the government is currently working with truck operators to use GPS data to identify bottlenecks at and leading to ports.

Table 1.1. Indicators of port efficiency chosen for Transport Canada's fluidity index

Intermodal indicators (containers)	Units
Truck turnaround time	Minutes
Vessel turnaround time	Hours
Vessel turnaround time per TEU	Seconds/ TEU
Average vessel call size	TEU
Berth utilisation	TEU/ m. of workable berth
Import container dwell time	Days
Dwell target - % under 72 hours	%
Vessel on-time performance	%
Gross port productivity	TEU/ hectare
Gross crane productivity	TEU/ gantry crane
Container throughput	TEU/month
Bulk indicators	Units
Vessel turnaround time	Hours
Average vessel call size	Tonnes
Berth occupancy rate	Percent
Gross berth productivity	Tonnes/ hour

Source: Transport Canada Transportation in Canada 2012 and Gateways and Trade Corridors Fluidity Index, May 2014

In Mexico, the IMT has begun gathering data of this kind, based on indicators developed for Barcelona and some other Spanish ports. The next step is to assess the performance of the ports through benchmarking. Manzanillo and Lazaro Cardenas are expected to agree to volumetric targets and to monitoring of indicators. They are looking at maximum and minimum performance ranges to use as a foundation for setting benchmarks. Among the issues to be addressed are security and damage to goods.

There is also an effort to assess each port's cross-border performance using similar metrics. IMT interviewed most of the larger port users in Tijuana and other northern border cities, and looked at logistic chains from the Far East to ports and dry ports. Development of these metrics also involved looking at indicators such as marine transit time; time for border crossing and more sophisticated indicators, like the variability of border crossing times compared to the average time. The idea is to understand the current range of operational parameters and use them to establish commitments by the ports to operate within these ranges and use these metrics as a basis for performance guarantees.

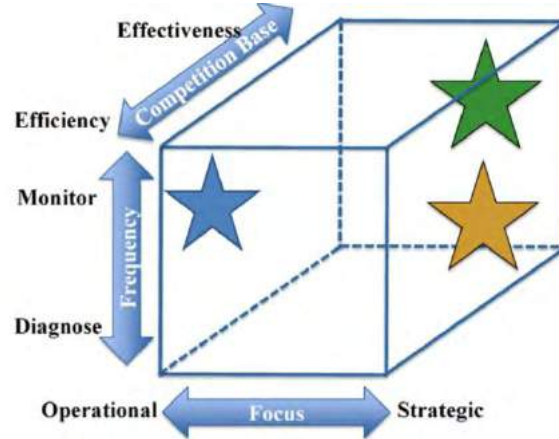
Usually when a volume commitment is given by a shipper or transport company to a port operator there are commitments to minimum levels of service in return. For example, Canadian National Railway (CN) has signed level of service (LOS) agreements with a number of Canadian ports guaranteeing a LOS delivery on the rail side to each port. This arrangement grew out of service problems that CN was having getting rail cars to the US Midwest markets in the early 2000s. Currently, CN has signed LOS agreements with four major Canadian container ports.

### *Perception indicators developed for the American Association of Port Authorities*

The fluidity index has been successfully employed to promote and improve transport through Canada’s gateway ports to industrial centres in the US, in competition with routes through US ports. However, the physical indicators of port performance are not the whole story and shippers make decisions on where to invest and which ports to use as much on perceptions of performance as the figures recorded in the Fluidity Index. This point was illustrated by Mary Brooks, outlining work on performance measurement completed in 2012 and 2014 for the American Association of Port Authorities (AAPA). This focused on qualitative, performance perception indicators.<sup>5</sup>

Figure 1.8 provides a framework for viewing indicators of performance. Organisations typically begin by diagnosing performance issues using very specific indicators and case studies and then switch to monitoring with less regular collection of data. The focus can be either operational or strategic. Both require information, but the information necessary to understand operations (e.g., indicators of port productivity) can be different than data needed to understand strategic position (e.g., market share).

Figure 1.8. **Measurement and dimensions of performance assessment and information needs**



Source: Griffis, S., T. Goldsby, M. Cooper and D. Closs (2007), “Aligning logistics performance measures to the information needs of the firm”, *Journal of Business and Logistics*, 28(2), pp 35-56, as adapted in Brooks, 2015.

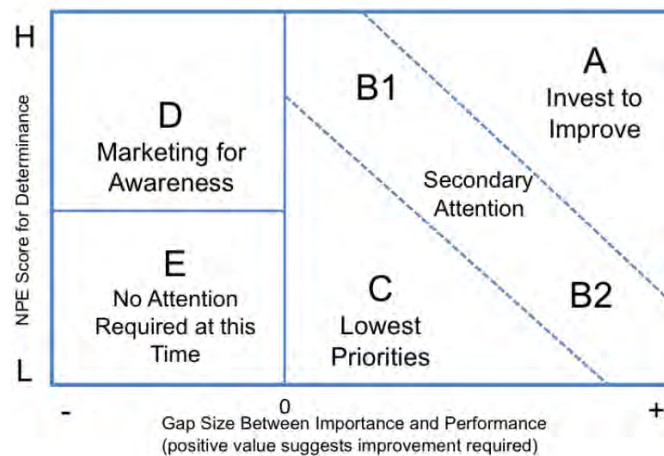
The “Competition Base” on the diagram is typically composed of both perceptual responses of system effectiveness and measured information about system efficiency. Effectiveness may include some of the measures reviewed above for the World Bank’s LPI, but should also look at the relationship between costs and the value of the LOS being purchased. The AAPA Port Customer Service Initiative examines effectiveness for service quality delivery, offering in 2012 a diagnosis of problems and in 2014 continuing monitoring for participating ports for strategic planning purposes.

There are eight possible combinations of focus, frequency and competition dimensions shown in Figure 1.8. A governmental agency charged with monitoring performance and responding with investments in infrastructure that addresses operational issues may look at performance measurement comprised of indicators associated with the location of the blue star in Figure 1.8 (front panel, upper left quadrant). A port service provider’s perspective may be more strategic. Consequently, they may want to focus more on effectiveness indicators (perceptual) and combine them with both monitoring data (high-level and less frequent) and diagnostic data (operational data collected daily or weekly). This corresponds to the green and yellow stars on the rear panel in the upper right and lower right, respectively. Understanding the information needs and objectives of the organisation and then carefully

examining the role that various indicators can play in achieving those objectives is the key to making good decisions about allocating resources to data collection and subsequent analysis.

Logistics service quality is measured by perception of effectiveness, as in the work for the World Bank's LPI. In this case, a more strategic approach was required and both diagnosis and monitoring were incorporated. The AAPA used a perception survey that asked about a number of elements of service – from gate access to perceptions of on-time service and terminal operator responsiveness. Performance gaps were computed based on these data and results were organised based on the framework shown in Figure 1.9. The framework implies the need to invest to improve performance in service-quality-critical areas where the port is perceived by users to be performing below expectations.

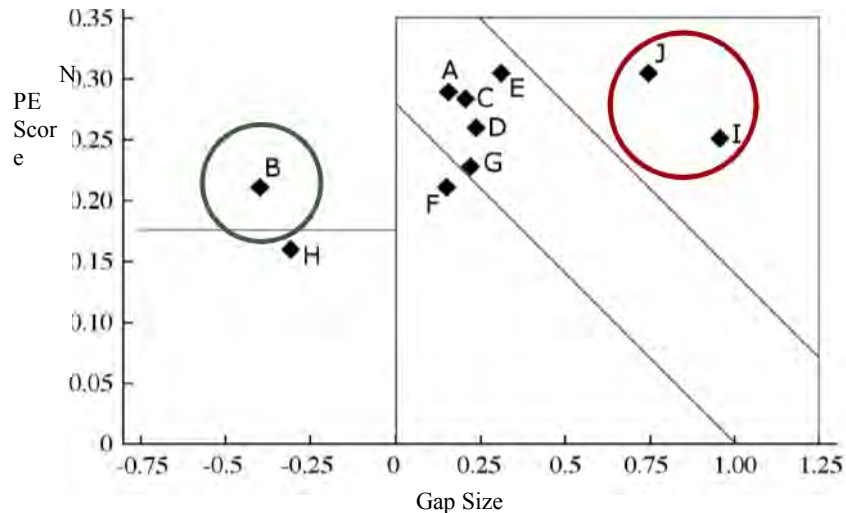
Figure 1.9. **Importance and Performance (IP) gap space model general structure**



Source: Brooks, 2015. Originally published as Schellinck, T. and M. Brooks (2014). Improving Port Effectiveness through Determinance/Performance Gap Analysis, *Maritime Policy and Management*, 41(4), pp.328-345

Results for all ports serving a port range could be aggregated to compare strategic positions based on geography. Individual ports could also be assessed and compared visually. An example of how this information can be used was provided for an anonymous port and is shown in Figure 1.10. The port in question had a positive IP gap score (indicating a need to address issues) for criteria J and I – provision of adequate on-time information and terminal operator responsiveness to special requests. This indicates that investments to improve performance in these areas needs to be considered as a possible strategic path forward. Using criterion B – the choice of available rail, truck or warehousing companies – the gap was negative indicating that marketing for awareness (from Figure 1.9) would be a good strategy for the port to follow in this area.

Figure 1.10. **Determinance of Importance and Performance (IP) gap for cargo interests – Port example**



Source: Brooks, 2015. Adapted from Brooks, M. and T. Schellinck (2013), “Measuring Port Effectiveness in User Service Delivery: What Really Determines Users’ Evaluations of Port Service Delivery?” *Research in Transportation Business & Management*, 8, 87-96

Developing these indicators was helpful to the ports and it sheds light on how public agencies might want to think about measuring and improving port performance. First, the requirements for service delivery at ports vary by port user. Some ports compete for different markets, and may not excel at providing services to all types of users. Second, industry sectors (e.g., retail versus manufacturers) perceived services differently, and forwarders can have very different perspectives than manufacturers and beneficial cargo owners. There are also differences between perceptions for different port ranges such as the US East Coast and US West Coast. By using the diagnostic structure described above, a number of unique conditions were identified for each port that resulted in various combinations of marketing, communications, information technology and infrastructure investments that might be needed. Several ports also used the information about their strengths to prepare new marketing materials.

A further complication is that the types of cargoes handled by a port will require a range of different indicators. Many bulk commodities are not time-sensitive and therefore time indicators may be less pressing as bulk shippers look for price breaks and streamlined service. At the other end of the service spectrum, aircraft parts, auto engines, and parts and equipment used in assembly are time-sensitive, so container dwell time, loading efficiency and other port efficiency indicators are important to logistics managers in these industries. Time is also important in terms of gate operations. Local drayage operators may look at the number of truck turns per day relative to gate time clearance. In these cases, they need to account for outside-the-gate congestion as well as factors inside the gate that contribute to delay. So, diagnostics and data are needed for each of these conditions if indicators are to be comprehensive.

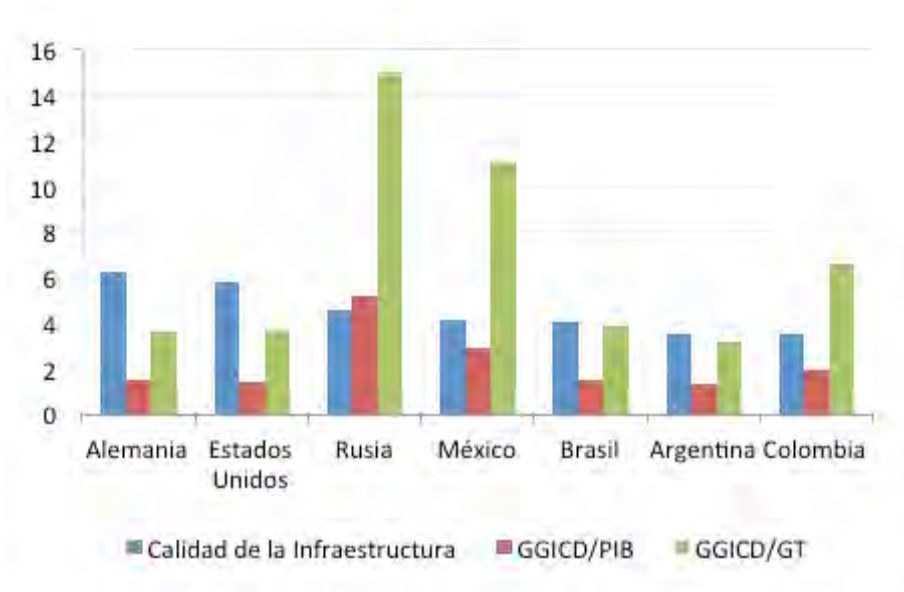
Concerns over disclosure of relative performance for particular ports, were addressed by AAPA only releasing aggregate information publically, and allowing ports to access their own information confidentially. Ports with relatively good scores or plans that address known shortcomings have tended to share results with partners and formed stakeholder committees to address issues raised in the diagnosis. Other ports have chosen not to participate in the program and have instituted their own performance initiatives so that they can address issues confidentially. A similar approach has been applied in the US by the EPA with its SmartWays program.<sup>6</sup> This program has been successful in gathering emissions and fuel efficiency throughout the supply chain. Private companies pool data and

results are made available to companies and shippers rating performance relative to emissions and fuel efficiency benchmarks.

### Indicators for efficient investment

Sissi De la Peña addressed the question of how to assess potential gaps in infrastructure investments for freight transport and ways in which the efficiency of infrastructure investment might be best measured and assessed. Most of the investments in public infrastructure in Mexico have been made by the public sector to date but more banks are now expressing interest in participating in financing freight infrastructure investments. In theory, investments increase productivity, which helps raise output and GDP. As shown in Figure 1.11, total infrastructure spending in Mexico is quite high relative to total public spending and relative to GDP.

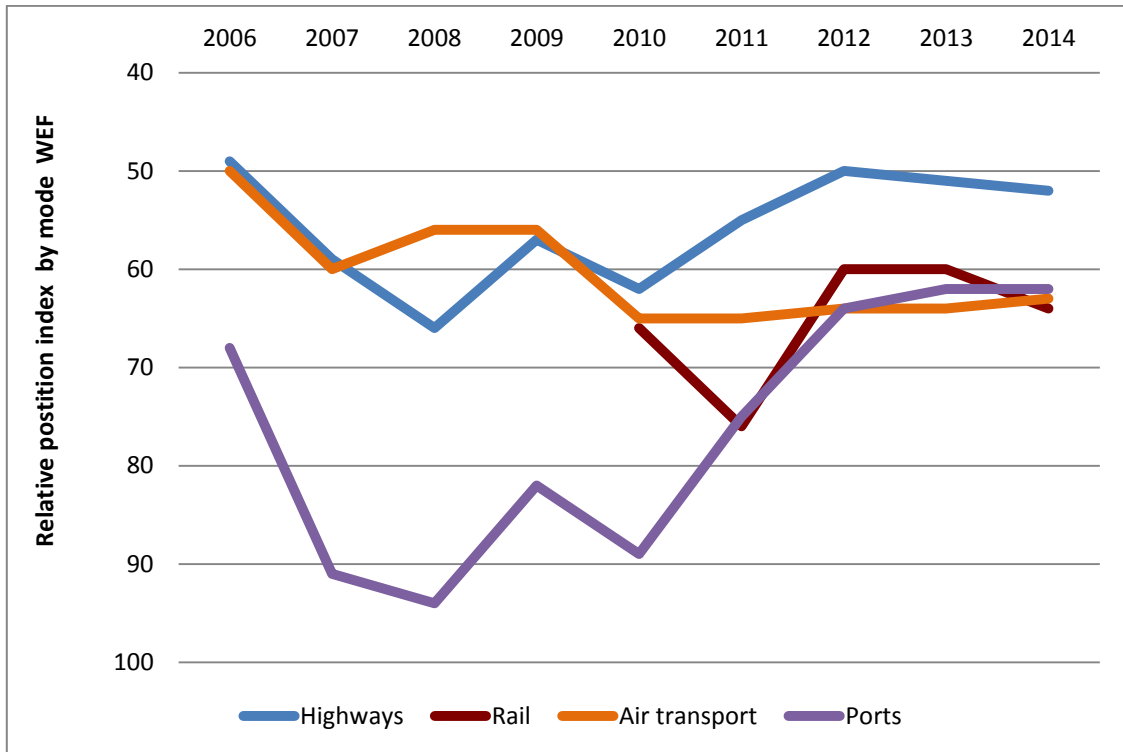
Figure 1.11. Comparison of perceived infrastructure quality (“Calidad”), spending (“GGICD”) relative to GDP (PIB) and total public spending (GT)



Source: de la Peña, 2015

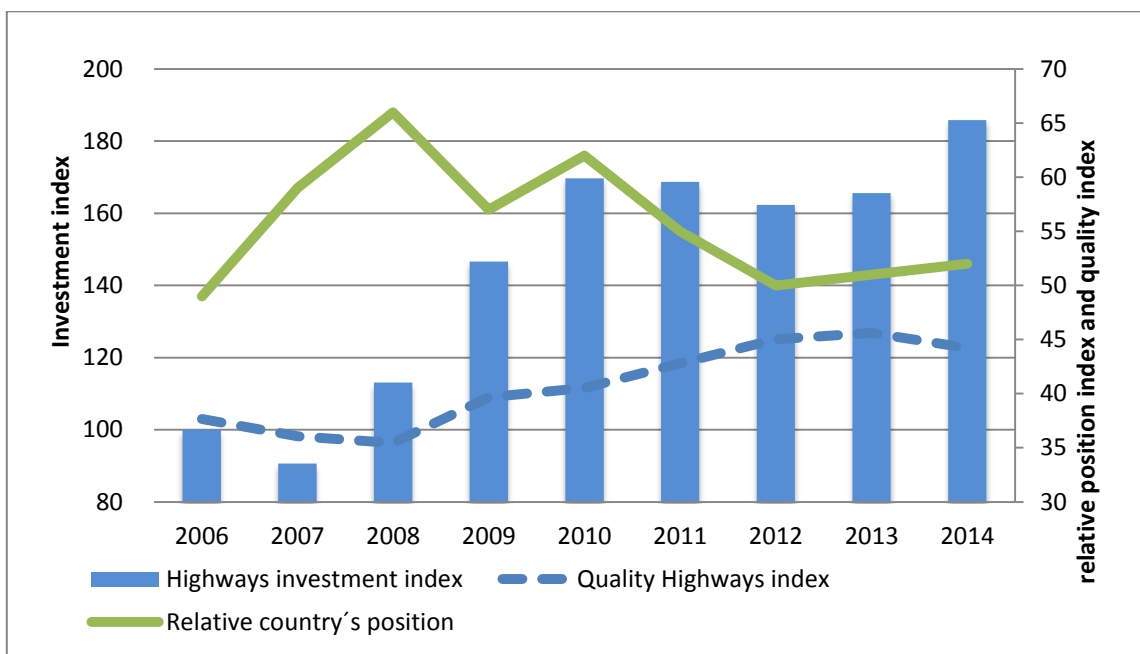
The quality (based on perceptual indices) of Mexican infrastructure is high relative to other Latin American Countries but lower than in developed countries; and comparable to Brazil. Mexican performance has declined slightly relative to past assessments. Tracking quality of infrastructure by mode using World Economic Forum perception indicators from 2006 to 2014, most modes have remained at or near their 2006 levels with the exception of Mexican ports, which have decreased slightly after a robust performance compared to other countries in the 2007 to 2010 period. These patterns are shown in Figure 1.12 (note the inverted quality index). Levels of investment have been increasing steadily over this period of time for roads (Figure 1.13) and ports (Figure 1.14), but user perceptions of quality have not responded in response.

Figure 1.12. WEF comparison of the perception of Mexican infrastructure quality relative to world benchmark by mode



Source: WEF in De la Pena, 2015

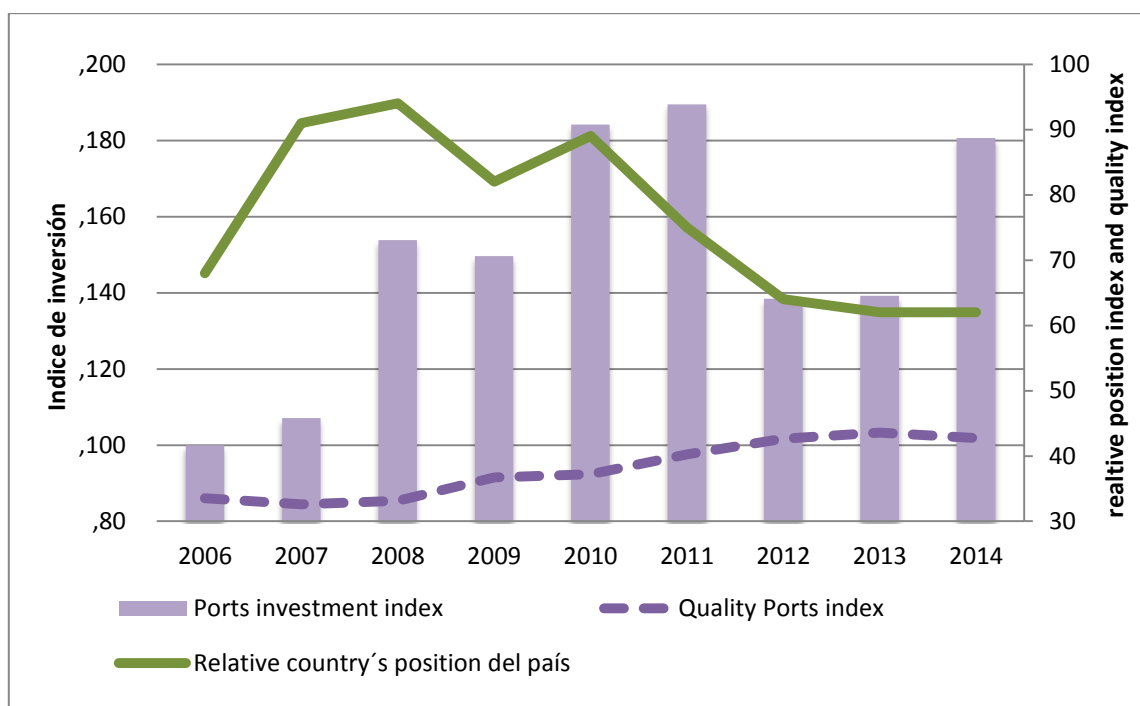
Figure 1.13. Investment index, relative quality and relative ranking for highways in Mexico



Source: de la Pena, 2015



Figure 1.14. Investment index, relative quality and relative ranking for ports in Mexico



Source: de la Pena, 2015

The concern is that as perceptions of quality have been stable while investments have gone up substantially, performance relative to other countries and returns on investment may be declining. This brings up several issues. First, are we able to accurately assess Mexican logistics performance and evaluate the efficiency of investments made in it? Second, do we need to include indicators of investment in the data analysed by the observatory in order to support the appraisal process of the Ministry of Finance? Third, could public infrastructure pay for itself if developed and managed correctly?

Investments in infrastructure are expected to increase GDP, employment and tax revenues – typically through reducing logistics costs. Savings are either retained as profits or passed on to customers or other businesses. These pass-through savings are different for each industry sector and can be affected by changes in market access conditions. Productivity improvements depend on the degree to which cost savings are reinvested in business processes and expanding the markets and product lines of companies that realise these savings. This implies that there are important linkages between assessment of investments for improved logistics and the data produced by other agencies, such as the National Institute of Statistics and Geography (INEGI) and industry cost indicators collected through the tax filing process.

The issue of effectiveness of infrastructure investments is of concern to many Latin American countries. Last year a survey of 100 experts in Latin America asked how it might be possible to accomplish more with less funding given it appeared that there were little measurable gains from previous investments. However, as noted in earlier discussion of the LPI, perceptions may not be consistent with reality. For instance, in some regions respondents said that connectivity had improved although no major infrastructure investment had been made. There was clearly no common understanding of connectivity and vague notions of what it meant in place of quantifiable indicators.

Despite these limitations, results were instructive, with five main findings:

1. In general Latin America countries (particularly Mexico) were not setting priorities through a coordinated and organised process;
2. Development projects were not prepared very well for delivery – project costs at completion were a lot more than planned because effective implementation planning was not being done;
3. Execution of publically funded projects was perceived as much less effective than privately funded projects. Projects using some combination of public and private funding with private oversight should be explored in more cases;
4. There has been a weakening of public organisations to manage public investments and attract investors; and
5. Corruption is an element that damages the effectiveness of the investment process and needs to be addressed more seriously.<sup>7</sup>

Roundtable participants noted two other factors that need to be assessed. Public infrastructure is quality is not the whole story, there needs to be complementary investments in private assets that are used by businesses operating services in the supply chain infrastructure. There may also need to be softer investments in process design or operations to effectively utilise new or improved infrastructure and maximise the potential for increased efficiency.<sup>8</sup>

The level of investment can nevertheless have value as a leading indicator of (potential) economic performance. It takes time to see results of infrastructure investment filter through an economy. In the case of ports, large sums of money must be raised and construction phased over time. With these investment lags and the “lumpiness” of capacity additions to infrastructure, there may be a substantial delay between the time that public investments are made and the organisational responses needed to take advantage of new efficiencies. This is reflected in research that found that perception indicators correlate better with hard measures of performance after a year for roadways and for ports after three years. This makes sense since most users have access to highways right away after they are built, but port investments are not so readily accessed and require complementary investments. Relationships develop over time and a three-year lag seems reasonable. Air infrastructure also seems to show a three-year lag.

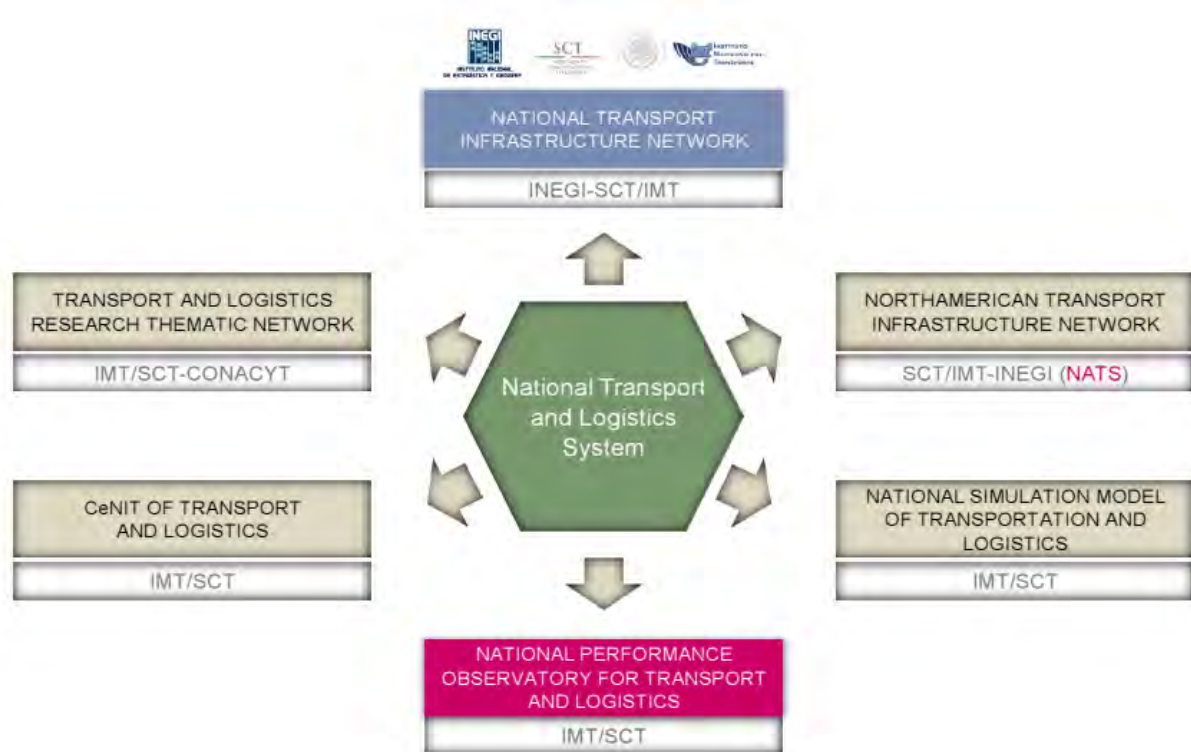
In many situations public investments in inland ports and terminals also require concurrent private investments in new equipment and in developing new markets to grow businesses. Having some idea of whether these kinds of private investments are being made and the time frame for completing them and integrating them into the supply chain operations helps to get a better understanding as to whether public investments really pay off. It was acknowledged that this may be difficult information to obtain but if the goal is to look at effects on productivity, competitiveness and GDP, then these kinds of information are important. The need to establish how potential productivity increases are linked to infrastructure capacity expansion underlines the need for a high degree of coordination between the infrastructure policies of the Ministry of Transport and the investment policies of the Ministry of Finance, and Ministries of Public Works in countries where these are separate from Ministries of Transport.

### **National logistics performance monitoring in Mexico and North America**

Mexico is developing a National Observatory for Transport and Logistics to lead monitoring of the logistics system (see ITF (2015) for a detailed discussion), one of six key research initiatives to improve logistics planning and strategy in the country (Figure 1.15). The IMT, supported by consultants IDOM,

have developed a typology of indicators that could be developed on the basis of data available or to be collected and has submitted plans for consideration by the Ministry of Communications and Transport. In a complementary initiative, IMT has worked with the National Statistical Institute (Instituto Nacional de Estadística Geografía e Informática – INEGI), to digitally map the national road network, linking national to urban to suburban networks, covering over 340 000 km of highways. Rail and other transport and communications infrastructure is to follow, together with logistics hubs, terminals, intermodal yards, border crossing points and other logistics centres. Combined with data from the observatory, this will provide a solid basis for modelling strategies to improve performance. Information on international connections is being coordinated with the US and Canada through Transport Canada, Statistics Canada and the US Bureau of Transportation Statistics (BTS). Together with INEGI, these organisations are working to develop a unified North American trade network map. The Texas Transportation Institute (TTI) is working as part of a joint committee on the US/Mexican border to help organise a full spectrum of institutions and agencies – beyond just customs and border enforcement – to define and address cross-border logistics issues.

Figure 1.15. **National Transport and Logistics System**

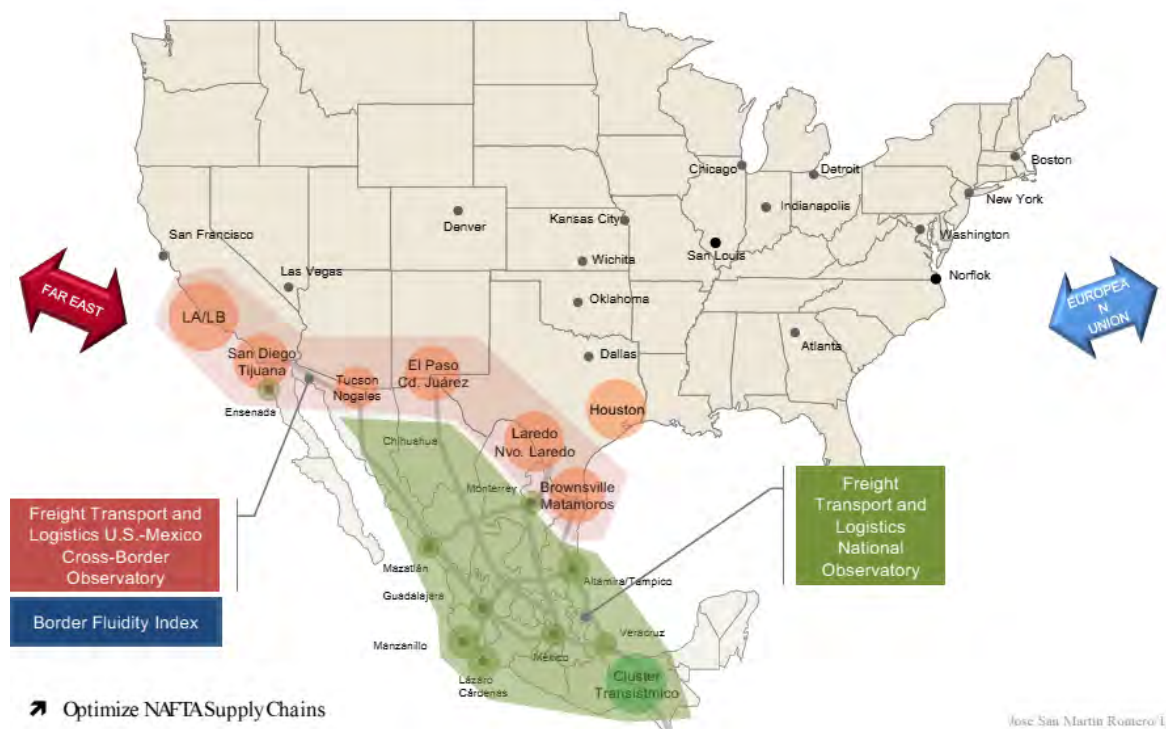


Source: San Martin, 2015

Another project that is part of the system is development of a tool for assessing the performance of the intermodal system in North America. In this project, both public and private participation is being encouraged. IMT is working with consultants PTV to develop a supply chain model looking at macro- and micro-simulation methods using a range of indicators to determine how the system will respond when investments are made. All of these elements will come together in the Cross-Border Observatory. The geographic relationships of elements of the system are shown in Figure 1.16.

The expectation is that all of the institutional structures shown in Figure 1.15 **Error! Reference source not found.** will inform and help shape future policy and investments. The National Council of Science and Technology (Consejo Nacional de Ciencia y Tecnología – Conacyt) is funding a network of research institutes, involving twelve national universities together with foreign observers, to drive development of logistics strategy.

Figure 1.16. **Freight Transport and Logistics: US-MX Cross-Border Observatory**



Source: San Martin, 2015

Most of the discussion centred on the structure and governance of the proposed observatory, including “ownership” of indicators. Relationships will need to be established with the entities that provide data to ensure that the indicators produced can be used to monitor their own performance. In particular, it was noted that a very large percentage of capital investment in logistics infrastructure originates with the private sector. All stakeholders should have an interest in providing information as long as they see the results as relevant to their own performance.

Different regions of Mexico have different needs, different institutional capacities and different economic and social development issues. Some flexibility will therefore be needed within the federal system to cover regionally important data designed to inform national logistics plans. Also along these lines, consideration should be given to the ways in which different economic sectors use, measure and evaluate system performance. For example, agriculture uses many elements of the logistics infrastructure shared by other highway and rail users, but their performance requirements may be far different than automotive, electronics or wholesale/retail sectors.

In structuring performance indicators, consideration also needs to be given to assessing the full range of externalities – congestion, emissions and safety. In Europe much attention has focused on the utilisation of highway capacity and the preponderance of empty vehicles in total traffic. Web-based load

matching systems have been introduced with the aim of reducing environmental impacts as well as improving profitability and incentives for more efficient loading and logistic organisation. Further incentives have been created through the introduction of electron truck-km charges on national road networks in some countries. Information on supply chain and logistics organisation and management and industry concentration is needed to assess the possible outcomes of policy and investment initiatives aimed at reducing the environmental footprint of freight transport.

Finally, in addition to expanding and improving logistics infrastructure, some consideration should also be given to sustaining and restoring the performance of existing infrastructure. It was noted that in the more developed economies, questions about prioritisation and funding for preservation versus funding for capacity expansion are increasingly the focus of decision-making.

### **Objectives, management and priorities for logistics observatories**

The discussion at the Roundtable addressed a number of issues that are relevant for establishing a dedicated logistics observatory, addressed for the Mexican Government in a dedicated research project with the ITF (2015). Many of the conclusions provided in this summary of discussions public sector organisation considering the development or improvement of their logistics performance indicators in any country.

Among the most important elements for any logistics observatory is a clear statement of objectives and clearly defined governance. Four key issues need consideration in structuring the observatory:

- Define the audience for the outputs of the observatory.
- Clearly establish the observatory's scope and limitations.
- Maintain a focus on credibility.
- Develop a data collection, management and dissemination strategy.

Goals for the publication of data and indicators should be tightly focused in the initial phase. As initial objectives are achieved, the mission should be expanded to encompass a broader range of indicators and analysis. Starting with the basics means concentrating on a few well-recognised metrics for travel time, reliability and cost. These should be defined for specific supply chains.

The scope of data and indicators to be covered as the observatory develops will be determined by national priorities in relation to perceived policy and performance issues but will begin with data to describe the sector and the operations of transport and logistics businesses completed with indicators of financial performance, travel and deliver time metrics and ultimately key performance indicators. An example of a systematic outline for the scope of data and indicators, developed in an ITF report on development of Chile's national logistics observatory, is included in Annex 1.

As the observatory will become a primary resource for policy makers, data should be accompanied with tools and guidance for use by both technical analysts and non-technical policy makers. Since the private sector stakeholders will have a significant role to play in both making data available and in investment decisions and allocation of private capital, providing meaningful involvement for the private sector will be important.

Private sector involvement in the observatory should be broadly based. It is important to understand how shippers will react to investments in the transportation elements of the supply chain. However, these costs are only a small part of total logistics costs. Other elements include warehousing and inventory management, vehicles and equipment and a wide range of labour considerations. So, understanding how performance measurements influence broader shipper decision-making and behaviours is important.

Many private companies also have access to technology or have developed methods of gathering data and doing analysis that are quite advanced – and in some cases better than those developed in academia or by government. Involving such stakeholders in the design and development of indicators and metrics may prove beneficial. Retailers and distribution companies understand urban networks and have good information on the location of distribution centres and major retail outlets. So, they may be able to make important information available under the right circumstances. Other sectors, like automotive and electronics may have location and route information that they are willing to share that, when put together with other sources, can provide a comprehensive picture of the structure of the underlying facilities used for a range of different logistics systems. In addition, private sector stakeholders can often provide benchmarks of performance that they use, which can inform benchmarks used in the public sector.

As noted in the assessment of the Turkish situation, a range of government agencies have an important influence on the operation of logistics systems. These should also ideally be made institutional partners in logistics observatories. Partnering with other data gathering agencies can be important. For example, in Mexico INEGI routinely gather relevant economic indicators. Linking these to transportation performance, or using the data gathering protocols already in place to obtain a few key metrics important in assessing logistics and supply chain operations might prove useful. There are also links to the mission of the Bank of Mexico in monitoring development of the economy at national and at local levels.

There are many potential metrics, so prioritisation is necessary but it also poses difficult choices. Investment in infrastructure is certainly not the only area of interest. Consideration should be given not only to federal information needs but to state and local priorities, recognising that many of the issues that need to be addressed involve the “last mile”.

From a societal as well as from a business cost perspective, performance indicators that address environment and safety are important. Some of these metrics may be difficult to quantify, but even qualitative indicators, or some combination of qualitative and quantitative indicators in these areas, can usefully inform policy. As discussed in relation to ports, indicators of perceptions as well as harder metrics are useful, as many private sector decisions are based on both ways of looking at business investments.

Quite a lot of data may already be collected by the private sector. This is often proprietary or deemed as sensitive or strategic by those collecting it. Some effort should be made to explore how this information can be made available without disclosing individual company data or information that is considered sensitive, but that could be aggregated at a regional or national level. An example of this type of aggregation is the waybill data collected by the Surface Transportation Board in the US. Also there are examples of using governmental repositories of individual company data to develop larger, more generalised data that can be shared and used by companies and the public for broad and higher level analysis.

In developing performance indicators, benchmarking against comparable countries (perhaps using some of the groups identified for the World Bank’s LPI) will be useful as will monitoring Mexican performance over time, to track progress over time. Documentation and dissemination of data and

research associated with these data is important. Developing metadata (documentation on the data's source, how it was collected, what it is supposed to measure and how it should be interpreted) will help to ensure that data collected by an observatory is used appropriately. Researchers and practitioners should be provided with a forum for publishing, discussing and sharing their research using observatory data. Communications and outreach support showing how to use information collected by the observatory may be an important “value added” element that could contribute to introducing better tools and developing the sophistication of measurement systems.

## Notes

1. <http://www.internationaltransportforum.org/jtrc/RoundTables/2015Logistics/index.html>
2. For example the SmartWay program sponsored by the US Environmental Protection Agency at: <http://www.epa.gov/smartway>.
3. For a more detailed description of the Bali package: see [https://www.wto.org/english/thewto\\_e/minist\\_e/mc9\\_e/balipackage\\_e.htm](https://www.wto.org/english/thewto_e/minist_e/mc9_e/balipackage_e.htm)
4. Briefing, Development in Mexico, *The Economist*, 19 September 2015
5. A complete copy of the 2012 report is available at: <http://aapa.files.cms-plus.com/PDFs/AAPA%20Report%20Final.pdf>.
6. “The SmartWay® Program is a public-private initiative between EPA, large and small trucking companies, rail carriers, logistics companies, commercial manufacturers, retailers, and other federal and state agencies. Its purpose is to improve fuel efficiency and the environmental performance (reduction of both greenhouse gas emissions and air pollution) of the goods movement supply chains.” (*Source*: US EPA Web Site: <http://epa.gov/smartway/>). Performance data from 2011 through 2013 is available at: <http://epa.gov/smartway/forpartners/performance.htm>).
7. Mexico ranks 103<sup>rd</sup> of 175 countries on Transparency International’s 2014 ranking of global corruption. This ranking is on par with other Latin American countries like Bolivia, Argentina and Ecuador. Of the NAFTA countries, Canada ranks 10<sup>th</sup> and the US ranks 17<sup>th</sup>. Chile and Uruguay are the highest ranked Latin American countries, tied at 21<sup>st</sup>. (see: <http://www.transparency.org/cpi2014/results>).
8. It was noted that where a “user pays” approach is adopted the issue is to an extent circumvented. Infrastructure use is paid for by those who value it, providing a strong signal as to the value of public investments.



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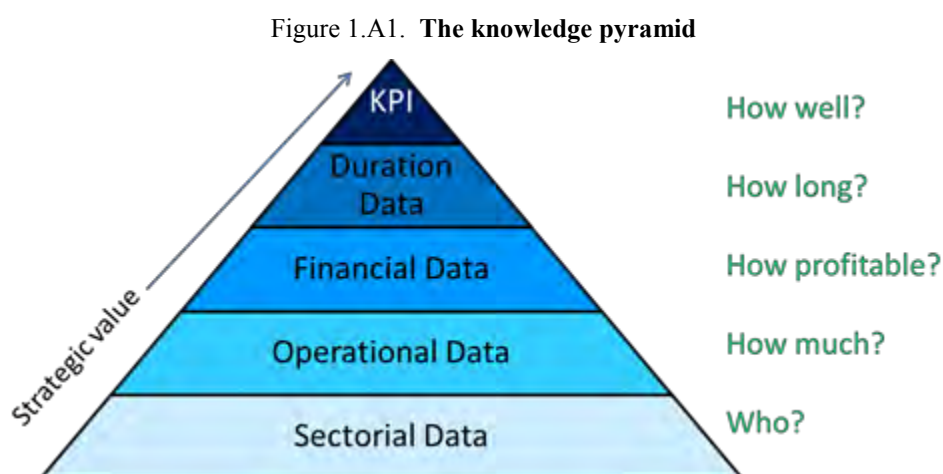
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## Annex 1

Outline of key data requirements for logistics observatories, developed in ITF 2016, *Logistics Observatory for Chile: Strengthening policies for competitiveness*.

### Key data requirements

The observatory should take a top-to-bottom approach to the knowledge pyramid presented in Figure 1.A.1, whereas national statistical agencies should take a bottom-up approach with the delineating line being where the national statistical agency determines that this data is incompatible with its service delivery model. The end result for the observatory is to be able to complete the entire pyramid, either in cooperation with other agencies or on its own.



### *Sectorial data*

The key starting point is the sectorial knowledge. This is first and foremost a measure of stock. Be it stock of transportation companies, stock of fleet or stock of infrastructure. This combines a national business registry with a national fleet survey and a national infrastructure inventory.

The ITF review team and Chilean stakeholders identified the following priority data elements under the sectorial data tier:

- Characteristics of industries involved in supply chains;
  - Firm count
  - Firm size (employment, revenues)
  - Firm location
  - Vehicle fleet (mode, type, number of units, age)
  - Governance and ownership
  - Contribution to GDP

- Characteristics of the labour supply
  - Employment by profession
  - Employment by mode
  - Employment location
  - Skills set
  - Educational programs
  - Remuneration
  
- Infrastructure inventory
  - Length of roads, railways, capacity of ports and airports
  - Warehousing and storage capacity
  - Geo-localisation of all transportation and logistics infrastructure
  - Age and state of repair of infrastructure

### ***Operational data***

Once the stock of Chile’s transportation assets has been adequately established, the observatory will be tasked with measuring transportation demand. This will enable policy makers to better understand how freight flows in Chile. The ITF review team and Chilean stakeholders identified the following priority data elements under the operational data tier:

- Freight origin, destination and routing (including mode and transfer points).
- Freight tonnage, tonne-km and value.
- Commodity description, as expressed through a harmonised code (HS Code for example) or other commodity classification in order to understand what is carried.
- Energy consumption.

### ***Financial data***

The goal of any logistics business is not only to move freight but to move freight profitably. From a policy perspective, two questions usually arise: First, is the transport sector cost competitive and second is the transport sector financially viable. It therefore could become important for the observatory to be able to analyse both the cost competitiveness and the profitability of the sector to make sure it is viable while at the same time monitoring freight rates to ensure Chile’s competitiveness in global value chains. The ITF review team and Chilean stakeholders identified the following priority data elements under the financial data tier:

- Freight and logistics’ services rates, for example by conducting regular surveys on freight rates or by putting additional emphasis on transportation in existing inflation surveys.
- Survey on total logistics costs including transportation rates, warehousing, inventory carrying, administrative costs and negative externalities.
- Financial statements from logistics companies, including detailed cost breakdowns.
- Data on taxes, licences and fees paid by logistics companies.

### ***Duration data***

A fundamental question in supply chain management, even before cost, is time. How long will goods take to get from shipper to consignee? How long will goods take to get to market? How long before goods clear customs? How reliable is the schedule? Firms have clearly and repeatedly shown willingness and an ability to pay, when necessary, to achieve a desired length and reliability of their supply chains. The ITF review team and Chilean stakeholders identified the following priority data elements under the duration data tier:

- Measuring the time goods take to travel between two nodes in the supply chain, by collecting time stamp data at point of arrival, final destination and strategic intermediary points (intermodal transfer node, customs inspection, etc.). This could be done for key commodities, especially if they are time-sensitive, such as fruits or fresh fish and can be done through a sampling approach if complete census data is not readily available.
- Measure delays in the supply chain caused by unforeseen incidents (natural disasters, strikes) to either develop a supply chain resiliency strategy or provide the necessary factual data and analysis to support which ever organisation will be tasked with such a responsibility.

### ***KPI data***

While other data only provide factual, quantitative information, KPI provide qualitative information in that it enables policy makers to evaluate how well Chile's supply chain is performing and identify gaps that require a closer attention. KPIs help diagnose a problem while the solution lies in the first four data tiers. To develop KPIs, the observatory and its leadership will have to identify operational objectives for Chile's logistics sector. These could be articulated, for example around total delivery time, cost competitiveness, maximising asset utilisation and minimising idling periods within the supply chain. The ITF review team and Chilean stakeholders identified the following priority data elements under the KPI data tier:

- Productivity (labour, assets).
- Total transit time between strategic points (i.e. from a warehouse to a port).
- Cost per tonne-km.
- Vehicle-km per year.
- Port dwell time.
- Benchmarking against logistics leaders and Chile's competitors.
- User perceptions.
- On-time performance.



## **Chapter 2. Performance measurement in freight transport: Its contribution to the design, implementation and monitoring of public policy**

Alan McKinnon, Kuehne Logistics University, Hamburg, Germany

Formulating and implementing evidence-based policies on freight transport requires the collection and analysis of large amounts of data. This chapter examines these data requirements. It begins by identifying a series of fundamental questions that policy-makers typically ask when trying to improve the performance of a freight transport system. This performance is defined with respect to six criteria: transport intensity, modal split, market diversity, operational efficiency, service quality and environmental impact. The paper discusses the choice of metrics for each of these criteria, considers how the appropriate data can be collected, analysed and interpreted and cites examples of good practice from around the world. It concludes with some general observations about the current quantity and quality of freight data available to policy-makers.

## Introduction

Freight transport is usually characterised as being the life-blood of a country and vital for its economic development, but political acknowledgement of its importance often does not extend as far as the statistics bureau. As a result, little or no data gets collected to establish the nature and scale of the freight task and how it is changing. Evidence-based policy-making is clearly impossible within a statistical vacuum, leaving officials to rely on anecdotes, intuition and lessons learned from other countries. Regrettably, this is the situation in much of the developing world, where the macro-level study of freight transport has to start from a clean slate.

At the other extreme are some developed countries with a long tradition of collecting freight data, where a range of parameters are carefully tracked on the basis of sample sizes that are large enough to make reasonably accurate assessments of patterns and trends. Even there, however, the statistical base is never complete. No country collects all the freight data that policy-makers and their analysts require to model, let alone understand, the detailed workings of the freight transport system. With the advent of Big Data there will potentially be a step-change in the availability of freight data, allowing many of the existing gaps to be plugged and permitting the macro-level analysis of freight flows and operations at a higher degree of granularity. This remains to be seen.

For many countries, the immediate objective is to collect enough freight data to answer four key public policy questions about freight transport:

- **How much freight is being moved?**

The amount of freight movement can be a good barometer of the level of economic activity. There has traditionally been a close correlation between freight tonne-kms and GDP, though the ratio of these variables can decline as an economy develops and services increase their share of total output. Knowing how much freight is being moved also indicates the related demands for infrastructural capacity, fuel, labour and vehicles. It can also shed light on the aggregate level of freight-related externalities.

- **Where is the freight going?**

Knowledge of the spatial pattern of freight flow is critical for infrastructure planning, the development of regional development strategies and the management of port and airport hinterlands. In an ideal world, statisticians would be able to track freight consignments across multi-link supply chains from initial origin to final destination, revealing the structure of logistics networks and product routing (McKinnon and Leonardi, 2009). Regrettably, the real world of freight statistics is a long way from this ideal.

- **What is the relative use of different transport modes?**

Few governments are satisfied with the existing freight modal split. Most aim to alter the allocation of freight between modes to relieve congestion on one or more infrastructures, reduce the environmental impact of freight movement and / or correct what is deemed to be a market failure. In the absence of freight data disaggregated by mode it is not possible to assess the scale of the problem and the potential for inducing a modal shift.

- **How efficiently is freight being transported?**

Where freight transport costs are higher as a result of inefficient operation, prices throughout the economy are inflated and business competitiveness impaired. Structural processes likely to promote

economic development, such as the expansion of market areas and centralisation of production and inventory, are inhibited. Inefficient transport operations also tend to be more environmentally-damaging. So the level of efficiency needs to be measured and the main causes of inefficiency identified and corrected.

These are the basic questions that need to be answered to start the process of freight policy formulation. The paucity of freight data in many countries suggests that these questions are not even being asked. As the US Transportation Research Board's National Co-operative Freight Research Program (NCFRP 2011) has observed, 'the lack of national freight system programs, performance goals, or targets partially explains the lack of freight system performance data'. The early stages of policy-making must be underpinned by a basic statistical knowledge of the freight transport system. One can get into a 'chicken and egg' argument over the sequencing of data collection and strategy formulation thereafter. As policy evolves, new objectives arise and a broader range of policy instruments are deployed, causing the freight data requirements to multiply. NCFRP (2011) suggest that one needs 'clarity regarding strategy and desired outcomes' before going on to develop 'metrics to gauge the strategy's effectiveness'.

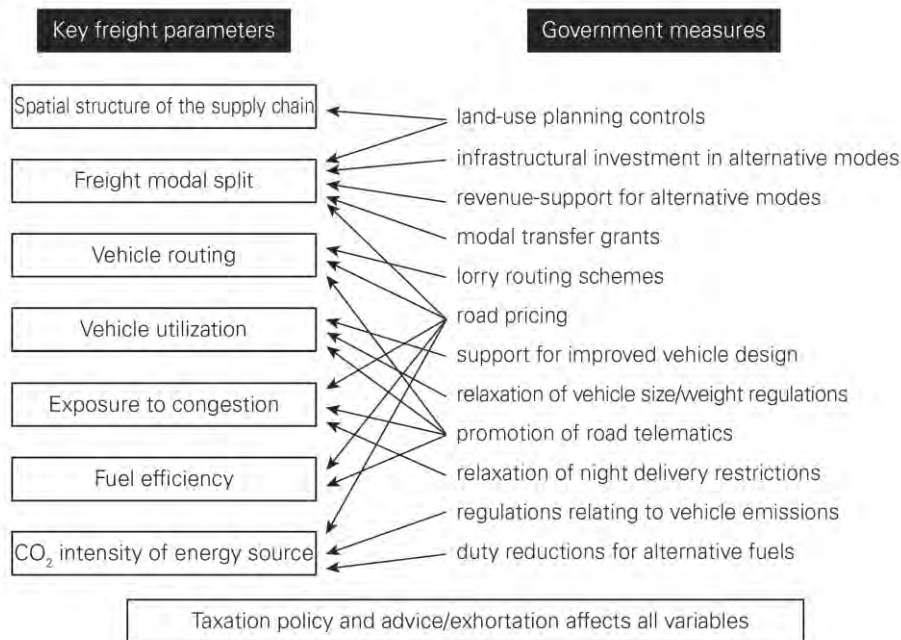
Figure 2.1 lists some of the main freight transport parameters that are often influenced by government intervention and identifies policy measures that can affect them. Evidence-based decision-making on this range of interventions is inevitably very 'data hungry'. These data demands expand as freight policies are formulated at regional and urban levels by lower tiers of government. Normally regional and municipal authorities will be responsible for their own data collection though they can benefit from the spatial disaggregation of national statistics where sample sizes are large enough.

At all levels of freight policy-making, the main goal must be to improve the performance of the freight transport system. The term 'performance' can be defined in different ways in this context. In this chapter, we will examine six performance criteria, all of which are inter-related

- Transport intensity
- Modal split
- Market diversity
- Operational efficiency
- Service quality
- Environmental impact



Figure 2.1. Range of freight transport parameters influenced by government intervention



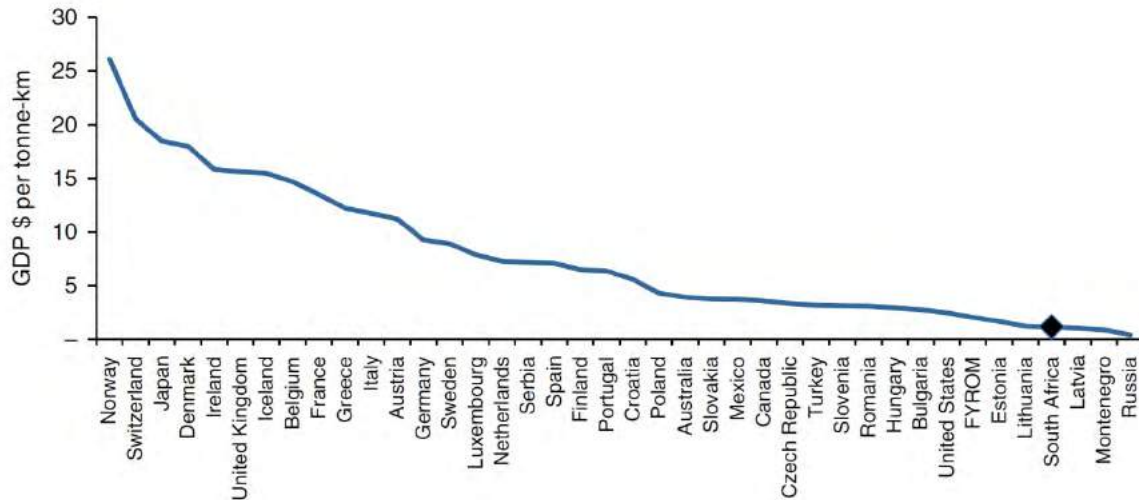
Source: McKinnon, 2015a.

The chapter will explain why these performance criteria are significant and discuss the indices commonly used to use to measure them. It will refer to freight policy and data issues in different parts of the world though many of the examples of good practice that it cites are drawn from Europe and North America.

### Freight transport intensity

This is usually defined as the ratio of freight tonne-kms to an economic output measure such as GDP. It is an important indicator of an economy's dependence on freight transport. Havenga and Simpson (2014) have shown that there are very wide international variations in the amount of GDP generated for each tonne-km of freight movement (Figure 2.2). For example, Switzerland earns approximately twelve times more GDP per tonne-km than South Africa, mainly reflecting differences in the structure of these countries' economies and the average value density (i.e. USD per tonne) of the freight. Countries at an earlier stage in their development are usually more dependent on the production and export of low-value primary products that have to be moved in large quantities relative to national income. As they develop, industrialisation, movement up the global value chain and growth of the service sector tend to depress the level of freight transport intensity. OECD / ITF (2015) indicate how freight intensity is a function of both per capita income in a country and the service sector share of GDP. It can also be affected by other factors, however, as illustrated by the diversity of freight intensity trends exhibited by EU member states, even between countries at similar levels of economic development and service penetration. Several studies have explored the observed decoupling of GDP and tonne-km trends in countries such as the UK (McKinnon, 2007), Finland (Tapio, 2005) and the Spain (Alises et al, 2014).

Figure 2.2. Freight transport intensity: amount of GDP generated per tonne-km



Source: Havenga and Simpson, 2014.

Freight transport intensity is a performance metric that few governments have tried to manipulate. Broader economic policy affects the GDP denominator in the intensity ratio, but governments seldom try to influence total tonne-kms as an explicit policy objective. The exceptions are those countries for which logistics accounts for a large share of GDP. For example, the ‘logistics and supply chain sector’ represented around 14% of the UEA’s GDP in 2013 (Geronimo, 2014). Such global logistics hubs have a strong vested interest in maximising tonne-km throughput. At the other extreme, there have been a few examples of public policies designed to rationalise the pattern of freight movement and thereby reduce tonne-kms relative to economic activity mainly to ease environmental and congestion pressures. The Dutch government, for example, had a ‘transport prevention’ scheme advising companies on ways of economising on their use of freight transport, while within the EU’s Marco Polo II programme companies could receive funding for ‘transport avoidance actions’. This could involve cutting the journey distance, reducing the number of empty runs or reducing the amount of waste’ but not ‘at the expense of jobs or total output’ (European Commission, 2012a). As discussed later, most governments’ environmental policies towards freight transport aim to decouple freight-related emissions rather than tonne-kms from the level of economic activity.

Although freight transport intensity is normally measured with respect to GDP, it is not the ideal metric for this purpose. For some types of analysis and policy formulation, it is preferable to have a physical rather than monetary measure as the denominator in the intensity fraction. The tonne-km, after all, is a physical measure. In some countries the physical mass of economic inputs and / or outputs are measured in weight terms to assess the overall ‘material intensity’ of the economy. For example, Eurostat (2014) publishes domestic material consumption (DMC) statistics measuring ‘the total amount of materials directly used by an economy [...] defined as the annual quantity of raw materials extracted from the domestic territory, plus all physical imports minus all physical exports’.

In deriving the tonne-km statistic, national freight surveys also estimate the total tonnes-lifted. This is an aggregate measure of the amounts of freight loaded onto vehicles at the start of a journey. As each unit of freight is loaded onto vehicles several times as it moves through multi-link supply chains, the tonnes-lifted statistic is subject to multiple counting. Dividing the tonnes-lifted by a measure of the mass of goods in the economy, such as DMC, indicates the degree of multiple counting. The resulting index

(known as the ‘handling factor’) can serve as a crude indicator of the average number of links in the supply chain. There have been several attempts in European countries to conduct this type of analysis (e.g. Fosgerau and Kveiborg, 2004), though few countries elsewhere in the world compile ‘material flow accounts’ that would permit similar calculations. Where sufficient data exist, this analysis can reveal the changing structure of supply chains and hence the underlying process of freight traffic growth.

### **Freight modal split**

In most national freight markets, rail, and to a lesser extent waterborne transport, are losing market share to road while one of the main freight policy priorities is to arrest and, if possible, reverse this trend. The modal shift to trucks is partly a response to improvements in road infrastructure but also to changes in companies’ logistical requirements which favour road because of its greater speed and flexibility. In countries, such as India, where this trend is pronounced a process of ‘logistical lock-in’ is underway whereby new production and warehousing capacity is gravitating to points of high accessibility in the highway network often distant from the nearest railway line. Once production and distribution systems are aligned to the road network, shifting freight back to rail or water can be very difficult. In European countries, where this process is at an advanced stage, a range of freight modal split policy initiatives deployed over many years have had limited success in winning goods traffic back to rail or water (Savy, 2010).

The formulation, implementation and monitoring of these policies requires detailed data on the allocation of freight between modes. Superficially this may seem straightforward, but in practice it raises a series of complicating issues:

#### ***Choice of metric***

Most countries that publish freight modal split data express it in terms of tonne-kilometres (often referred to, quietly misleadingly, as ‘transport performance’) and / or tonnes-lifted. Using the former measure gives rail and waterborne transport a higher share as these are essentially long-haul models whose comparative advantage over road increases with the length of haul. Targets for altering the modal split can also be defined in terms of tonne-kms or tonnes lifted. For example, in a report for the Indian government, McKinsey et al. (2010) recommends a target of raising rail’s share of the surface freight market from 36% of tonne-km in 2010 to 46% by 2020. The European Commission (2011), on the other hand, in its last transport White Paper, set a target of getting 30% of freight tonnage moving over distances greater than 300 km onto to rail or water by 2030.

All weight-based measures of modal split are deficient, however, in the sense that they take no account of the average density of the products carried. Rail and waterborne services generally move heavier primary products, like coal, steel and chemicals, which have a higher average density than the mix of products typically transported by road. This means that ‘weight-based measurement of modal split intrinsically favours modes carrying denser product. If it were expressed in terms of the cubic metres of freight moved, road would account for a significantly larger share of the market’ (McKinnon, 2010: p.7). To our knowledge, no attempts have been made to calculate freight modal split on a volumetric basis.

It is, nevertheless, important to bear in mind the differing product density profiles of the freight modes when considering the feasibility of modal shift targets defined by tonnage or tonne-kms. Much of the freight diverted from road would be likely to have a lower density than the average for rail or water. As Woodburn (2007) notes for the UK ‘a coal train operating over the same distance is likely to have a tonne kilometres weighting around four or five times that of a premium logistics service. It would therefore be far easier to achieve a target growth volume through new coal flows rather than premium

logistics ones’ (Woodburn (2007) p.64). He challenges the validity of a weight-based modal split target for rail as it ‘appears contrary to the likelihood that the majority of potential rail freight growth will come from relatively low weight sectors rather than traditional heavy products’.

### ***Directness of the routing***

Measuring the modal split by tonne-km can also give a distorted view of the freight market because of differences in the relative connectivity of the road, rail and waterway networks. As the latter two networks are invariably much less dense than the road network, routing of the freight flows tends to be less direct. Simply comparing the total length of a country’s road and rail infrastructure can also result in under-estimation of differences in the degree of circuitry in freight routing. Sometimes, freight is confined to particular lines. In the UK, for instance, Woodburn (2007) found examples of freight trains travelling 9% further to release capacity for passenger trains on trunk lines and 15% further because of loading gauge (which is the amount of clearance around the track at bridges, tunnels and stations) constraints on particular routes. Wagons may also have to be routed via marshalling yards or train depots, causing them to deviate further from the more direct route that the freight would normally travel on the road network. For example, in the case of one specimen haul between Rotterdam and Prague, the rail distance was 13% longer than the road journey (McKinnon, 2010). This ‘route distance’ bias can be corrected by comparing the lengths of a large sample of hauls between pairs of locations across the different modal networks and deriving a set of scaling factors.

### ***Intermodal freight movements***

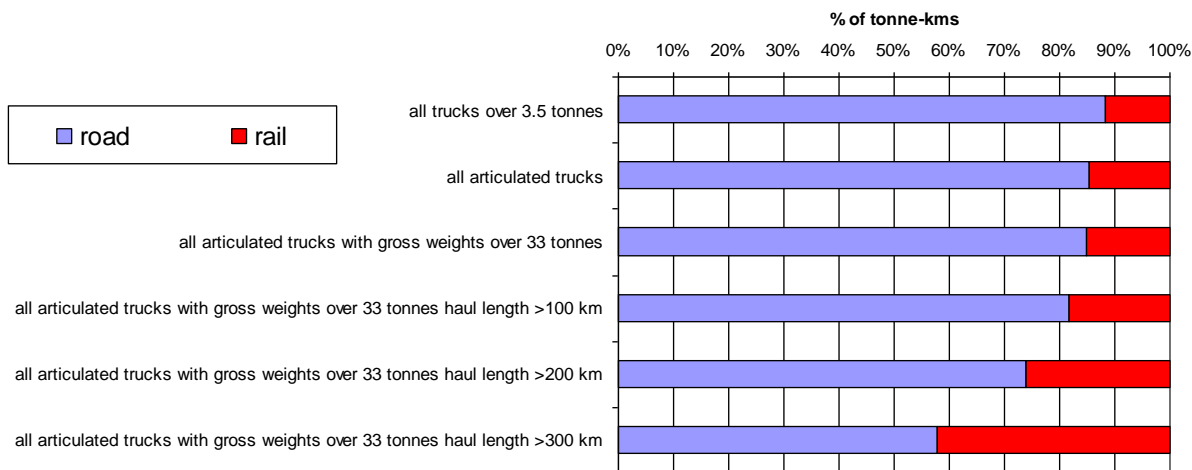
Where the origins and destinations of freight consignments are not directly connected to the rail or waterway networks, road feeder movements are required to provide a door-to-door service. Most government transport statistics do not separately identify these ‘inter-modal’ movements, though this data can sometimes be obtained from trade associations representing intermodal operators, such as the International Union for Road-Rail Combined Transport UIRR in Europe. In many European countries and the US, intermodal services are projected to be the main source of future rail freight growth providing rail access to traffic moving between non-rail-connected premises. Most currently available freight data, however, do not adequately measure the net effect of a switch from road to intermodal services. This is partly because insufficient allowance is made for the road feeder traffic, but also because the routing of freight on an intermodal service is more circuitous than the direct road movement, generating more tonne-kms. Across a sample of eight trans-European routes, door-to-door intermodal routes were on average 8% longer than the equivalent direct road journey (McKinnon, 2010). The magnitude of the deviation from the direct route depends on the numbers, locations and catchment areas of the intermodal terminals and can be significant even in regions with relatively mature intermodal markets. Although greater circuitry can partly offset differences cost, energy use and emissions per tonne-km between road and rail, the net economic and environmental benefits of a modal shift can still be substantial.

### ***Contestability of the freight market***

Statistical evidence of a large modal imbalance may give the impression that there is huge potential to switch freight between modes. In practice, however, modes may only compete for a relatively small proportion of the total freight market. For example, as mentioned earlier, rail and water are generally only competitive over longer distances, except where freight volumes are large, regular and moving between rail-connected premises. These alternative modes are also ill-suited to low density, high value products moving in variable quantities on a just-in-time basis. Figure 2.3 uses UK data to illustrate how rail’s share of the road-rail freight market can vary depending on the definition of the combined market

(Department for Transport, 2008a and 2008b). Using a broad definition with all freight moved in trucks with a gross weight in excess of 3.5 tonnes included, rail's share was only 12%. Within a much more narrowly-defined market excluding freight not carried in heavier articulated trucks over distances greater than 300 km rail's share rose to 42%. To be able to measure the size of the contestable market and hence assess the true potential for freight modal shift, one requires a disaggregation of modal freight data by variables such as length of haul, commodity type and truck class and weight.

Figure 2.3. **Effects of market definition on the road rail modal shift, UK 2007**

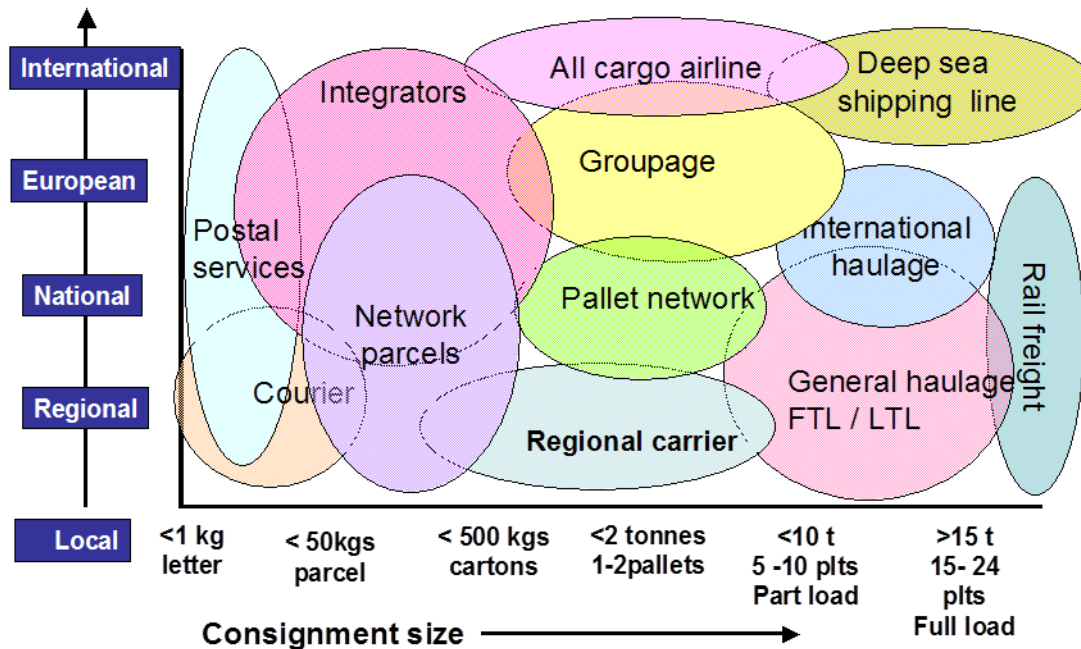


Source: UK. Department for Transport, (2008a and 2008b).

## Market diversity

In the transport economics literature, the structure of national freight markets has traditionally been assessed solely in modal terms, reflecting the deep concern of public policy makers that the modal split was unbalanced because of market failures. Viewed from a shipper's perspective, however, market structure is a good deal more complex than the road versus rail debate would suggest. Within each transport mode there is a broad range of service offerings. There are now many variants of intermodal service, combining modes in different ways. Carriers vary in the size and type of consignment they handle, the speed with which they deliver and the geographical extent of their coverage. Some operate only a basic transport service, while others integrate transport within a logistics package comprising storage, inventory management, order picking and, possibly, a range of other value-adding services, qualifying for the title logistics service provider (LSP). As economies develop, so the spectrum of logistics services expands to cater for the varying needs of the new types of business that emerge. Annual surveys of the global third party logistics market have found demand for a broader portfolio of 'value-adding' logistics services steadily increasing (Cap Gemini et al, 2015). In a mature logistics market one would expect to find the range of services shown in Figure 2.4, differentiated by two criteria, consignment weight and distance range. Were third and fourth axes to be added to this graph they would be calibrated with respect to the range of logistics services offered and speed of delivery.

Figure 2.4. Portfolio of freight transport services classified by consignment size and geographical extent.



So in judging the logistics capability of a country one must consider the diversity of logistics services on offer and the competitiveness of their respective markets. These are factors that affect not only the performance of other business sectors within the country but also its attractiveness to inward investment, particularly in activities that demand a mix of logistical services.

Few countries systematically monitor the state of the national freight / logistics market in the manner described above. Some compile data on the numbers of registered trucking companies and their fleet sizes, permitting an analysis of the changing degree of market concentration. Depending on the nature of the licensing system, it can also be possible to differentiate companies operating vehicles on an own account as opposed to hire-and-reward basis and to distinguish carriers engaging in domestic and/or cross border work. Such statistics, however, offer very limited insight into the structure and dynamics of this complex sector. To gain a deeper insight one normally has to turn to the reports of market research firms which scan company annual reports and trade directories to build up a detailed picture of the freight / logistics market in particular countries and regions, often supplementing their databases with original survey work (e.g. Transport Intelligence, 2015). Their supply-side view of the market can be compared with the results of the demand-side surveys of companies regularly buying freight services, of which the Logistics Performance Indicator survey is by far the largest and most authoritative (World Bank, 2014).

Although governments tend not to routinely monitor the freight market themselves, relevant data is sometimes available from other sources and should certainly be incorporated into the logistics policy-making process, as was done in the UK (Department for Transport, 2010a).

## Operational efficiency

Central to most, if not all, government freight transport policies is a desire to improve efficiency. This used to be justified purely on economic grounds, but it is now recognized that it yields environmental co-benefits and so is considered more sustainable in the ‘green-gold’ sense of the word. Given the importance attached to this policy objective, it is surprising that so little effort is made to collect the data required to monitor freight transport efficiency at a national level. There is even uncertainty about the choice of metrics that should be used for this purpose. In this section, we will focus on the efficiency with which vehicle capacity and fuel are used in the freight sector.

### *Vehicle loading*

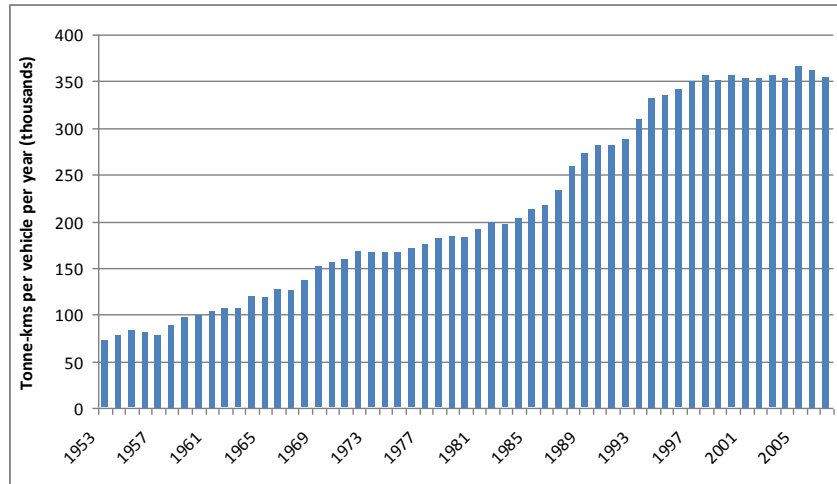
In a seminal paper on performance measurement in logistics, Caplice and Sheffi (1994) distinguished two types of operational measure widely encountered in the freight sector:

**Productivity:** defined as the ratio of outputs (such as tonne-kms or vehicle-kms) to inputs (such as fuel, vehicles or labour). They described this as ‘transformational efficiency’ as it measures the efficiency with which a resource is converted into an activity.

**Utilisation:** the ratio of the capacity actually used to the total capacity available (such as the amount of space in a container actually occupied by a load).

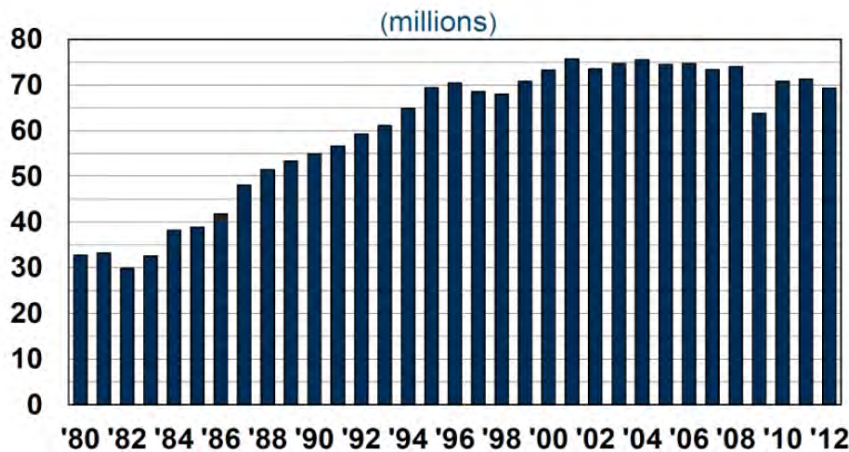
Both types of efficiency can be measured in several ways, giving differing impressions of just how well a transport operation is performing. For example, tonne-kms per truck per annum is a productivity index that generally presents the haulage industry in a favourable light, as in the UK between 1953 and the late 1990s (Figure 2.5). In most countries it has risen steeply in recent decades because trucks have increased in size, weight and power rating, road infrastructure has been upgraded and the move to 24:7 operations has allowed vehicles to be double- or treble-shifted. A similar productivity trend was observed among US Class 1 railroads between 1980 and 2000 following the Staggers Rail Act of 1980 which largely deregulated the American rail freight business (Figure 2.6). Higher productivity does not necessarily mean, however, that the trucks and wagons are on average running any fuller than before. When the maximum permitted weight of a truck goes up, the average payload weight typically increases (inflating the productivity index) but not raising it enough to increase the average ‘lading factor’ (defined as the actual tonne-kms carried to the maximum that could have been carried if the vehicle had been running at maximum weight). Indeed, following increases in the maximum truck weight, lading factors can actually decline as it takes time for companies’ ordering and replenishment systems to adjust to the new vehicle weight regulations (McKinnon, 2005). This example demonstrates the need for a separate set of utilization metrics to show how much of the available carrying capacity in vehicles is actually being used.

Figure 2.5. Increase in the productivity of UK road freight: 1953-2009



Source: McKinnon 2015b

Figure 2.6. Increase in the productivity of US Class 1 railroads:  
1980-2012 ton-miles per locomotive per annum



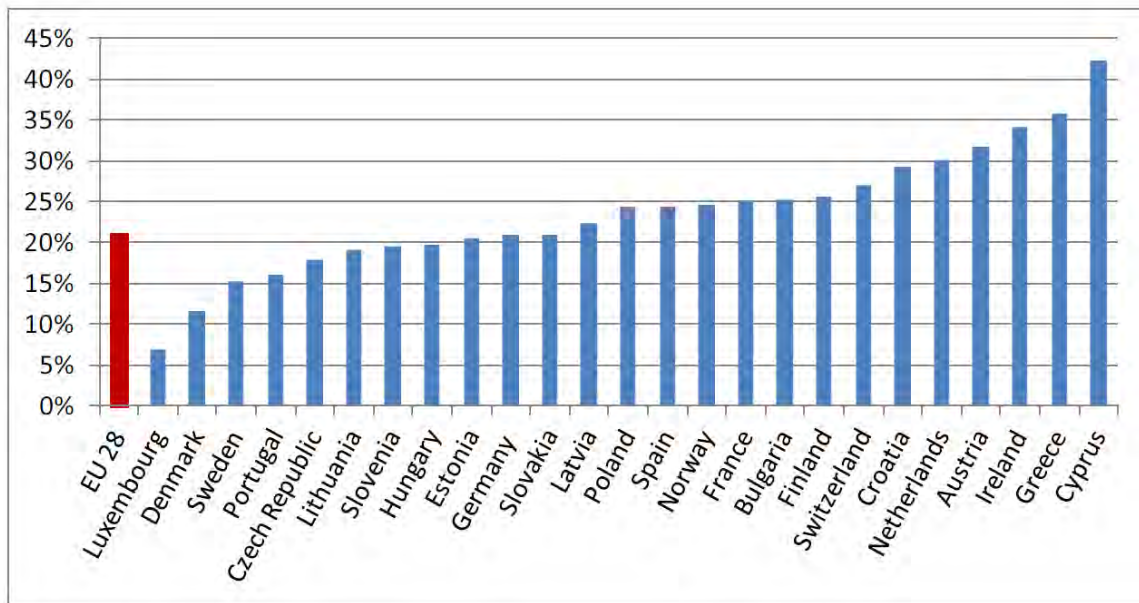
Source: Association of American Railroads.

Very few countries routinely collect freight transport utilization statistics. EU statistical directives relating to road freight make the collection of only one utilization metric mandatory for member states, the percentage of truck-kms run empty (European Commission, 2012b). As a result the EU's statistical agency, Eurostat, has by far the most comprehensive set of truck empty running statistics in the world, expressed in terms of distance travelled and trip numbers and split by type of operator (own account and hire and reward) and between domestic and cross-border movements. This European data set reveals wide international variations in empty running ranging from 38% of truck-kms in Greece to 15% in Denmark (Figure 2.7). No attempts have so far been made to explain these variations or assess their sensitivity to differences in government freight transport policies. In the US, the Federal Government's Vehicle Inventory and Use Surveys (VIUS) of 1997 and 2002, despite their name did not collect data on either empty running or load factors. The empty (or tare) weight of the surveyed vehicles was recorded



but not the distance they travelled empty. Regular surveys of Motor Vehicle Use by the Australian Bureau of Statistics (2014) classify vehicle-kms travelled by rigid and articulated trucks as either ‘laden’ and ‘unladen’. Across the developing world, truck empty running data is sparse. A joint initiative of the World Bank and DFID (called Transport Research Support (2009)) compiled a set of truck empty running estimates for 12 developing countries (6 for Africa and 3 each for Latin America and Asia), which were mostly in the range 30-35%, not much higher than the mean for around half of EU member states.

Figure 2.7. **Proportion of truck-kms run empty in EU member states, 2012**



Source: Eurostat.

Empty running can be considered clear evidence of the under-utilisation of transport capacity, leaving carriers exposed to the criticism that they are not using their assets efficiently. This, however, would be a misinterpretation of much of the available empty running data. Several studies have shown that there are often good reasons for empty running, including geographical imbalances in freight traffic flows, short lengths of haul, tight delivery scheduling and vehicle compatibility issues. When allowance is made for all these operational constraints the proportion of feasible, let alone commercially-viable, backloads available to be collected by a returning empty vehicles can be drastically reduced (McKinnon and Ge, 2006). This is not to deny that some empty running is the result of market failures, where, for example, carriers simply lack knowledge of the available backloads or where the silo structure in many businesses prevent logistics and procurement departments from jointly exploring back loading opportunities. There is a limited role for government, however, in trying to correct these failures. The commercial pressures on vehicle operators to backload their vehicles are already very strong and, in many countries, a broad array of online load matching services have been developed by the private sector to facilitate the search for suitable backloads. Arguably the main way in which governments can reduce empty running is by removing any legal restrictions on carriers’ ability to pick-up backloads, possibly as part of a more general deregulation of the freight transport system.

Operational efficiency is also compromised when vehicles are only partially-loaded. Measuring the degree of under-loading, however, is fraught with difficulty. This is mainly because the maximum

available carrying capacity on a vehicle has to be defined in different ways for different categories of freight. For dense commodities the vehicle weight limit is critical. For low density products with high ‘stackability’ the main constraint is cubic capacity, while for those with low ‘stackability’ it is the available floor area (or ‘load length’). As all countries’ freight comprises a mix of these three categories of commodity, no single metric can provide an accurate measure of average capacity utilisation. The UK government, for example, uses data from its annual survey of road freight movement to calculate average ‘lading factor’ values for different vehicle classes. For the entire truck fleet this average dropped from 60% in 2000 to 57% in 2009, suggesting a decline in vehicle loading (Department for Transport, 2010b). As the lading factor is an entirely weight-based measure, however, it gives no indication of any changes in the average density of road freight over this ten year period. The same surveys also enquired about the proportion of loads subject to a weight and / or volume constraint (in either 2 or 3 dimensions). This revealed that the proportion of loads solely or partly constrained by volume approximately doubled between 2000 and 2010, suggesting that trucks were not necessarily less full in 2010 than in 2000 but just more likely to ‘cube or floor out’ than to ‘weigh out’. This highlights the danger of relying only on weigh-based measures of utilisation when assessing the operational efficiency of a freight transport system.

Very few surveys of freight transport efficiency have attempted to compile volumetric data. This is mainly because it is difficult to collect this information on a consistent basis given differences in the nature of the handling equipment and in the ways companies record consignment data. Between 1997 and 2009 a series of transport KPI surveys, sponsored by the UK government, collected weight-based and volumetric utilisation data to benchmark the operational efficiency of carriers in several industrial sectors, such as food, drink, non-food retailing, parcels and building materials (McKinnon, 2009). These surveys were labour-intensive and required a high level of company engagement. They may be difficult to replicate in other countries.

In much of the developing world, efficiency is often impaired more by the overloading of vehicles than by their under-loading. This has been identified as a chronic problem in countries such as India and Indonesia (Asian Development Bank, 2012) where weight restrictions are often poorly enforced and penalties low. The immediate adverse effects of overloading are a substantial loss of fuel efficiency and an increase in the accident risk. The longer term damage to road infrastructure further reduces the efficiency of trucking operations because of the unevenness of the road surface and the delays caused by the additional maintenance that is subsequently required.

One controversial area of government freight policy-making that requires both weight and volumetric utilisation data is the regulation of maximum vehicle size and weight. Numerous studies have been conducted on the costs and benefits of relaxing size and weight limits to permit the use of high capacity trucks, typically with lengths in excess of 20 metres and gross weights above 45 tonnes (e.g. OECD / ITF, 2011; Steer Davies Gleave, 2013). In modelling the impact of this regulatory change, researchers have to estimate the proportion of loads likely to migrate to longer and heavier vehicles and this can be done more accurately where data are available on the proportions of loads cubing and weighing out within the existing vehicle fleet.

As in the case of empty running, under-utilisation of laden vehicles is often justified and not necessarily evidence of inefficiency. Governments must therefore exercise caution in using utilisation data as a freight performance measure. The demand for freight transport services can fluctuate widely across daily, weekly and monthly cycles, making it difficult for carriers to match the supply of vehicle capacity with freight volumes in a way that ensures high average utilisation. Companies under-loading their vehicles may also be “making perfectly rational trade-offs between transport efficiency and other corporate goals, such as minimizing inventory, optimizing the use of warehouse space or maximizing

staff productivity at the loading bay. As a result, total logistics costs may be minimised” (McKinnon, 2015b: 248). Much depends therefore on where the boundary is drawn around the operational efficiency calculation. If it is drawn tightly around the freight transport system the efficiency may appear much lower than if it encloses an entire logistics system. Clearly, from the standpoint of national economic competitiveness, it is preferable to adopt this broader logistical perspective.

A final observation under this heading is that, in most countries, very little is known about the utilisation of rail freight capacity. This can be measured at a wagon, train, terminal or route level. While many rail freight operators are likely to compile this data, very little of it is divulged for public scrutiny or research purposes. In competitive, privatised rail freight markets, operators have a legitimate claim to confidentiality, though their data could be aggregated and anonymised to provide industry-wide statistics comparable to those for the road freight sector. In many countries, rail freight is moved by state monopolies which could provide greater transparency of their internal efficiency.

### ***Fuel efficiency***

Fuel accounts for a large share of operating costs in the freight transport sector and is the source of virtually all freight-related emissions. Policy-makers therefore need little convincing of the importance of fuel efficiency as a performance metric. The metric itself is a productivity measure showing the efficiency with which energy is converted into the movement of freight. This can either be done with respect to vehicle-kms (fuel efficiency) or to a denominator that takes account of the weight or volume of goods transported (often called ‘energy intensity’).

Macro-level analysis of energy efficiency trends in freight transport has been quite a fertile field of research in recent years, particularly in the trucking sector. Kamakate and Schipper (2009), Eom et al (2012) and Liimatainen et al (2014), for example, have undertaken multi-country reviews of these trends while other studies have focused on individual countries: e.g. UK (Sorrell et al, 2009), Spain (Pérez-Martinez, 2009), Finland (Liimatainen and Pollanen, 2010) and China (Li et al, 2013). Most of the latter studies suggest that the energy efficiency of the road freight sector is improving relative to both truck-kms and tonne-kms. Eom et al (2012), however, found wide variations in both the average energy intensity of trucking across the eleven developed countries they examined and “their overall trends ... mixed”. In much of the developing world, data are too limited to make similar assessments. Clean Air Asia (2012), however, were able to compile average fuel efficiency data for light- and heavy-commercial vehicles in thirteen Far Eastern countries. Statistics are also available on the average energy intensity of rail freight operations in many countries. The most recent set of figures assembled by IEA / UIC (2014) suggest that the average energy intensity of moving freight by rail declined by roughly a quarter between 2000 and 2011.

Compiling data on the fuel used by trucks can be challenging. In many countries no records are kept of the proportions of diesel fuel going into different types of vehicle at the point of sale. Splitting this fuel by trucks, vans, cars and buses must therefore be done by other means. This usually entails measuring vehicle-kms travelled by these vehicles and multiplying this by an average fuel efficiency measure (litres per 100 km) derived from operator surveys or laboratory-based drive cycle testing. Research has found, however, that there can be significant discrepancies in government estimates of both truck-kms and average fuel efficiency derived in different ways (McKinnon and Piecyk, 2009). One must therefore exercise caution in interpreting national level fuel economy data.

## Service quality

There is a substantial academic literature on the measurement of logistics service quality at a company level (e.g. Gunasekaran and Kobu, 2007), but little discussion of the metrics that should be used at a national level to assess the quality of a freight transport system. This may be because the basic criteria are essentially the same at the micro- and macro-scales, comprising average transit time, reliability (i.e. variance around the average) and the condition of goods on arrival. In this section we will focus on the former two which top most companies' ranking of service criteria. Quantifying these variables in a meaningful way at a national level is very difficult. This is partly because the speed and reliability for freight services varies enormously by mode, carrier, route, consignment size and commodity type making it very hard to calculate average values. Carriers are also naturally reluctant to divulge information about as sensitive a competitive variable as service quality.

In the case of timetabled services it is possible to access publicly-available data on service frequency and transit times to produce composite measures of average speed of delivery and punctuality. Several studies have examined the range of metrics that can be used to measure the quality of rail freight services either across a complete network or on particular corridors (Rail Net Europe, 2012). Some rail performance data enters the public domain, as, for example, on the website of the American Association of Railroads (AAR).

Measures of the quality of freight transport services have to be compared with some norm or benchmarked against similar data for other countries. Service quality is after all a relative concept. Supply-side metrics used to assess the quality of a country's freight transport system need to be accompanied by surveys of the perceptions of companies using it. It is the perceptions of large samples of freight forwarders which the World Bank (2014) effectively captures and synthesises in its bi-annual LPI survey. Freight transport variables, such as timeliness, track-and-trace and infrastructure feature very prominently in this survey as they clearly have a strong influence on managers' ratings of a country's overall logistics capability. The DHL Global Connectedness Index provides another perspective on a country's networking into the global economy (Ghemawat and Altman, 2014). It is based on actual trade flows rather than logistical and infrastructural capabilities. The authors justify this approach on the grounds that, 'while connectivity or the technical potential for connectedness has improved a great deal thanks to changes in transportation and communication technologies, actual levels of flows significantly lag that potential. This focus also allows the index to be based solely on hard data...' (Ghemawat and Altman, (2014) p.75). The trade flow data used, however, is monetary rather than weight- or volume-based and the levels of trade are clearly influenced by many factors other than the quality of a country's international transport links.

Nevertheless, where a country scores poorly in these international rankings it is naturally keen to diagnose where the problems lie and that is when some of the supply-side metrics become relevant. For example, low ratings for timeliness and infrastructure quality are often found to be correlated and congestion blamed for much of the delay. Highway engineers can measure the level of traffic congestion reasonably objectively in various ways, such as calculating average time lost per truck-km, a congestion index used in the UK. Using value of time data for vehicles and freight, it is possible to monetise these estimates (e.g. Significance et al, 2012). A national infrastructure policy can set targets for reducing average time loss and / or congestion costs for different categories of traffic on different classes of road. Such a policy requires several qualifications, however.

First, the impact of congestion on logistics performance is not so much a function of the average delay as of variability around this mean. Where congestion is regular, stable and reasonably predictable, companies can build extra slack into their delivery schedules to maintain service standards, admittedly at

a significant resource cost. Where a highway network is nearing full capacity, however, the vehicle flow becomes unstable and much more vulnerable to accidents, breakdowns, roadworks and bad weather. The resulting loss of delivery reliability not only increases the direct, on-the-road cost of traffic congestion; it also imposes indirect disruption costs on production and logistical activities at the destination and possibly several other downstream links in the supply chain. Few attempts have been made to quantify these ‘consequential costs’ of traffic congestion.

Second, it should be recognised that traffic congestion is only one of several causes of unreliability in companies’ logistics systems. This was demonstrated by the UK Transport KPI surveys, which analysed the causes of ‘deviations from schedule’ across a sample of 55 820 truck movements in seven sectors (McKinnon et al 2009). It found that 26% of these deliveries were delayed, but only 35% of the delays were due primarily to traffic congestion. The average duration of congestion-induced delays was also relatively short averaging 24 minutes, 17 minutes less than the unweighted average for all delays. There is often a complex interaction between congestion and other causes of disruption occurring at points of origin or destination or on the road. Sankaran et al (2005) noted that congestion was ‘*often an amplifier of delays and costs*’ caused by these other factors. The main message from research on this topic is that efforts to improve reliability should not concentrate solely on infrastructural deficiencies but be based on a more holistic analysis of variability in transit time and logistical cycle time.

Although demonstrating a point, the delays recorded in the UK road freight system appear miniscule by comparison with the long delays experienced by, for example, trucks in India (Transport Corporation of India, 2012) or the average container vessel turnaround time in the ports of some African countries, which exceed five days against a global average of 1.4 days in 2011 (Ducruet et al, 2014). The excessive dwell times for consignments at ports, airports and international frontiers have been the subject of several studies of the contribution of improved logistics to trade facilitation. That conducted by the World Economic Forum et al (2013) was one of the few to quantify the potential uplift in global GDP (by 5%) and international trade volumes (by 15%) ‘if every country improved just two key supply chain barriers – border administration and transport and communications infrastructure and related services – even halfway to the world’s best practices’ (WEF et al (2013)p. 4). This report contains a wealth of case study data to show how the movement of trade is obstructed by a host of ‘supply chain barriers’ encountered at international frontiers. The World Bank’s LPI survey and the *Global Enabling Trade* report of the World Economic Forum (2012) allow countries to benchmark their ‘cross-border’ performance, but many of those that seriously under-perform in these rankings could do more to analyse where they are deficient. Although such analyses often reveal that the main barriers are administrative and customs-related, shortcomings in freight transport are also a major inhibitor and need careful monitoring. Holloway (2011) reviews the various transport and non-transport metrics that can be used for this purpose.

## **Environmental impact**

Freight accounts for a high proportion of transport-related emissions of noxious and greenhouse gases. Clean Air Asia (2012), for example, estimated that in 2010 freight vehicles accounted for only 9% of all road vehicles in Asia but 54% of total emissions. Much of the environmental impact of freight transport is associated with energy consumption and hence correlated with the metrics discussed earlier. Carbon dioxide emissions are a direct function of the amount of fossil fuel burned, with specific emission factors for the different grades of fuel. On the other hand, emissions of noxious gases per litre of fuel consumed vary with the quality of the fuel and the emission standard of the vehicle engine and exhaust system and so must be measured separately. This is normally done by measuring the proportions of vehicles in the national truck fleet meeting particular emission standards. As tightening standards are introduced on specific dates, knowing the age profile of the fleet provides a crude indication of its emission performance. This information is deficient in several respects, however. First, it needs to be

supplemented with data on the distances travelled / fuel consumed by trucks of varying age. Second, the emission performance of vehicles generally deteriorates with age and not at a constant rate. Distances travelled, driver behaviour and maintenance levels all shape the emission profile over time. Third, the impact of vehicle-related pollution varies with the environmental sensitivity of the area through which the freight is moved and is at its highest in urban areas. It is desirable, therefore, to have statistics on the emission performance of vehicles in particular areas and corridors. Estimates can also be made of the health effects of freight-related emissions at country, regional or city levels, taking account of freight's share of total emissions and preferably using established methodologies such as the Impact Pathway Approach (Bickel and Friedrich, 2005).

Another major freight externality is the involvement of trucks in traffic accidents. It is not known what proportion of the 1.25 million people killed in road accidents annually at a global level are involved in collisions with freight vehicles. In the EU24 in 2010, 17% of road fatalities were in accidents involving trucks, though the incidence of truck-related fatalities varied widely by country (European Road Safety Observatory, 2012). For example, the probability of being killed in an accident involving a truck was eight times higher in Poland than in Ireland. The European trend in truck-related fatalities has been strongly downward, however, dropping 42% in the EU19 between 2000 and 2010. In the US, trucks account for 8% of vehicles but 11% of road fatalities (Dong et al, 2013). While driving standards among truck drivers are generally higher than those of the driving population as a whole, the greater momentum of freight vehicles increases the risk of accidents being fatal or causing serious injury. The compilation of accurate accident statistics disaggregated by vehicle type is essential for the development and monitoring of national road safety policies and campaigns.

As one of the first countries to develop a sustainable logistics policy, the UK undertook much of the early work on the measurement of freight transport externalities (DETR, 1999 and Department for Transport, 2008c). The SmartWay program, set up by the US Environmental Protection Agency in 2004, now sets the standard for the collection and benchmarking of energy and emission data from freight carriers (US EPA, 2014). It has proved the inspiration and model for numerous green freight initiatives that have been launched in Europe, China, India and elsewhere in recent years.

## Conclusion

This paper has reviewed the main areas of freight transport policy-making and discussed the related data requirements. Several general points have emerged from the discussion:

In most countries the amount of freight data available is insufficient to support evidence-based decision-making across the full spectrum of freight / logistics issues. In some countries, government officials are essentially working in the 'statistical dark' unsure about the nature and scale of the problems they are trying to manage and the effects of any initiatives they apply.

Different metrics can give differing impressions of freight transport performance: this is well illustrated by the alternative use of productivity or utilisation measures. A high score on one criterion can sometimes be achieved at the expense of a low score in another, making it important to keep freight performance measurement multi-dimensional. It should also be recognised that in the interests of maximizing logistical and overall corporate performance the efficiency of freight transport may have to be compromised.

Poor choice of metrics can induce the wrong behavioural response: for example, pre-occupation with maximising the lading factor on a multiple drop round can encourage carriers to deliver the largest

and heaviest loads last (Arvidsson, 2013) increasing overall fuel consumption and emissions. Again, a combination of KPIs may be required to correct anomalies and drive optimal behaviour.

The nature and quantity of freight performance data varies widely between modes. This makes it difficult to compare modes on a consistent basis and to integrate data into multi-modal overviews of the freight transport system.

There is a serious dearth of volumetric data. This results in an over-reliance on weight-based performance measures. This may be acceptable for dense commodities that typically ‘weigh-out’ but puts companies moving low density products at a disadvantage when comparing load factors, energy intensity and carbon efficiency.

Data relate to individual freight journeys and generally lack a supply chain perspective: the unit of freight data collection is almost invariably the journey leg, spanning only one link in the supply chain. It is not possible to reconstitute links into end-to-end supply chains to plot the path that products follow. This frustrates efforts to give freight transport policy-making a supply chain dimension.

Insufficient attention is paid to performance measurement during the freight policy-making process. As a consequence the impact of policy initiatives is not properly assessed and the policy ‘learning process’ constrained.

Isolating and evaluating the effects of individual freight policy initiatives is difficult. This is because several initiatives can run in parallel, their impact can be felt over differing time-scales and they can interact in complex ways. The analytical challenge is great enough when confined to the freight transport policy arena. When this arena is broadened to include the full spectrum of government policy measures that can have an indirect effect on freight transport, the data and methodological requirements move onto a higher plane, well beyond the reach of most countries.

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## **Chapter 3. The World Bank's logistics performance index (LPI) and drivers of logistics performance**

Lauri Ojala, Turku School of Economics, Finland

Dilay Çelebi, Istanbul Technical University, Turkey

The World Bank's Logistics Performance Index (LPI) provides the most comprehensive international benchmark for trade and transport facilitation. It also commands attention at the highest political levels. Assessing trade and transport performance as the basis for action to improve national logistics systems, customs services and related inspection and regulatory procedures requires data and analysis that goes well beyond the LPI but the LPI can be used to good effect. Through a case study of Turkey, this chapter illustrates how the LPI can be combined with sectoral analysis to drive effective reform and improvement of the national logistics system and deliver trade benefits

## Introduction

A sound and comprehensive set of national-level performance indicators is critical for effective policy, preparation and implementation. In this context, the World Bank's Logistics Performance Index (LPI) provides the most comprehensive international comparison tool to measure the trade and transport facilitation friendliness of countries. Understanding and decomposing the components of trade and logistics performance can help countries improve freight transport efficiency and identify where international cooperation could help overcome barriers.

Increasingly respected by policymakers, use of the LPI has significantly enhanced the dialogue between policymakers and the private sector as they determine priorities in trade and transportation facilitation. However, making trade logistics work for competitiveness at the country or sub-regional level requires more than just raising awareness. An in-depth multidimensional assessment of the trade and transport performance related to the action plans and policies such as changes in national regulations and taxes or infrastructure investments in specific links, nodes and corridors requires a variety of different analytical approaches. The LPI, used in conjunction with other in-house resources, can instigate discussion on elements that drive logistics performance and those areas where barriers hinder performance.

This chapter presents qualitative assessment of the trade and transport policy environment through a case study on Turkey. It gives an analysis of the country's logistics performance in relation to policy components that affect trade and logistics regulations, procedures, and operations. The chapter is structured as follows: next section gives an overview of the Logistics Performance Index (LPI), its methodology and role in promoting trade. It is followed by the case study which presents the impact of various policy actions on national logistics performance in Turkey. Findings of the study have been summarised and some suggestions are given to improve logistics performance in the following section. The last section finishes with broad conclusions and ideas for future research.

## Overview of the Logistics Performance Index

### *Description the Logistics Performance Index (LPI)*

A multi-dimensional assessment of logistics performance, the LPI of the World Bank, is an international benchmarking tool focusing specifically on measuring the trade and transport facilitation friendliness of a particular country, and in doing so, helping them to identify key barriers to and opportunities for, improvement. The LPI summarises the performance of countries through six dimensions that capture the most important aspects of the logistics environment:

- Customs: efficiency of the customs clearance process.
- Infrastructure: quality of trade and transport-related infrastructure.
- International shipments: ease of arranging competitively priced shipments.
- Logistics quality: competence and quality of logistics services.
- Tracking and tracing: ability to track and trace consignments.
- Timeliness: frequency with which shipments reach the consignee within the scheduled or expected time (Arvis et al.2014).

The LPI provides not only a comprehensive assessment of logistics performance worldwide, but also an analysis of performance trends which makes it possible to understand trends over time.

Performance is evaluated using a 5-point scale and the overall LPI is aggregated as a weighted average of the six areas of logistics performance. The LPI also includes a set of domestic performance indicators which is not included in the overall country score. It is also complemented with quantitative information on particular aspects of international supply chains in respondents' countries of work, including import/export, lead time, supply chain costs, customs clearance, and the percentage of shipments subjected to physical inspection (Arvis et al. 2012).

The overall index is calculated by analysing the six main sub-dimensions listed above. None of these independently guarantee a good level of logistics performance, and their inclusion is conditioned to empirical studies and extensive interviews carried out with specialists in international freight transport. Each component is defined in detail in following sections.

### ***The role of the LPI in promoting trade***

Political decisions and implemented policies have both direct and indirect effects on the attractiveness of a region or a country in terms of business location decisions and/or foreign direct investment (FDI). Here, the FDI stock in a country is a good indicator of its attractiveness.

Transport system efficiency and industry profitability are closely related. Inventory reduction through high turnover, ability to respond to volatile demand, short lead times and achieving lowest possible transportation costs are essential aspects of a company's competitiveness. For this reason, transportation systems are considered as a production factor and as one of the key determinants of facility location decisions.

Transport infrastructure has a significant impact on the productivity and the cost structure of businesses (Haughwout, 2001). For example, better port and hinterland connections may reduce the expenditure required for construction of distribution networks or transport of raw materials. Empirical studies show that FDI is attracted to areas with efficient transportation systems (Saidi, 2011). For this reason, an effective and efficient logistics system is the cornerstone of a prosperous economy in attracting foreign investment.

Allowing for comparisons across 160 countries, the LPI is used by companies to identify challenges and opportunities related to the receiving country's transport infrastructure, logistics competence, and availability of efficient supply chains. In this context, the LPI is a useful indicator of the host country's trade logistics performance and also a benchmark when choosing locations for various types of operation. This is one of the main reasons why countries tend to focus on their ranking rather than on improvements in actual indicator values of the LPI.

Several countries have announced specific targets of LPI score or LPI rank in their strategic development plans. To increase their attractiveness, countries are embarking on major projects in a number of areas to improve their LPI position. However, the proximity of a country's score to others at any given performance level might be more telling than the exact ranking.

Countries at similar performance levels may have substantially different ranks, especially in the middle and lower country income ranges. Particularly, ranking and relative changes in ranks from one LPI edition to another need to be treated with caution. The latest LPI report also provides a country listing with the weighted average of LPI scores and ranks across all four editions in 2007-2014. This listing smooths out the inevitable variation from one year to another in survey-based data, and it thus provides a more balanced overall picture.



To account for potential sampling error and the LPI's limited domain of validity, LPI scores are calculated with approximate 80% confidence intervals over the standard error of LPI scores across all respondents (Arvis et al. 2014). These confidence intervals must be examined carefully to determine whether a change in score or a difference between two scores is statistically significant. Countries with small number of respondents, such as Sweden, Norway, Bahrain, New Zealand, and Ethiopia have larger intervals between upper and lower bounds for scores and ranks, since their estimates are less certain. The average confidence interval translates into an average of 20 rank places, using upper and lower rank bounds.

Understanding the trends in the logistics performance requires looking behind the LPI scores and rankings to see the interactions between the logistics performance and policy actions, competitive forces, economic and political environment. Over the case study we present here, we propose implementation of a holistic point of view, which constitutes an analysis of coherent and interlocking sets of processes for identifying the hidden bottlenecks that have a critical impact on sector competitiveness, and taking necessary actions to support the industry in bottleneck areas require a comprehensive analysis of policy impacts on all dimensions.

### **Drivers and barriers for Turkish logistics performance: a case study**

This case study has been carried out in two phases<sup>1</sup>. The first phase provides an understanding of the quality of logistics services, physical and procedural bottlenecks, and how both contribute to competitiveness in international trade. The first phase involves the decomposition of the key elements of trade and logistics performance and identification of current status and general bottlenecks in infrastructure, regulations, transport and logistics services, and border crossing and customs clearance procedures that affect trade competitiveness in the country being assessed. Here, The World Bank's Logistics Performance Index (LPI) has provided an important starting point for the assessment.

This first phase was conducted as desk research to gather background information from both published reports and statistical data sources. It covers the collection and analysis of the information on the country's trade and logistics performance by reviewing background data on the structure of foreign trade, the level of activity at the major international gateways and land borders and performance of the logistics sector. The output of the desk research presents the findings and including the discussions of the highlights and prominent outcomes.

The second phase focuses on a qualitative assessment of the implementation status of trade and transport policy environment through a survey followed by a series of meetings with experts, policymakers, associations, and selected companies involved in trade and logistics services for the design of the framework and analysis of findings.

This second phase provides an in-depth assessment of the impact of policy components on national freight transport and logistics performance on the basis of the LPI and other in-house and partner resources and of how implemented policy acts change trade and transport performance on national and industrial level.

Using Turkey as an example, the case study assesses potential impacts of policy components to the quality of logistics services, trade competitiveness, and trade and logistics related performance indicators. It aims at providing a holistic understanding of Turkey's trade and transport structure and drivers of its logistics performance. Finally, the case study provides a general framework for this type of assessment which could be followed as a standardised and replicable methodology for other countries.

### *A brief overview of Turkey*

Turkey is an upper-middle-income country with a population of 75.2 million in 2012 and a diversified economy. It is the world's 17<sup>th</sup>-largest economy (6<sup>th</sup>-largest in Europe) and 22<sup>nd</sup>-largest exporter by value. Its economy grew with an average annual real GDP growth rate of 5% between 2002 and 2013. According to the OECD, over the last two years, it has had the highest real growth in GDP of any OECD country and, it is projected to maintain its position with an annual growth rate of 5.1% until 2018 and 4.3% between 2018 and 2030.

Figure 3.1. **Geographical position of Turkey**

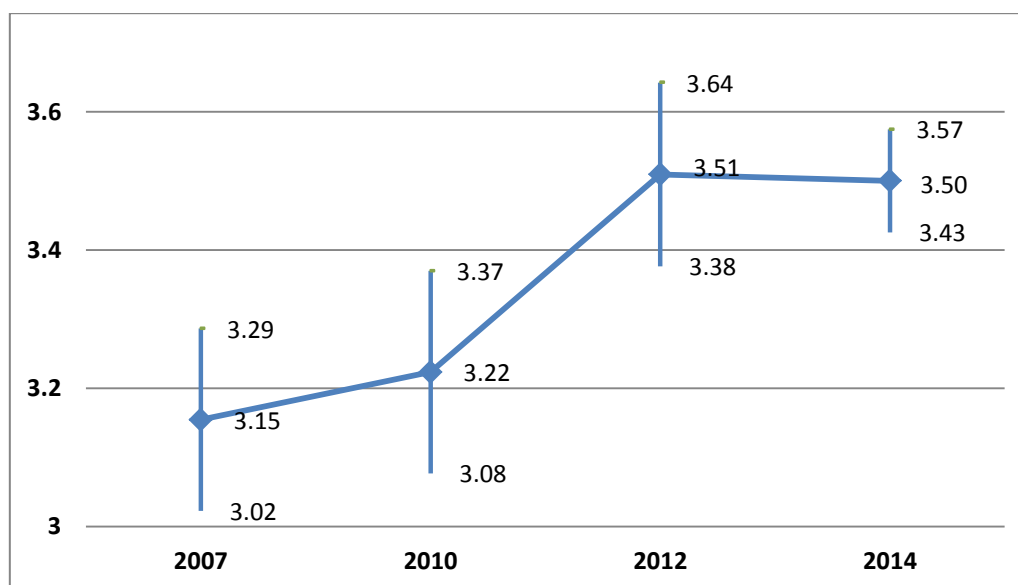


Turkey is a significant hub in international trade due to its position on a traditional and historic trade route between Asia and Europe (Figure 3.1). Recent economic and political developments throughout neighbouring regions (the Balkans, the Black Sea, the Mediterranean Basin, the Caucasus, Central Asia and the Middle East) have contributed to Turkey's importance as an international hub. Turkish exports are expected to grow more than 5% from 2013 to 2017, while import growth is projected to exceed 9.5% during the same period (IMF). The country plans on tripling its exports by 2023 and becoming one of the world's 10 largest economies with an ultimate goal of reaching USD 500 billion in exports.

### *Indicators of trade and transport facilitation in Turkey*

The latest available World Bank Logistics Performance Indicator (LPI 2014) places Turkey in a relatively good position, ranked number 30 among 160 countries, with an overall score of 3.5 on a scale from 1 to 5. Figure 3.2 presents Turkey's overall LPI scores with confidence intervals from 2007 to 2014. The overall score is based on the scores of the six LPI dimensions shown in Figures 3.3 and 3.4.

Figure 3.2. Turkey's LPI overall score for the period 2007-2014



Note: with confidence intervals (min. = 1, max. = 5).

The increase in Turkey's overall LPI score between 2010 and 2012 was largely driven by improvements in customs, infrastructure, and tracking and tracing capability dimensions. Trends of the sub-dimensions scores of Turkey over the four LPI editions are presented in Figure 3.3. The absolute scores for timeliness and ease of arranging shipments have declined over the last two years and customs, tracking and tracing performances have shown the greatest improvement. Trends in the scores have been reflected in rankings as well. Turkey's ranking in customs, infrastructure, and quality performance increased significantly. Yet, significant declines have been observed in timeliness and international shipments rankings.

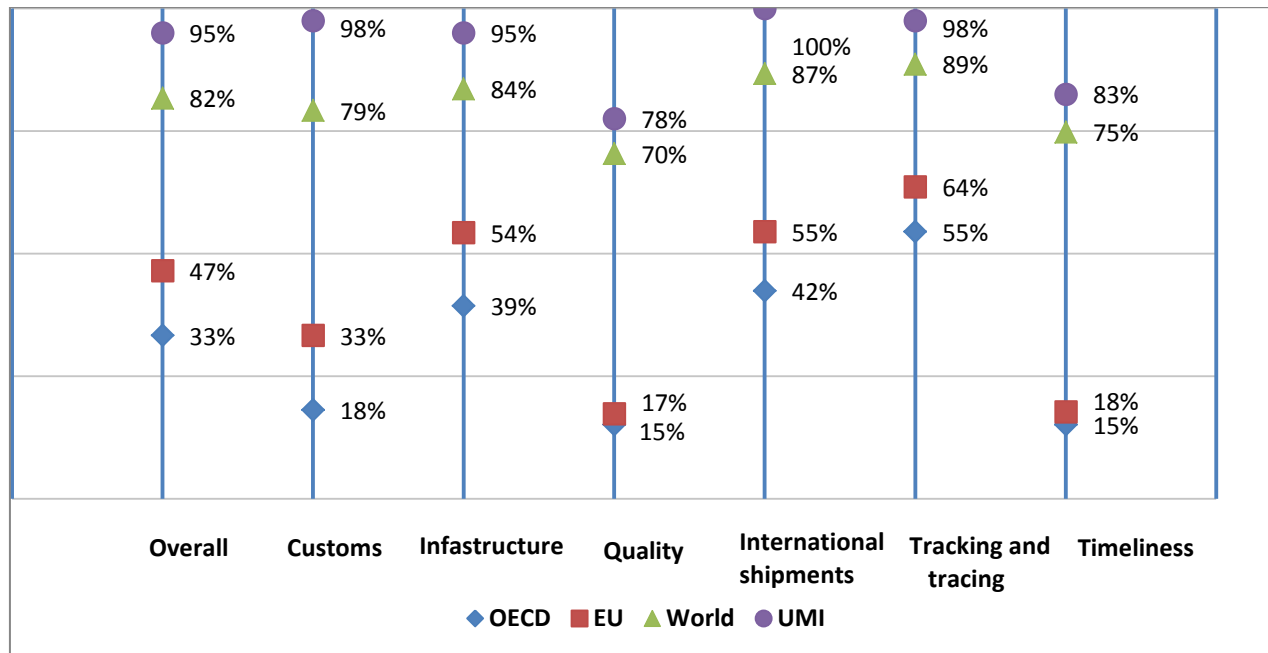
Figure 3.3. Turkey's LPI score development along the six LPI dimension for the period 2007-2014



Note: min. = 1, max. = 5.

The strengths and weaknesses in Turkey's relative performance vis-à-vis other countries may be revealed by a more detailed analysis of the six components which make up the LPI. Figure 3.4 displays the percentile ranking of Turkey within the world, the OECD, the EU, and upper-middle-income economies for the overall LPI score and its six components. As displayed in the figure, Turkey is ranked in the top quintile in terms of logistics performance worldwide. It is placed in the top 5% among the upper-middle-income (UMI) economies, the country's LPI performance scores in all dimensions are above the average score of UMI economies. However, EU and OECD countries perform significantly better than Turkey, especially in customs, quality and timeliness dimensions in which Turkey is ranked in the lowest 20% among OECD countries. On the other hand, even among OECD and EU countries, Turkey performs above average in tracking and tracing of shipments and the quality of trade and transport infrastructure.

Figure 3.4. Percentile ranking of Turkey in LPI 2014



Source: Arvis et al. 2014

Note: vis-à-vis selected peer groups: Upper-middle-income countries UMI (N = 41), World (N = 160), OECD (N = 34) and EU (N = 28).

### ***Determination of peer groups of comparison***

Nations compete in creating the policy, structural and institutional framework that enable its enterprises to develop competitive advantages and thereby participate successfully in international and domestic markets. Porter (1990) notes that “*the competitive advantage of nations is determined by the strength of their factor endowments; their demand conditions; the competitiveness of firm strategies, structures, and rivalries in major industries; and the strength and diversity of related and supporting industries*”. Even though the notion of the competitiveness of nations is controversial and complex, there is little doubt that international trade is vital to a nation’s wealth. The development options for countries depend on the kind of export roles they take in the global economy and their ability to become a high-value industrial environment. Briefly, a country is competitive if its industries can produce at an average level that is at least equal to or above that of its foreign competitors. Well-functioning logistics is one of the most important elements of national competitiveness (Mustra, 2011).

Hence, a comprehensive analysis of a country’s logistics performance requires investigation of a nation’s comparative performance with respect to relevant reference countries which can provide a benchmark in setting objectives or whose industries are considered as the main competitors of the country’s leading industries. The peer group for Turkey used in this instance comprises Germany, USA, Italy, Malaysia, China, Romania, Bulgaria, and Azerbaijan. This group includes Turkey’s main competitors in transportation and logistics, world trade leaders, and the top performers of LPI in view of the relevant income group, trade and transport structures, and geographical proximity.

### *Estimating the potential impact of the LPI improvements on Turkey's trade*

Korinek and Sourdin (2011) suggest that improvements in general logistics quality have a stronger trade enhancing effect on exports than on imports. On average, for every 10% increase in the overall LPI score of a typical exporter, bilateral imports increase by more than 69%, all other determinants of trade being equal. Based on these results, if Turkey's overall logistics performance were at par with Malaysia, the top performer in upper-middle income economies, its imports would increase by 14% and its exports by 18% on average, all other things being equal. The effect would be +31% for imports and +40% for exports if Turkey's logistics performance would reach the level of average high-income OECD countries.

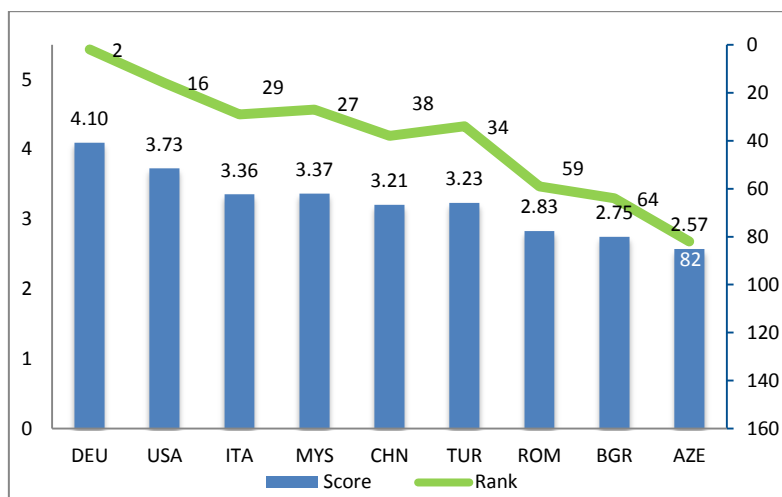
Similar magnitudes of effect may be estimated for other components of the LPI such as tracking and tracing, infrastructure and logistics competence. A 10% increase in the quality of the infrastructure, as measured by the LPI, would increase seaborne trade by over 50%.

These significant correlations should be interpreted in terms of their association rather than causality. Improvements in the logistics contribute significantly to international trade, at the same time, a growing economy is likely to have the will and the means to improve its logistics performance. Though, these magnitudes provide an insight on the development trend of international trade in parallel to logistics performance. For example, if Turkey manages to improve the LPI score on infrastructure to the level of high-income OECD countries' average, associated impact on the exports are estimated to be more than 29%. A 12% improvement in the indicator for the quality of customs procedures, which is sufficient to reach the average of high income OECD countries, is associated with an increase in bilateral exports of 48% for seaborne trade. Moreover, reaching at top performer's (Germany) LPI score level in tracking/tracing or logistics competence will increase exports by 52% and 55%, respectively. On the other hand, to be able to reach its target of USD 500 billion of exports in 2023, Turkey needs to raise its overall LPI score up to 4.15 in the next 10 years.

#### *The efficiency of customs and border clearance*

The efficiency of customs and border clearance measures these procedures in terms of speed, simplicity and predictability when dealing with customs and other border agencies. This is one of Turkey's two lagging LPI components in 2014, yet the country's fast progressed in this dimension after 2010. On a comparative basis, Malaysia is the only country among upper-middle-income economies that performs better than Turkey in the LPI score for customs and other border agencies (Figure 3.5).

Figure 3.5. Efficiency of customs and border clearance: LPI score and rank among 160 countries



Source: Arvis et al. 2014

Notes: Peer Group Scores (left-hand axis; 1 = min; 5 = max.) and country ranks (right-hand axis).

2014 domestic LPI results indicate that the main determinant of the performance difference between two countries is the efficiency of processes in clearance and delivery of the shipments. Even though Malaysia significantly lags in transparency of customs clearance procedures, all of the respondents evaluated country's efficiency of customs clearance processes (i.e. speed, simplicity and predictability of formalities) as high or very high both for imports and exports.

Table 3.1. Customs process efficiency

	Per cent of respondents answering often or nearly always				
	Turkey	UMI	Europe & Ctr. Asia	Malaysia	Germany
Transparency of other border agencies	52%	65%	77%	67%	70%
Transparency of customs clearance	53%	69%	80%	33%	80%
Expedited customs clearance for traders with high compliance	70%	60%	81%	67%	80%
Clearance and delivery of imports	74%	75%	93%	100%	80%
Clearance and delivery of exports	90%	81%	91%	100%	85%

Source: Arvis et al. 2014.

### *Reform and automation of customs procedures*

After adopting a new Customs Law in 2009, Turkey accelerated regulatory harmonisation with the EU and the implementation of modern techniques. With regard to international cooperation, Turkey has signed a considerable number of bilateral agreements on Police and Customs cooperation and mutual assistance, including protocols on exchanges of pre-shipment information.

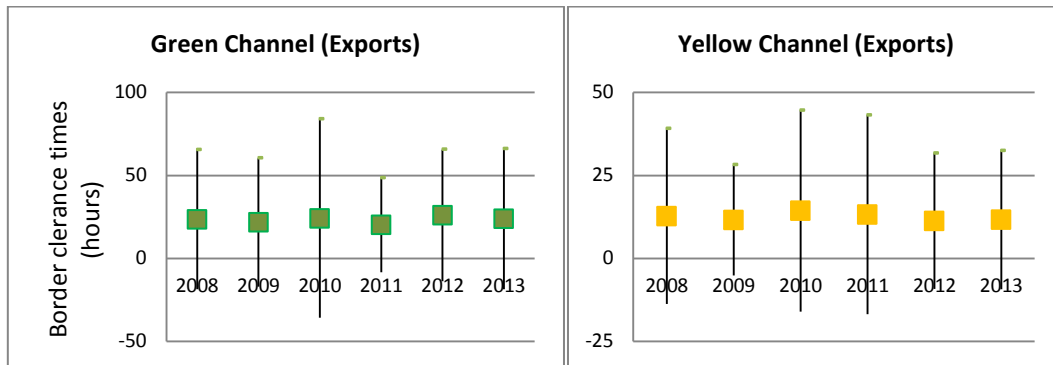
By December 2012, Turkey had joined the *Convention on Common Transit*, which reduced the problems in the transit zones and allowed Turkish carriers to transport goods in Europe and in the European Free Trade Association (EFTA) countries through the same electronic processes. Turkey has also made significant reforms in its customs laboratories to appropriately classify the goods for smuggling prevention.

However, the conflicts among various classification schemes utilised by different authorities still appear as an obstacle for the ease of international trade, creating unreliability and insecurity among customs practices. For example, Customs Laboratory Analysis reports are not taken to be officially binding as “Binding Tariff Information” which may result in additional tax assessments or tax irregularity fines on importers.

#### *Reduced variability of clearance times*

Figure 3.6 illustrates average customs clearance times (hours) within one standard deviation range for red and yellow channels. Even though average clearance times have not changed significantly, the variability of clearance times increased in 2010. As a result Turkey experienced a decline in its Customs Clearance performance score in 2010. Improvements in customs processes between 2010 and 2014 then saw Turkey’s customs clearance score increase from 2.82 to 3.23, mainly the result of a decrease in the variability of clearance times. Simplification and automation of customs procedures, increased productivity gains due to improved IT capability, and investment in improved management and human resources capability have all contributed to this improvement.

Figure 3.6. Average border crossing times through green and yellow lines (hours)



Source: Turkish Ministry of Customs and Trade; see also Table 3.2 for detailed data.

The changes in the coefficient of variation are also presented in Table 3.2. These numbers provides a good evidence for supporting importance of variability in clearance times on customs score. Successful implementation of build-operate-transfer (BOT) schemes in construction and operation of border gates has also contributed to improvement of customs clearance procedures.



Table 3.2. **Border crossing times (hours)**

			2008	2009	2010	2011	2012	2013
<b>Exports</b>	Red Channel	Mean	23.4	21.6	24.1	20.0	25.9	23.7
		CV	1.8	1.8	2.5	1.4	1.5	1.8
	Yellow Channel	Mean	12.7	11.5	14.3	13.2	11.2	11.6
		CV	2.1	1.4	2.1	2.3	1.8	1.8
	Green Channel	Mean	11.9	11.8	10.5	9.8	8.0	9.7
		CV	2.1	2.0	2.1	1.3	1.3	1.3
<b>Imports</b>	Red Channel	Mean	50.3	33.6	41.7	49.5	45.0	66.0
		CV	1.6	1.4	1.6	1.4	1.3	1.3
	Yellow Channel	Mean	33.1	30.7	36.8	31.7	28.5	34.6
		CV	2.0	1.8	1.1	1.8	1.5	1.6
	Green Channel	Mean	26.8	18.7	10.5	18.3	16.2	17.5
		CV	2.1	2.2	2.1	1.6	1.5	1.5

Source: Turkish Ministry of Customs and Trade.

### *Increased utilisation of computerised border clearance systems*

The computerisation of customs offices and automation of customs procedures is one of the key factors in improvement of the score. By the end of 2011, legislative arrangements concerning paperless declaration have been made - e-signature/m- signature for customs declarations have been made compulsory, 100% of customs transactions have been computerised, and paperless customs declaration procedures have been introduced in all customs offices.

All automated Customs offices are connected with each other and the Customs headquarters via local area and wide area networks. During the last five years, existing customs automation system is further developed also to work in sync with other systems utilised by related authorities and to allow external access for traders and eligible foreign trade intermediaries.

As of January 2012, all Customs offices in Turkey started to use New Computerised Transit System (NCTS), which is a European wide system of electronic declaration and processing that enables traders to submit community transit declarations electronically. The system provides a reduction of costs which are incurred in relation with the paper-based system of declaring goods. NCTS also allows less time spent waiting at customs, by declarations sent electronically beforehand. The system has a significant contribution to increased efficiency of transit operations, prevention and detection of fraud, and acceleration of transit transactions.

With a new set of actions and legislations put in force recently, a further increase in efficiency of customs clearance procedures is expected to come. On March 2012, the Turkish government has launched the single-window system, providing a centralised platform to streamline and simplify the operation of customs and other government agencies involved in border control. Under the single-window system, all required documentation and information needed for the import or export operation is submitted by the trader to a single application point.

The system aims at coordinating border control procedures, such as port transactions, customs transactions, technical controls and licensing through an integrated management system. The implementation has been divided into two phases due to complexity of the system. In the e-document phase, trader can apply to related public institutions via electronic or paper based methods. Then related institutions send data of the traders to Customs electronically. A registration number is assigned to each application and status can be checked electronically by using this number. The e-application phase is currently in the pilot phase. Full implementation will take place after an adoption process including

software development, review of current legislations, and training sessions for both public officials and traders.

Future plans include the incorporation of additional services and new features in relation to international data exchange. A voluntary Authorised Economic Operator (AEO) programme was launched on January 2013 to enhance security through granting recognition to reliable operators and encouraging best practice at all levels in the international supply chain. Turkey has commenced negotiations with EU, Korea and USA to sign Mutual Recognition Agreements (MRAs) to increase the benefits of the system.

Although the technical and operational conditions for the introduction of ‘one-stop’ controls at border crossings are in many cases satisfactory, there are currently no links between the databases of the different border services. Information exchange occurs on an ad-hoc basis and is not institutionalised. There is a process underway for database integration which will include databases from the Customs, Ministry of Interior, Ministry of Foreign Affairs, Land Forces and Coast Guard.

#### *Integrating activities of border management agencies*

Another obstacle to efficient management of customs clearance processes is the lack of coordination between the government departments and agencies involved in controlling cross-border transactions. For a number of reasons, border crossings are subject to substantial and often unpredictable variability. Even though the average border crossing capacity is sufficient, significant volumes during peak seasons result in long delays. This is partly due to insufficient infrastructure and telecommunications capacity. Also the multiplicity and diversity of sometimes uncoordinated data and document requests by different agencies increases transaction costs and the risk of making mistakes.

According to *Doing Business 2014* (World Bank, 2013), on average eight documents are required for export and import operations in Turkey. Yet, according to a study conducted by the Ministry of Trade and Customs in 2011, 330 different documents are used in customs transactions where 94% are collected from other institutions than the customs administration.

Similarly, only 1.5 days of the average time recorded for imports are spent in customs agencies. Remaining days are spent for collection of the documents from other public and private institutions, laboratory inspections, and other similar supporting processes. The complicated and rigorous customs controls and elevated fines that serve to thwart the corruption of a few actors place high time and money costs on all others.

#### *Improvement of border facilities*

Around 40% of Turkey's foreign trade is conducted through the country's land borders. Modernising inefficient border crossing points (BCP) has become one of the most important issues in the country's reconstruction policies. However, these have not been realised for some time due to a lack of financing.

A private institution, the Customs and Tourism Enterprises (GTI), established by The Union of Chambers and Commodity Exchanges of Turkey (TOBB) in 2005, is undertaking the modernisation of BCPs, including the actual border gates. This is done using the ‘build-operate-transfer’ model in a partnership between TOBB and government and public institutions.

Modernisation of five BCPs is already completed, and the reconstruction and renovation of five new points is still on-going. “Build” stage covers modernisation of BCPs, reconstruction of the physical and

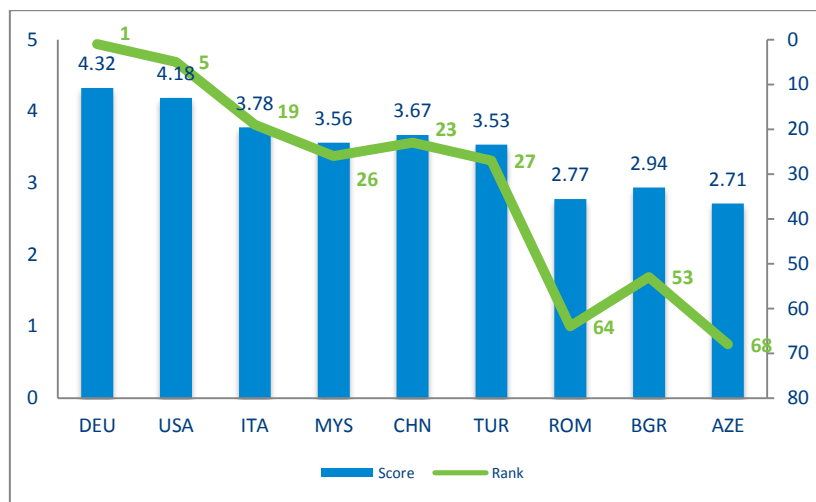
telecommunications infrastructure, building supporting facilities, and providing the advanced technological equipment. In the “Operation” stage, GTI operates only the commercial areas; food and beverage stores, banks, souvenir shops, gas stations and duty-free stores, and also assists cleaning and maintenance services. Any administrative processes and procedures such as customs clearance and travel documents inspection are undertaken by government institutions and bodies. At the end of the concession period, the modernised facilities will be transferred back to the public sector in the “Transfer” stage.

As a result, waiting times at the borders have been substantially reduced, queues have been shortened, and vehicle and passenger passing time has been sped up by a factor of four. The technical improvements that accompanied the modernisation of BCP infrastructure have also made an effective contribution to security and control over smuggling and human trafficking.

### *The quality of trade and transport infrastructure*

Infrastructure development is essential for assuring basic connectivity and access to gateways. Surrounded by four seas on three sides, Turkey is geographically advantaged with easy access to Eastern Europe, Central Asia, the Middle East and North Africa. However, inland connections are relatively underdeveloped due its hilly landscape and poor infrastructure in remote areas. In the World Economic Forum’s global competitiveness index for 2013-2014, Turkey is ranked 27<sup>th</sup> out of 144 countries for its transport infrastructure, particularly benefiting from reasonably developed road and air infrastructure. Maritime and rail transport infrastructures rank below average, with a ranking of 63<sup>rd</sup> in ports and 52<sup>nd</sup> in quality of railroad infrastructure.

Figure 3.7. **Quality of transport infrastructure: LPI score and rank among 160 countries**



Source: Arvis et al. 2014

Notes: Peer Group Scores (left-hand axis; 1 = min; 5 = max.) and country ranks (right-hand axis).

2014 Domestic LPI results for the quality of trade and transport related infrastructure (e.g. ports, roads, airports, information technology) are presented in Table 3.3. Turkey’s performance is noticeably above the group average in three areas: warehousing, road and port infrastructure.

Table 3.3. The quality of trade and transport related infrastructure in the LPI 2014

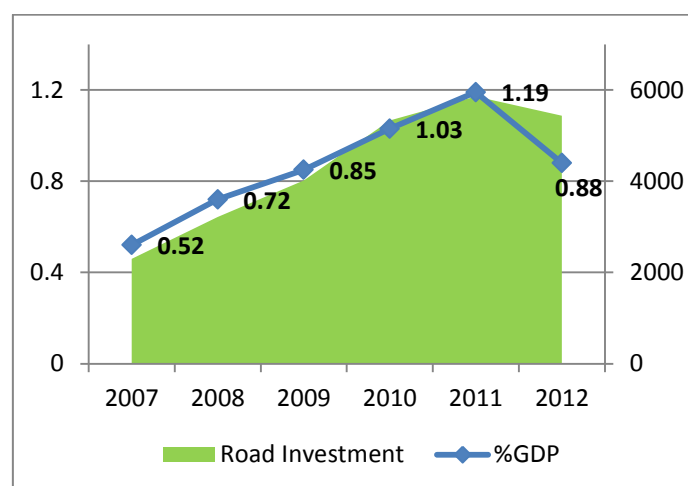
	Per cent of respondents answering above average				
	Turkey	Average UMI	Europe & Central Asia	Malaysia	Germany
Ports	88%	38%	25%	67%	100%
Airports	84%	44%	33%	100%	100%
Roads	88%	29%	30%	100%	100%
Rail	39%	22%	26%	100%	100%
Warehousing	97%	55%	26%	100%	100%
Telecom and IT	94%	59%	40%	100%	100%

Source: Arvis et al.2014.

### Construction of new transport links

Turkey's LPI score in quality of trade and transport infrastructure has significantly improved since 2007. Massive road investment plays a crucial role in increasing Turkey's infrastructure performance. As Figure 3.8 illustrates, the percentage of road investment in GDP has almost doubled in the last 5 years, reaching up to EUR 5.9 billion in 2011. International freight forwarders are the direct assessors of logistics performance in the LPI methodology and since they constitute almost 60% of the road freight industry, any improvement in road infrastructure is likely to be reflected directly in the LPI.

Figure 3.8. Road investments in Turkey 2007-2012



Source: Turkish General Directorate of Highways.

Notes: in million Euros (right-hand axis) and percentage of GDP (left-hand axis).

### Increased private sector participation to provide and maintain transport related infrastructure

The improvement in the infrastructure score also depends on the successful projects and strategic actions taken to increase the competitiveness in transport infrastructure and to promote private sector participation in infrastructure development projects. The Build-Operate-Transfer (BOT) model has extensively been utilised for raising the standards of the road network and developing modern road infrastructure between important industrial centres in Turkey. Logistics connectivity has been improved by construction of several new motorways and bridges through BOT model.

Currently, a number of existing ports are being expanded and new container terminals are being built. Turkey's container capacity is expected to be tripled by 2023, if all the current expansion and construction projects are carried out. This is also reflected in improved ratings in UNCTAD's Liner Shipping Connectivity Index<sup>2</sup> where Turkey was ranked 21<sup>st</sup> out of 155 countries in the world.

Table 3.4. **Public-Private Partnership Projects (PPP) in transportation in 2014**

Sectors	On-going		Completed	
	Value (USD million)	Number	Value (USD million)	Number
Airports	538	2	12,580	8
Roads	8,000	3	195	18
Ports	73	1	2,278	3
Border Gates	22	1	197	7

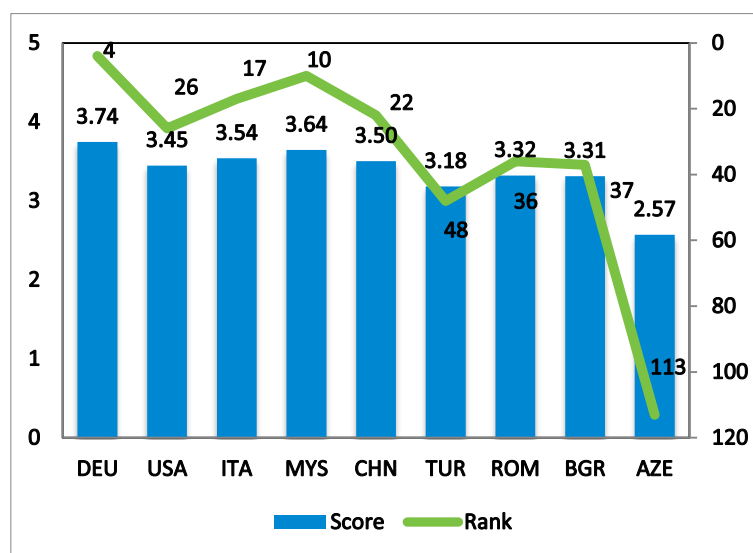
Sources: Turkish Ministry of Development and <http://ppi.worldbank.org/>.

Despite the intense infrastructure investments and capacity enhancement efforts in maritime transport, freight handling capacity of the Turkish ports is still restricted by hinterland transport facilities and connections between international ports and manufacturing sites. As port hinterlands are limited, increased throughput causes delays to the movement of goods and increased variability in handling times. Turkish maritime industry still suffers from lack of a standardised system which provides a seamless communication between ports and other port related institutions. Due to the lack of a system for online data exchange, most of the operations are still paper-based (Keceli, 2011).

#### *Ease of arranging competitively priced shipments*

The ease of arranging shipments is Turkey's weakest LPI component, which has also been the one with the lowest level of improvement after 2007. On this component Turkey ranks 48<sup>th</sup> out of 160 countries, and 10<sup>th</sup> out of 41 upper-middle-income economies. (Figure 3.9)

Figure 3.9. **Ease of arranging competitively priced shipments: LPI score and rank among 160 countries**



Source: Arvis et al. 2014.

Notes: Peer group scores (left-hand axis; 1 = min; 5 = max.) and country ranks (right-hand axis).

The macroeconomic factors generally make services more expensive and may make it hard to arrange low priced shipments (Arvis et al. 2014)] in high income countries. Table 3.5 presents the typical charge for a 40 foot dry container or a semi-trailer when exporting and importing a full load in selected countries. The numbers illustrate that Turkey has shipping charges as high as the high-income-economies despite being a middle-income-country which places it at a disadvantage compared to its regional competitors, particularly over land supply chains.

In comparison with EU, facility utilisation rates and operational charges related to logistics services are relatively low in Turkey. For example, Turkish port service charges are much lower than charges incurred in other major ports around the globe. However, the cost advantage is surpassed by longer times spent at ports due to delays and longer and complicated import procedures (TUSIAD, 2012).

Table 3.5. **Typical shipping charge for a 40-foot dry container (USD) according to LPI 2014**

	Port		Land	
	Export	Import	Export	Import
<b>Germany</b>	675	892	1 129	1 326
<b>United States</b>	921	769	1 293	944
<b>Italy</b>	647	647	1 316	1 456
<b>China</b>	494	683	683	514
<b>Turkey</b>	759	767	1 165	1 196
<b>Romania</b>	866	707	500	500
<b>Bulgaria</b>	600	600	508	454

Source: Arvis et al.2014.

Turkey's heavily road dominated transport system accounts for high costs of transport and maintenance, congestion, which has a negative impact on the environment and affects also road safety. High energy costs represent one of the greatest obstacles for road transport and trade.

#### *Promoting low cost transportation modes*

To strengthen combined and intermodal transport and decrease the country's dependence on road transport, authorities recently approved the law on the liberalisation of the Turkish railway transportation which has opened doors to private investment. The law also allows international investors to enter into the Turkish railway sector. Government incentives for the railway sector are expected to speed up the privatisation process. For example, the government expanded the definition of "large scale investments" to include the manufacturing of locomotives and rolling stock. This qualification means that manufacturers can now benefit from a number of incentives such as low corporate taxes, social security support, and land allocation. Expected impacts include improved quality of rail transport services and increased availability of competitively priced shipments.

Outside of the logistics system itself, high energy costs represent the single greatest obstacle for road transport and trade network. Particularly for long distance destinations, diesel fuel accounts for over 60% of total freight costs. Given high domestic energy costs, companies are seeking low cost practices such as using fuel-efficient trucks or intermodal transport.

Especially large international companies use intermodal transport for creating a competitive advantage rather than relying purely on road transport. However, the sector is highly fragmented and the many smaller logistics firms lack the profit margins and upfront capital required to purchase fuel-efficient vehicles. Similarly, the main obstacle to more generic use of intermodal transport is the lack of intermodal equipment. More than 90% of semi-trailers cannot be lifted by cranes and cannot be loaded onto standard intermodal trains. Even though intermodal transportation is utilised in international

transport and logistics activities, at present, no financial and administrative incentives are utilised to empower intermodal transport, such as tax reduction and subsidy schemes.

Moreover, there is no national legal framework or provision that will regulate the national and international intermodal transport or facilitate the transition to lower cost transportation modes. There is a requirement for a comprehensive intermodal transportation strategy and framework (ITF, 2009). Turkish Ministry of Transport Maritime and Communication is planning to solve this problem through the EU Twinning Project of Strengthening Intermodal Transportation in Turkey with the goal of preparing an intermodal transportation legislation that is harmonised with the EU legislation.

#### *Encouraging economies of scale*

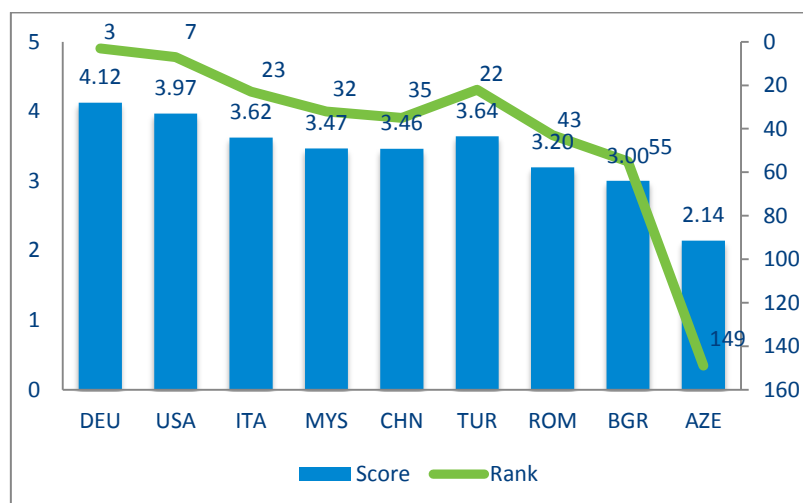
The Turkish transport market is internationalizing through the entry of large European and Asian logistics groups in. This mostly occurs through acquisition of Turkish companies. Turkish logistics providers are also becoming larger, growing both nationally and internationally. Market entry has been made easier to attract FDI and the sector has also welcomed several leading international firms over the years. This has elevated competition and accelerated the inward transfer of technology and expertise.

Though Turkey has introduced important regulatory reforms in road, air and maritime transport sectors and launched significant infrastructure investments to promote rail, maritime and air transport, these actions often focus only for the specific single transport mode concerned.

#### *Competence and quality of logistics services*

The competence and quality of logistics services measures the overall level of logistics services available in a country. It also represents the quality of the logistics services and operational excellence of the transportation operations. Turkey's performance on this dimension is relatively high in its peer group with an increasing trend of 12% growth from 2010 to 2014.

Figure 3.10. **Quality of logistics services: LPI score and rank among 160 countries**



Source: Arvis *et al.* 2014.

Peer group scores (left-hand axis; 1 = min; 5 = max.) and country ranks (right-hand axis).

### *Supporting logistics industry and private sector*

There is an especially large and diverse pool of internationally oriented global providers in Turkey offering transportation, bonded warehousing, fiscal representation and value-added logistics services at competitive rates. Turkey scores very high on the competence and quality of logistics services such as road and maritime transport operations and freight forwarding services, but the quality of rail transport operations and supporting services such as customs and inspection agencies lag behind the regional and economic averages (Table 3.6). Turkish government regulates various aspects of the freight transportation sector. Government imposes several regulations on safety, environment and economic aspects across all modes of transport in line with the compliance with EU.

**Table 3.6. Competence and quality of services according to LPI 2014**

	Per cent of respondents answering high/very high				
	Turkey	UMI	Europe and C. Asia	Malaysia	Germany
<b>Road</b>	81%	48%	61%	33%	90%
<b>Rail</b>	20%	21%	44%	0%	68%
<b>Air transport</b>	70%	60%	66%	67%	94%
<b>Maritime transport</b>	83%	66%	80%	100%	84%
<b>Warehousing and distribution</b>	77%	66%	77%	67%	90%
<b>Freight forwarders</b>	81%	73%	81%	100%	85%
<b>Customs agencies</b>	55%	55%	69%	67%	85%
<b>Quality inspection agencies</b>	47%	44%	61%	33%	85%
<b>Health/SPS agencies</b>	33%	43%	59%	0%	76%
<b>Customs brokers</b>	55%	61%	78%	67%	80%
<b>Trade and transport associations</b>	68%	52%	58%	0%	78%
<b>Consignees or shippers</b>	61%	49%	68%	33%	84%

Source: Arvis et al. 2014.

Turkey's logistics performance is primarily bolstered by development of the private sector. The sector is getting more internationalised through entry of large European and Asian transport and logistics groups in the Turkish transport market, mostly over acquisition of Turkish companies. Turkish logistics providers are also becoming larger, growing both nationally and internationally. Market entry has been made easier to attract FDI and the sector has also welcomed several leading international firms over the years. This has elevated competition, but also led to the inward transfer of technology and expertise.

Chambers of Commerce and industry associations also take an active role in the development of the sector and the improvement of service quality. Several successful projects are accomplished by these associations, such as BALO project and build-operate-transfer model for modernisation of border crossing points. International Transporters Association (INTA) offers consultancy, certification, and training services for its members on a wide range of topics such as legislations, insurance, finance, institutionalization, and safety and security.

### *Supporting human resources and skill development in logistics and transportation*

Despite the high growth performance of the industry, the availability of skilled work force in the logistics sector is scarce, leading to lacking management skills especially at tactical and strategic levels. The logistics sector in Turkey suffers from organizational skills, lack of leadership, disjointed skills, and positions and lack of sufficient R&D activities.



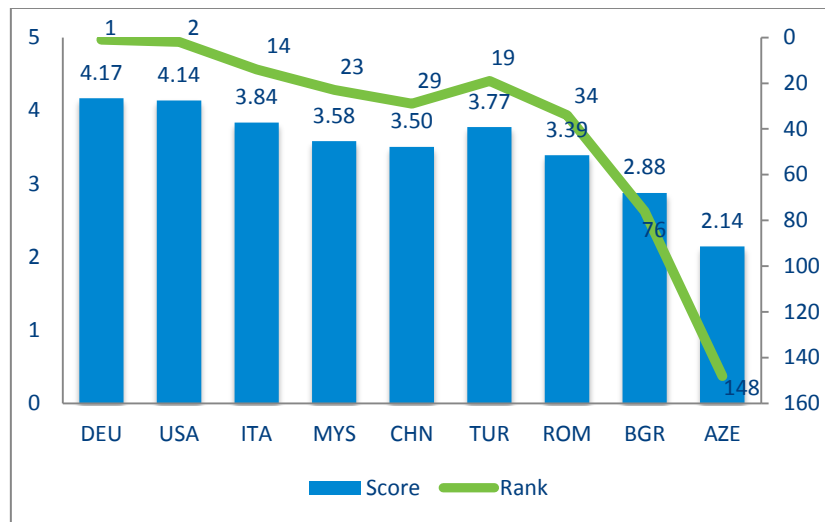
The transport and logistics industry appears highly unattractive due to its poor image, extreme working conditions, low pay scale, and lack of clearly defined career paths. Incentives to support professional training and higher education in logistics and transport are scarce. The most severe and immediate need for skill development is in the technical and middle management levels.

#### *Ability to track and trace consignments*

It is important to identify the exact location and the route of each consignment up to its delivery to the end customer. Traceability is the result of the activity of the logistics sector as a whole, since all parties in the goods' supply chain are involved in this component. Since lower income countries do benefit significantly from improved tracking and tracing, it can be regarded as one of the priority areas for future investments in trade logistics (Korinek and Sourdin, 2011). Improved traceability creates more reliable distribution channels processes and provides a better risk management system and helps improving internal and external business.

Ability of tracking and tracing shipments is Turkey's strongest point; country's performance in this dimension has shown a consistent and remarkable increment after 2010. Increasing its rank from 56<sup>th</sup> in 2010, currently Turkey is ranked 19<sup>th</sup> in traceability, performing better than many high income economies.

Figure 3.11. **Ability to track and trace consignments: LPI score and rank among 160 countries**



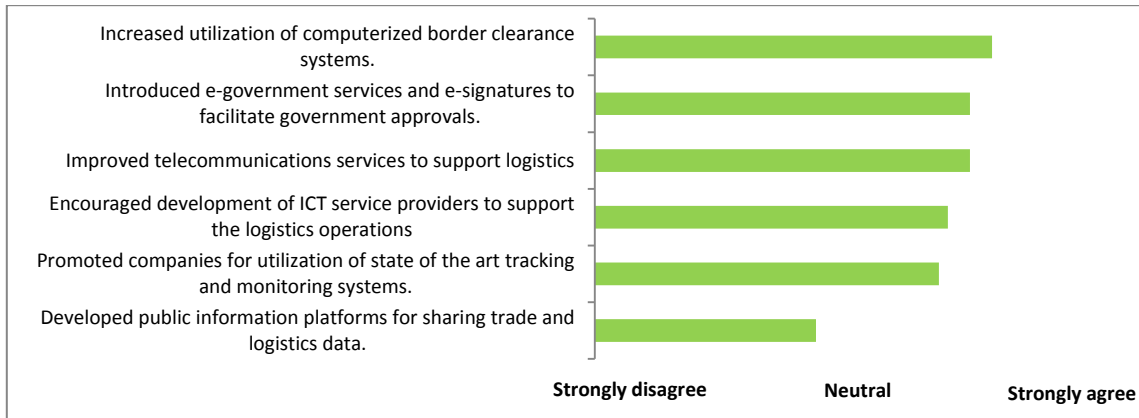
Source: Arvis *et al.* 2014.

Notes: Peer group scores (left-hand axis; 1 = min; 5 = max.) and country ranks (right-hand axis).

#### *Promoting utilisation of ICT in logistics services*

The increase has greatly profited from widespread use of information and communication technologies (ICT) in public and private institutions. ICT provides a convenient way of improving the tracking and traceability performance by enabling gathering, organizing and distributing information on products, services and trade regulations. Several companies use the internet as an exchange mechanism for planning the supply chain with their partners. Major freight transport service providers provide information on their services, schedules and rates that can be easily accessed.

**Figure 3.12. State of policy actions for tracking consignments**

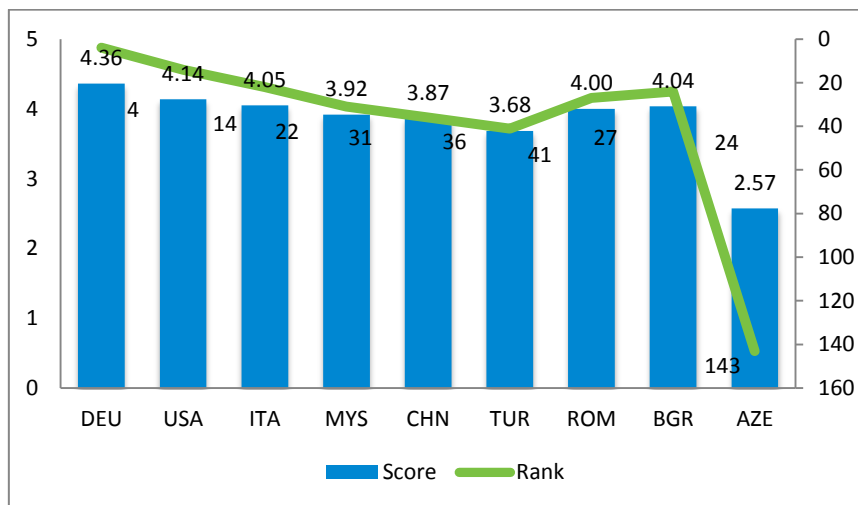


One of the major barriers confronting companies in the uptake of advanced ICT technologies is the high investment risk. This imposes great uncertainties on the willingness of the private sector to invest in ICT, particularly if there is uncertainty surrounding governments’ communications policy and spectrum allocation. Hence, policymakers need to keep up with the rapid development of ICT and develop a stable communications framework that is conducive to logistics planning by the private sector (OECD, 2002).

*Timeliness of shipments in reaching destination*

Timeliness of shipments in reaching destination measures how reliably shipments meet the promised delivery times. Turkey’s performance on timeliness of shipments is relatively low compared to most peers. The score has decreased significantly since 2010. Shipment times depend on the nature of the product, planning and management, logistics services, distance to customers and suppliers, but also on external factors such as supply chain disruptions related to political risks or weather conditions. Table 3.7 gives the average time measures for selected countries in terms of export and import lead times recorded in Domestic LPI report, and trade times, recorded by WB Doing Business project. The latter measure also includes the waiting time between procedures, for example, during unloading of the cargo.

**Figure 3.13. Timeliness of shipments in reaching destination: LPI score and rank among 160 countries**



Source: Arvis *et al.* 2014

Notes: Peer group scores (left-hand axis; 1 = min; 5 = max.) and country ranks (right-hand axis).

Timeliness of the shipments mainly is an indicator of supply chain reliability. A long lead time is not necessarily a problem if delivery is predictable and demand is stable. However, if there is uncertainty about future demand, long lead time is costly. Table 3.8 details possible causes of delay that are not directly related to how domestic services and agencies perform in benchmark countries. Turkey performs relatively well in terms of compulsory warehousing and criminal activities. Of the five LPI delay categories, maritime transshipment has the highest percentage of respondents who often or always experience delays.

Table 3.7. **Indicative average export and import lead-times in days**

	Export Lead Time*		Import Lead Time*		Time to Export**	Time to import**
	Port	Land	Port	Land		
Germany	1	2	2	3	9	7
USA	2	2	3	3	6	5
Italy	1	2	1	1	19	18
Malaysia	1	1	-	-	11	8
China	2	3	2	2	21	24
Turkey	2	2	2	3	13	14
Romania	2	2	-	1	13	13
Bulgaria	1	1	1	1	20	17

\* Time taken to complete trade transactions (days) Arvis *et al.* 2014]

\*\*Time necessary for a procedure starts from the moment it is initiated and runs until it is completed (days)

Source: World Bank (2014), *Doing Business 2015*.

Table 3.8. **Sources of major delays according to LPI 2014**

	% of respondents answering often or nearly always				
	Turkey	UMI	Europe and C. Asia	Malaysia	Germany
Compulsory warehousing/trans loading	6%	46%	38%	0%	15%
Pre-shipment inspection	13%	60%	49%	0%	20%
Maritime transshipment	33%	54%	59%	33%	21%
Criminal activities	3%	40%	40%	33%	11%
Solicitation of informal payments	10%	53%	64%	33%	5%

Source: Arvis *et al.* 2014.

### *Reducing transport network system vulnerability*

The need to reroute shipments due to political instability and war in neighbouring countries has been one of the major reasons for delays in delivery times. For international shipments, Turkish trucks use sub-optimal routes, some of which are limited by capacity restrictions. This results in increased delivery times and shipment costs. Turkish trucks are directed to use the two Ro-La3 lines from Slovenia and Italy in order to transit Austrian territory. In 2012, 90% of the trucked carried on Slovenia-Italy Ro-La lines were carrying a Turkish plate. Due to capacity constraints in those lines, transporters often experience long waiting times during peak hours.

Any uncertainty in the border crossings creates unpredictable circumstances and delays, increases transactional costs, and can even lead to the loss of business and opportunities. On a daily basis, such unpredictable circumstances are the result of multiple and contradictory documentation requirements or

lengthy inspection procedures by agencies that include customs, immigration, health and sanitary authorities, police and other security agencies. However, certain external events, when combined with existing network vulnerabilities, have the potential to cause widespread, systemic disruptions with high impacts, such as natural disasters, wars, political disputes, or government imposed legal restrictions.

For example, in 2014 a transit permit crisis that loosed the border between Turkey and Bulgaria for almost two weeks has created a truck queue of over 10 kilometres, waiting for border crossing. Transporters immediately turned to alternative routes to transport goods to Europe, yet the absence of one of the major and cheapest transit options has created huge losses.

Similarly, the number of Turkish trucks crossing the Syrian border has decreased by 87% after the free trade agreement between the two countries has been suspended and Syria imposed prohibitive duties on fuel and freight. As a response, new trade routes to the Middle East have been created where cargo ships sail between the Turkish port of Mersin and ports in Egypt.

## **Findings**

This case study used Turkey as the focal country. It also gives an idea how an intensive and relatively quick analysis of a country's logistics performance could be made in view of trade and transport operations. One starting point for the analysis was the World Bank's bi-annual Logistics Performance Index (LPI), which is an indicator of a country's trade logistics performance. Being a survey with comparative findings across more than 160 countries, it provides overall metrics of a country's supply chain efficiency. It also provides a broad indication of related problem areas. However, the LPI is not a diagnostic tool. Therefore, other tools are needed to perform that function, such as the structured stakeholder interviews and surveys, along with other available statistical and survey evidence, that were used in the case study on Turkey.

While some findings are specific to Turkey given e.g. its size, economic level of development, endowment structure and geographic location, some more generally applicable observations can also be drawn. These include the following:

### ***Variability is one of the main factors of efficiency of the customs and border clearance***

Clearance time variability mainly affects the efficiency of the customs and border clearance. A high rate of variability is typically more damaging than having long, but predictable lead times. Policies related to the simplification and automation of customs procedures, efficient risk management, optimal use of information and communications technology, effective partnership with the private sector, and increased cooperation and transparency can significantly improve efficiency and reduce variability. Even though the average clearance times haven't changed, Turkey managed to decrease the variability of the clearance times significantly after 2010. This progress particularly relies on the simplification and automation of the procedures, increasing IT capability, and investing for improved management and human resources capability.

### ***Capacity management plays vital role infrastructure efficiency***

Despite the sufficient capacity levels in terms of terminal facilities for loading and unloading containers, port infrastructure of Turkey still suffers from unavailability of well-connected, high-speed roads and railways which prevents port areas to satisfy capacity extension requirements. Restrictive constraints on the port capacities are mainly related to the hinterland areas and connections to other transport modes. Many ports are located in or near cities which limits the availability of hinterland areas.

As port hinterlands are limited, increased throughput causes delays to the movement of goods and increased variability in handling times.

Most of the transport facilities operate with low utilisation rates, yet suffer from capacity constraints in peak periods due to high variability of demand. Flexible transport systems, better resource allocation, and higher utilisation of existing physical infrastructure provide less costly and more efficient improvement opportunities than capacity extension.

On the other hand, Turkey's road dominated transport system accounts for high costs of transport and maintenance, congestion, negative impacts on environment and difficulty of providing road safety. High energy costs represent one of the greatest obstacles for road transport and trade network. At present, there is no national legal framework or provision that will regulate the national and international intermodal transport or facilitate the transition to lower cost transportation modes.

***A successful and powerful private sector is the leading factor in providing high quality logistics services***

Turkish logistics performance is primarily bolstered by development of the private sector. Market entry has been made easier to attract FDI and the sector has also welcomed several leading international firms over the years. This has elevated competition, and also led to the inward transfer of technology and expertise. Chambers of commerce and industry associations also take active role in the development of the sector and improvement of service quality. There exist various government actions to support private sector to develop logistics competencies, such as promoting competition, increasing managerial capacity, setting quality standards, supporting professional organizations, regulating business certification, and ensuring standardisation of operations.

***As the external risks are hard to predict or prevent, the focus must be on making the right investments before the event to reduce transport network system vulnerability and improve recovery capability***

Turkey's performance on timeliness of shipments in reaching destination has experienced a significant decrease after 2010. The current practice of road transport routes results in sub-optimal routes, some of which are limited by capacity restrictions. This results in increased delivery times and shipment costs. Similarly the need to reroute shipments due to political instability and war in neighbouring countries has been one of the major reasons for delays in delivery times.

Any uncertainty in the border crossings creates unpredictable circumstances and delays, increases transactional costs, and can even lead to the loss of business and opportunities. As the external risks are hard to predict or prevent, the focus must be on making the right investments before the event to reduce transport network system vulnerability and improve recovery capability. It is necessary to for the public and private sector to work together, sharing data and information, to enable organisations to better understand and quantify logistics risks. This will improve network risk visibility, and in turn will facilitate the development of proactive and effective actions.

## **Conclusion**

This study highlights the importance of promoting policies to improve logistics performance and by implementing efficient policies countries significantly may improve their ability to trade competitively in international markets. For countries, it is important to establish a clear relationship between performance indicators and the transport policy objectives, in order to transform indicator values into relevant action and link them to past and future development. Findings show that even though most aspects of the country's logistics performance are in line with previous findings, the LPI score is a function of various

factors, with complicated associations within structure and time, and improving logistics performance is a complex task which requires comprehensive reforms and long-term commitments from policymakers and private stakeholders.

Further steps cover development of a standardised framework for assessing the potential impacts of policy components on the quality of logistics services, trade competitiveness, and trade and logistics related performance indicators based on a standardised and replicable methodology. This framework will further be developed to a generic toolkit for other countries for managing policy changes and suggest future projects to realise opportunities to remove the trade impediments, as well as determining the priority areas of policy actions, given limited resources of investment.

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## Notes

- <sup>1</sup> The process resembles the one outlined by Arnold *et al.* 2010
- <sup>2</sup> See e.g. <http://data.worldbank.org/indicator/IS.SHP.GCNW.XQ>
- <sup>3</sup> Ro-La refers to "Rollenden Landstrassen" (in German), where trucks are piggy-backed on freight trains for a certain part of the route, typically through an alpine region in Austria.





## **Chapter 4. Supply chain performance measurement in Latin America**

Gaston Cedillo, National Researcher, National Council of Science and Technology

This chapter discusses improving supply chain performance measurement in Latin America. First, it provides an overview of supply chain performance measurement approaches currently applied in the academic world, identifying the most common metrics and methods. Second, it provides a critical analysis, from a Latin American perspective, of approaches to measuring supply chain performance based on logistics costs. Third, it sets out an emergent supply chain analysis approach that could usefully be incorporated in a future supply chain performance measurement framework

## Introduction

According to the International Labor Organization (ILO), the real salaries in Asia between 2000 and 2008 increased almost 1% per year, whereas in China, they increased 10% per year between 2000 and 2005 and 19% between 2005 and 2010. These figures, added to the increasing energy and logistical costs, have damaged the competitive advantages of the Asian Giant as the main manufacturing platform to the West, and initiated a new step to the global hyper-competitiveness, a “*regionalization of the global economy*”.

For any industrial organization, controlling operational costs has been a main issue for decades. The transfer of the Lean Manufacturing concepts to the logistics and supply chain area has enabled developing concepts based on efficient operations (Lean Logistics, Lean Supply Chain, etc.). However, nowadays, the increasing volatility of the markets, as well as the variability in demand and the increasing risk of disruptions in the supply flow (either caused by natural disasters or intentionally by men) are driving the design of more agile, cheaper, and above all, more resilient supply chains (Gaonkar and Viswanadham, 2004; Giunipero and Eltantawy, 2004; The White House, 2012; Bueno and Cedillo-Campos, 2014; Cedillo-Campos et al., 2012; Cedillo-Campos et al., 2014a; Cedillo-Campos et al., 2014b). In fact, uncertainty is making companies go from a “lean” approach (efficient) to integrated effective solutions in which efficiency is only important when it guarantees a proper level of resilience in the supply chain to face operational unexpected events (Waters, 2007; Wilson, 2007; Wu et al., 2007; Stecke and Kumar, 2009; Thun and Hoening, 2011; Vilko and Hallikas, 2011).

Nowadays, both companies and regions are facing a complex set of ever changing factors that constantly transform their business environment. This situation requires major analytical abilities, a comprehensive perspective when designing a competitive model, and a substantial improvement of their decision-making abilities to respond to the demand. With the increasing globalization, manufacturing companies have standardised, and replicated process with some success almost everywhere companies have decided to settle. However, only a few countries have achieved distinctive capabilities to reach an economic development more based on supply chain, engineering, and continuous innovation than on low-cost labour. With an increasing amount of regions with high manufacturing capabilities, we see today a major global interaction, where supply flows are the key element of the global trade (Notteboom and Rodrigue, 2012; Rodrigue, 2012).

Today, the region is considered as the physical context that facilitates the development of relational strengths and drives the success, innovation, and competitiveness of the industrial operations and services (Marshall, 1961; Storper, 1997; Porter, 1998; Theo and Roelandt, 2000; Li and Cai, 2004). Consequently, the most competitive companies at a global level acknowledge that success is mainly because they are located in regions able to go along with them in their own competitive challenges (Cedillo-Campos et al., 2006; Cedillo-Campos and Perez-Araos, 2010).

This is why an “efficient” (low-cost) answer is no longer considered enough to compete in the current global market. In fact, companies in areas such as hi-tech, automotive industry or aerospace will not only require major logistical innovation within organization, but also a major dexterity and accuracy in decision making from the public agencies. The future of both companies and of the region will always be more interrelated in dynamic interactions that have not until now been properly analyzed (Cedillo-Campos, 2012; Cedillo-Campos and Sanchez, 2013).

Since “supply chain consists of all parties involved, directly or indirectly, in fulfilling a customer request” (Chopra and Meindl, 2013), to improve supply chain performance measurement in emerging

regions as Latin American one is increasingly complex. Since in the Latin American region there are operational risks due to factors like market and financial volatility, quality fade, supply chain disruptions, security issues, infrastructural challenges, and lack of transparency; a systems approach in logistics is needed (Bertalanffy, 1968).

Accordingly, based on literature review, this chapter proposes a threefold discussion for improving supply chain performance measurement in the region. First, this chapter offers an overview of supply chain performance measurement approaches currently applied in the academic world identifying the most common metrics and methods. Second, it provides a critical analysis and proposes a Latin American perspective when measuring supply chain performance based on logistics costs. Third, it exposes information about an emergent supply chain approach that could be important to integrate as part of a future supply chain performance measurement framework.

### Supply chain performance measurement

In 2001, Perchet was already expressing that “the world economy is now structured according to a double competition: a) the competition between companies that are increasingly globalizing; and b) the competition between the regions that try to attract the best investments. The competition between companies keeps on looking for major parts of the world market, so the competition between regions must take into account not only perseverance, but also maximization of the attraction of productive investments, generating major incomes for the region, and must at the same time, develop at least some significant competitive advantages”.

From this perspective, based on Chopra and Meindl (2013), the modern concept of supply chain also involves now the region (the local geographic space) where supply chains operate. A territory where local and global supply chains interact building the global value chains. For decades, international trade was based on three main flows: i) exchange flows of manufactured products between industrialised nations; ii) export flows of products from industrialised nations to developing nations; and iii) export flows of raw material and primary goods from developing nations to industrialised ones. However, since offshoring strategies became a critical part of most of the manufacturing business models, nowadays this context is fundamentally different. The geographical dispersion around the globe of different value components of the same value chain, allowed emerging countries to be part of the manufacturing and trading fragments of goods where they did not participate before (Blyde, 2014). Today, according to Accenture (2014), between the success factors achieved by leader companies when operating their supply chains in emerging markets as Latin American, four factors count with a strong local component:

- investments in assets located in the region (plants, supplier basis, etc.)
- service providing from local sites
- hiring local talent
- set up a joint venture or partnership with a local organization.

Considering the current Latin American context where companies and regions are in front of the competitive challenge for integrating global supply chains with more local content, local governments are in a fierce battle to attract industrial investments. Still, the question about how local regions can effectively support in the long term the supply chain competitiveness of the different industries remains (beyond the initial fiscal incentives, development of dedicated infrastructures and resources, among others).

Today it is clear that monitoring supply chain performance is critical to transform strategic planning into concrete competitive actions across different entities (companies, public agencies, universities, non-profit organizations, etc.). Nevertheless, to identify the right measurement techniques and attributes when measuring supply chain performance remains a significant challenge.

### *Measurement techniques and attributes: a global perspective*

A measurement technique is here understood as a procedure or set of rules, standards or protocols, which aim to achieve a particular result, whether in the field of science, education or any other activity (Avelar-Sosa et al., 2014). On the other hand, an attribute is understood as a set of metrics used to express a value, which is related to company's competitive strategy. The measurement and control of these attributes must provide direct or indirect feedback information that supports a better control of business processes (Chan, 2003; Abu-Suleiman et al., 2004).

Therefore, since supply chain is a concept emerged in the business context, currently, most of the measurement techniques take into account industrial attributes leaving aside the territorial component. Thus, Elgazzar et al. (2012) and Chen and Gong (2013) argue that because one of the main companies' objectives is to compare their own performance with others in the same industry when measuring supply chain performance, measurement should be extended to all supply chain members from a global perspective.

Currently, there are two main types of measurements to evaluate the overall performance of companies: financial; and operational. The first considers strategic indicators derived from economic and financial outcomes, while the second considers indicators regarding tactical attributes critical for short or mid-term activities. However, authors as Gunasekaran et al. (2001) note that companies do not achieve a balance when measuring these two groups of attributes. It is because, when designing measurement frameworks, managers mainly focused their analytics efforts on financial attributes, and researchers on operational ones. In fact, Bhatnagar and Sohal (2005) highlight that academic literature has tended to emphasise on quantitative factors, and consequently, operational attributes have gained more importance. As a result, it seems that modern approaches to diagnose supply chains should not only include quantitative attributes, but also qualitative ones. Actually, Jiménez and Hernández (2002) have mentioned that to improve measure attributes oriented to planning, material procurement, production and distribution as well as customer service an integrated qualitative and quantitative approach is a need.

More operationally, modern supply chain literature highlights the importance of complementary attributes of cost (Otto and Kotzab, 2003; Guiffrida and Nagi, 2006), such as collaboration among partners (Ramanathan, 2014), globalization (Caniato et al., 2013), risk of disruptions (Cedillo-Campos and Bueno, 2014) carbon food-print (Velázquez-Martínez et al., 2014), corporate social responsibility (Cruz, 2013), among others. Some other authors include local advantages when analyzing supply chain performance (Veltz, 1993; Veltz, 2000; Dzever et al, 2001; Saives, 2002; Bhatnagar et al., 2005; Cedillo-Campos et a., 2006; Cedillo-Campos and Perez-Araos, 2010; Cedillo-Campos and Sanchez, 2013).

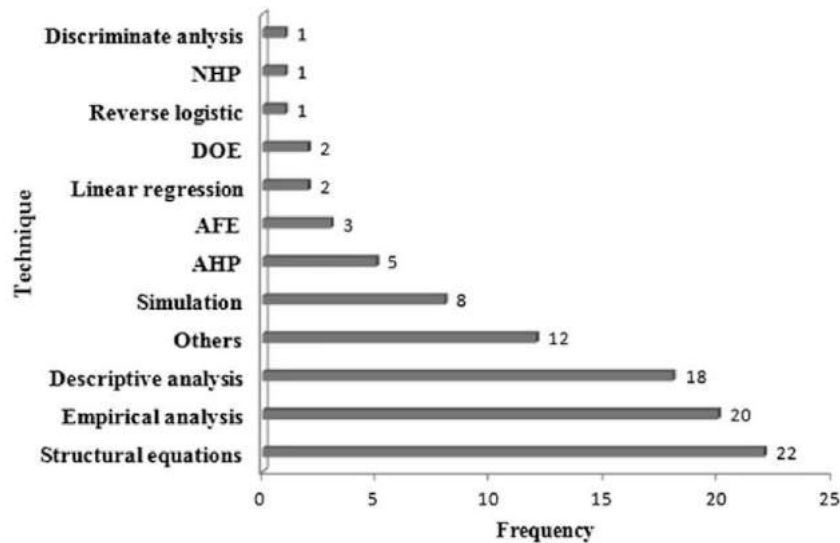
Other authors analysing supply chain performance measurement highlight important attributes, such as collaboration (Ramanathan and Gunasekaran 2014), environmental management (De Giovanni and Esposito 2012; Perotti et al. 2012), dynamism in the supply chain (Wiengarten et al. 2012), responsibility and partnership (Gallear et al. 2012).

In that sense, based in a large literature review and laborious statistical analysis, that involved 95 scientific articles published from 2000 to 2012, Avelar-Sosa et al. (2014) identified the main techniques used when measuring supply chain performance. The study found that multivariate analysis was the most widely technique used by 30 references during the last 13 years. Case study was the second

most used technique by 29 research works in different industrial sectors. Other quantitative techniques based on mathematical models, multi-criteria approaches, intelligent systems as neuronal networks or genetic algorithms, and six sigma were identified.

Concerning multivariate techniques, structural equation modeling (SEM) was the most used (see Figure 4.1). This technique allows researchers to find causal relationships among latent variables. In fact, SEM is used by researchers because of its capacity to isolate observational error from measurement of latent variables. On the other hand, regarding the case study technique based on empirical analysis of different sectors, the main advantage argued by researchers who used this technique was its flexibility to perform comparisons among companies, as well as an in deep analysis of the real operational context.

Figure 4.1. **Multivariate techniques**



Source: Avelar-Sosa et al. (2014)

Even if there are a number of analyses in supply chain measurement where only one technique is used, the number of studies using hybrid techniques to better understand the topic is increasing. Currently, academic documents as well as practitioner reports agree that cost still the main attribute when measuring supply chain performance, however, quality, service, reliability and lead-time are now critical elements to be considered (Accenture, 2014; Hausman et al., 2013).

Other commonly used attributes are delivery time, fulfillment rate, perfect order, information transparency, but other attributes as risk or reliability are starting to be considered as key elements for measuring global supply chains. Furthermore, there are other attributes related to how green the supply chain activities are, as well as agility and innovation involved in the operations management.

### ***A Latin American perspective: the logistics cost***

As mentioned above, logistics costs are an important part of supply chains. However, they are not the unique component. It is probably because Latin American countries face important challenges in terms of lack of logistics infrastructure, trade facilitation agility including customs procedures, transparent market regulations, supply chain security as well as efficiency and quality of logistics services, measurement perspective, still based on logistics costs. In fact, challenges exposed above are causing not only important costs to regular operations, but also over costs by creating a lack of

coordination, inefficiencies in the export and import processes, and inappropriate public policies. In that sense, the supply chain concept as an opportunity for improving economic competitiveness is taking time to arrive to the region. Furthermore, as mentioned before, since supply chain is a concept emerged from the business world, a delay is foreseen in its adoption in less industrialised countries (since a less dynamic government-industry interaction), as an integral part of the public policies for improving national competitiveness.

Actually, as Pérez-Salas et al. (2014a) argue, in the region logistics costs represent a high percentage of the total value of products. For example, for tomato exports in Central America, logistics costs represent 49% of their total value while its price at the farm accounts only for 31% of the total cost. Thus, González et al. (2008) provide evidence concerning the critical impacts of logistics cost on competitiveness, regional development, and poverty levels in the Latin American region.

Since logistics costs are defined as resources required for moving goods from an origin to a point of consumption, they involve a spatial dimension as well as a temporal dimension. The first is associated to transport and warehouse activities. The second is associated to process as inventory, dead times for loading and unloading operations, stock-out costs, and the variability of lead-times.

According to Pérez-Salas et al. (2014a), there are two main approaches in the literature to measure logistics costs: a macro-economic perspective, and a micro-economic perspective. The macroeconomic methodologies aim to determine the logistics performance of a country based on the global estimation of its logistics systems and its relative importance with respect to the country's productivity and its competitiveness. In most of the Latin American countries, those studies are currently been part of the basis to design and operate their public policies and investment decisions. At the same time, due to a lack of reliable national entities measuring logistics cost, strategic decision-making in private sector are also based on this approach.

Macro-economic methodologies are mainly based on descriptive tools (qualitative approach) and econometric methods (quantitative approach), where the variables do not necessarily include all of those involved in the total logistics cost, but represent general estimations of national logistics performance. For doing this, primary and secondary information sources are employed.

One of the main advantages offered by current macro-economic approaches is the availability of indicators that are critical in decision-making. However, since this type of analysis deal with aggregated data, and there is, for instance, a lack in product differentiation (bulk products, perishable items, dangerous cargo, etc.), then, specific logistics requirements of products are not properly considered. Furthermore, the specific operational characteristics related to every industry are not sufficiently taken into account. As a result, distortions related to the real costs of operations and times involved are part of those studies. On the other hand, micro-economic studies involving total cost of ownership are the most common analysis supporting enterprises decision making in Latin America. Those studies are mostly used when selecting suppliers or identifying opportunities for collaboration in design, planning and fulfillment. Since they are performed from a business perspective, most of them do not take into account induced cost derived of all public services inefficiencies. Consequently, an integral vision of logistics cost is needed.

### **An integral approach for Latin America**

Based on Pérez-Salas et al. (2014a), this section presents an integral approach to measure logistics cost. This methodology was already used in countries as Bolivia and Paraguay (Pérez-Salas et al., 2014b). In fact, United Nations - Economic Commission for Latin America and the Caribbean (UN-

ECLAC) is promoting an integral framework when analyzing every trade processes, identifying the potential inefficiencies, in terms of time and costs involved. This analysis is not correlated to a specific transport mode or supply chain stage, and considers both public and private stakeholders. The proposed framework is structured in three steps that are further described.

### ***Definition of the scope of the study and selection of the logistics chains***

#### *Identification of the most relevant logistics chains*

This activity consists in the analysis of the export and import transactions of the country under analysis, with the aim to determine a set of representative logistics chains to be include in the study. This considers the identification of logistics chains and modeling the main process and stakeholders involved, as well as the main transport corridors used to transport cargo. Historical data of trade volumes and the coverage of the transport modes that are more frequently used for each logistics chain are an important basis for this analysis.

Regarding export transactions, the analysis should consider those logistics costs from the origin of the product (i.e. at the farm) to the point of consumption. Related to import transactions, the analysis should consider since the product arrives to the point of origin until it arrives to the warehouse of the importer.

#### *Selection of logistics chains*

It consists in the identification and selection of the main logistics chains based on a multi criteria analysis. For this and as a first step, a pre-selection of the most relevant logistics chains is performed. Then, criteria to select a set of logistics chains are defined. Criteria to be considered could be the relative importance of each productive sector with respect to trade volumes, value of the cargo, innovation opportunities, among other criterion that may be important to consider. Finally, based on the relative importance of each criterion, the pre-selected logistics chains are evaluated and those with a higher score are selected.

#### *Definition of costs categories*

Costs have to be categorised in order to be measured. Table 4.1 presents a general categorization of costs that may be used and should be adapted to the specific considerations of each case study.



Table 4.1. **Cost categories by transport mode and trade**

Cost category	Description
<b>Pre-shipment</b>	Costs related to the activities performed for cargo handling prior to its shipment to its final destination such as: i) packing; ii) labeling; iii) consolidation of cargo and storage of products; and finally, iv) transport of cargo among facilities. It also includes the cost of the activities related to cargo inspection and certifications required by any public agencies.
<b>Shipment to the port of origin</b>	Costs of the land transport from the warehouse of the exporter to the port terminal where it will be transferred.
<b>Port/ Airport/ Border entry</b>	Costs for cargo handling at the port/airport terminal where the cargo will be loaded to a ship. It also includes all the related costs for delays at the gate and within the terminal.
<b>Customs and control agencies</b>	Costs incurred for Customs and other control agencies for the inspection, control and clearance procedures. It also includes those costs incurred for certifications and inspections required by the customer or the country of destination. For the case of road transport, it also includes those costs incurred at the borders.
<b>Shipment to destination</b>	Costs related to the freight shipment that could be either by road, air or sea. It also considers any other handling costs as well as insurances.
<b>Inventory and finance</b>	Costs such as in-transit inventory costs as well including those incurred due to waiting times. In addition, supplementary costs that resulted because of delays or lead times variability are considered in this category.

Source: Pérez-Salas et al., 2014a

### *Identification of information sources*

It consists in the identification of main information sources both primary and secondary for data gathering. Primary sources of information consider those relevant stakeholders involved in the process either of export or import of each logistics chain. An agenda should be planned, with the dates for interviews and focus group.

### ***Costs, excess costs and processes analysis***

#### *Development of a logistics processes mapping*

This activity consists in the analysis of the export and import processes of each logistics chain under study, with the aim of determining potential impacts that these factors and its regulation have respected to the efficiency of the logistic chains. For this, in-deep interviews should be performed with those stakeholders previously selected of each logistics chain. With the information gathered during the interviews and the secondary information also obtained, a logistics processes map should be designed, such that the main physical and information flows are identified with their corresponding costs. Other techniques such as Business Process Analysis (BPA) to model the process could be also employed.

#### *Costs and excess costs analysis*

A diagnostic of the current situation of each logistics chain may be elaborated, based on the logistics process mapping. The costs and potential excess costs incurred at each stage of each logistics chain must be identified. For this, a base scenario is determined first, where the costs of the logistics chain are identified under a “normal” operation.

Then, excess costs are determined considering other scenarios that can occur (based on in-field observations and interviews), such as inefficient operations that resulted in additional costs (i.e. a late arrival of export cargo for the stacking period at a port that resulted in an additional fees for the exporter). Furthermore, costs associated with waiting times or delays in each of the stages of the logistics

chain (i.e. waiting times at the gate of the port or at an empty container park) are estimated. This estimation may be computed according to average observations or probabilities of occurrence.

### *Logistics inefficiencies analysis*

This activity aims to provide a general analysis of the most relevant inefficiencies observed for the logistics chains under study, and current gaps with respect to other economies and best practices. Impacts on the competitiveness of foreign trade at a macro level of those gaps and potential benefits obtained by the reduction or elimination of those over costs observed should be estimated.

Recommendations identified to reduce those gaps should be provided and analyzed with the stakeholders involved in the processes in order to prioritise them and generate a roadmap of the specific actions required to significantly reduce those over costs per product and transport corridor. This process is not proportional to the scale economies of the potential solutions recommended, and is actually a complex process in which political and social variables may be also considered.

### *Recommendations and proposals for public policies*

A summary of the recommendations to improve current export and import processes as well as public policies recommendations should be reported. It is based on the results obtained with the logistics costs analysis, as well as the priorities defined for the specific projects to be implemented and its impacts on national productivity and competitiveness.

Today it is clear that for the average of the Latin American region, to measure and reduce logistics cost is an important first step to be achieved in order to improve their competitiveness. However, in emerging industrialised countries as Brazil and Mexico, even if logistics costs are still a challenge, in order to remain competitive these countries should pass to the next logistics step and should adopt a supply chain paradigm in their public policies.

### **Supply chain clustering: the next logistics paradigm?**

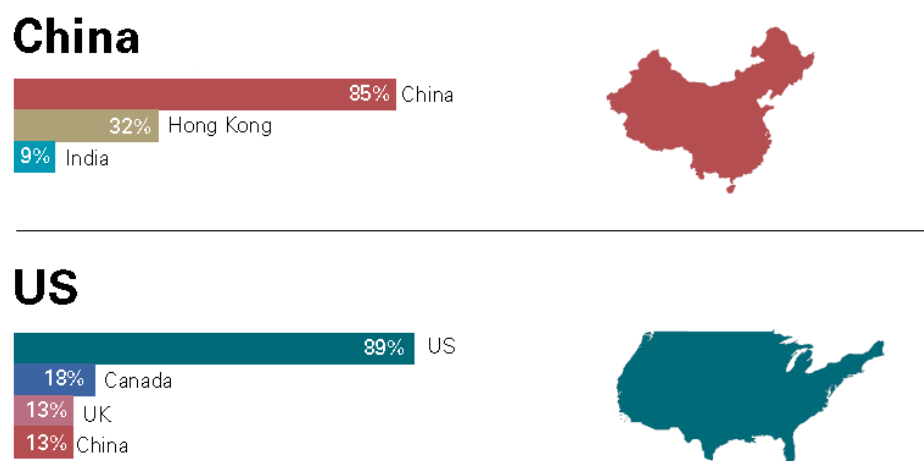
The global-local structure of key industries, as well as the economic losses because of the fierce competition between bordering regions, is providing the incentives to propose more collaborative, efficient, and innovative solutions.

In fact, since the concept of supply chain strongly emerged, the industrial companies try to develop new capabilities to coordinate internally and externally their technical, commercial, and relational dimensions. These dimensions enable them first, to adapt to the current changes and then, to improve their capabilities to react more swiftly to the changing requirements imposed by the technological change and the final customer. However, these issues are not always identified or not considered as critical by the government agencies focusing on the regional development. As such, a key component of the industrial competitiveness is that the region remains outdated, generating competitive “losses” to the company-region system (or interaction between global-local supply chains and the local industrial cluster). In a global economy that moves to increasing complexity, improving the “synchrony” of flows will become a key element for both global supply chains as well as for industrial clusters interacting with the local environment to optimise their common competitive opportunities.

On the other hand, mainly because of the risk mitigation strategies in global supply chains, manufacturing is expected to increase, as well as the business interchanges within the limits of the free-trade zone, that is to say, a regionalization of the global economy. This phenomenon is confirmed by the

Global Manufacturing Competitiveness Index [30], which highlights the trend of the companies to make regional supply decisions (Figure 4.2).

Figure 4.2. Percentage of answers regarding supply decision



Source: Deloitte and U.S. Council on Competitiveness, 2013

The strategies of “near sourcing” try to reduce costs between 5 to 20% according to estimations done by different consulting companies (GCI, 2008; Deloitte and U.S. Council on Competitiveness, 2013; EIU, 2013). However, although the increasing labor and energy costs represent a critical part, they remain a small part of the total landed costs. The greater added value a product has, the more expensive its components are. As such, regarding products with high added value, the most important costs are not the ones related to labor and energy, but the total costs within the supply chain and the ones related to intellectual property rights. The location of the production plants near their target market and in countries with greater intellectual property rights enables at the same time reducing supply chains and guaranteeing respect of the transactions deriving from patenting innovations.

In this sense, because of current industrial changes, it is foreseen that the next logistics frontier would be defined by a competition between industrial clusters and their supply chains operating along the freight transport corridors, more than between the supply chains of individual companies.

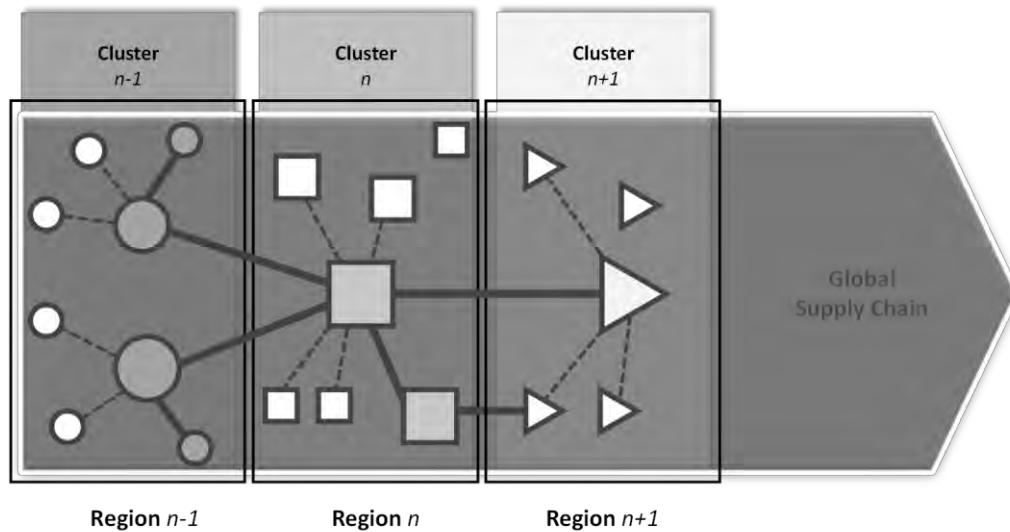
This approach is spreading to collaborations every time more related to the region where the company (industrial cluster) is located. This is due to the fact that the company clearly remains in a geographical space in which it is constantly in interaction. Under the influence of the interchanges or transfers of flows between the company and its extern environment (throughout its supply chain), the “company” system evolves and its variables (performance indicators) are constantly changing. In fact, while operating in environment of dynamic change, the company develops its operations with a stated “imbalance”. However, thanks to its capability to keep through time its competitive advantage lined up with its company business model, it could remain a winner in the market.

These interactions between the “original business model” of the company and the reality of its economical, industrial and regional environment shape is what Boyer, Freyssenet (2000) define as “hybridization”. These authors argue that a business model, because of its dynamic interactions with its external environment, evolves up to the point of taking its own personality depending of its local

operational environment. This way, the local environment of operation (industrial cluster) influences the competitiveness of the company-region system throughout the flow of processes (global supply chain).

As such, the emergence of new manufacturing regions makes the current manufacturing regions wonder constantly about their abilities to attract and keep investments with high added value. As a result, observing, and understanding the behaviors and evolutions of cutting-edge industrial sector, as well as what other regions are developing to be more attractive is every day more critical. The existence of transversal “meta-systems” (global supply chains) enables the collaboration-cooperation, but also the competitiveness between the different industrial clusters where some of the links develop operations (see Figure 3). Therefore, since these industrial “meta-systems” called global supply chains ease the comparison of performance between different regions of location through their industrial clusters, a dynamic and transversal analysis approach have become a key element to improve the competitiveness of both the industries as well as of the regions that receive them (Mélèse, 1979, 1990).

Figure 4.3. **Integrated structure industrial cluster and supply chain**



Source: Cedillo-Campos, 2012

### ***Implications of a supply chain clustering approach***

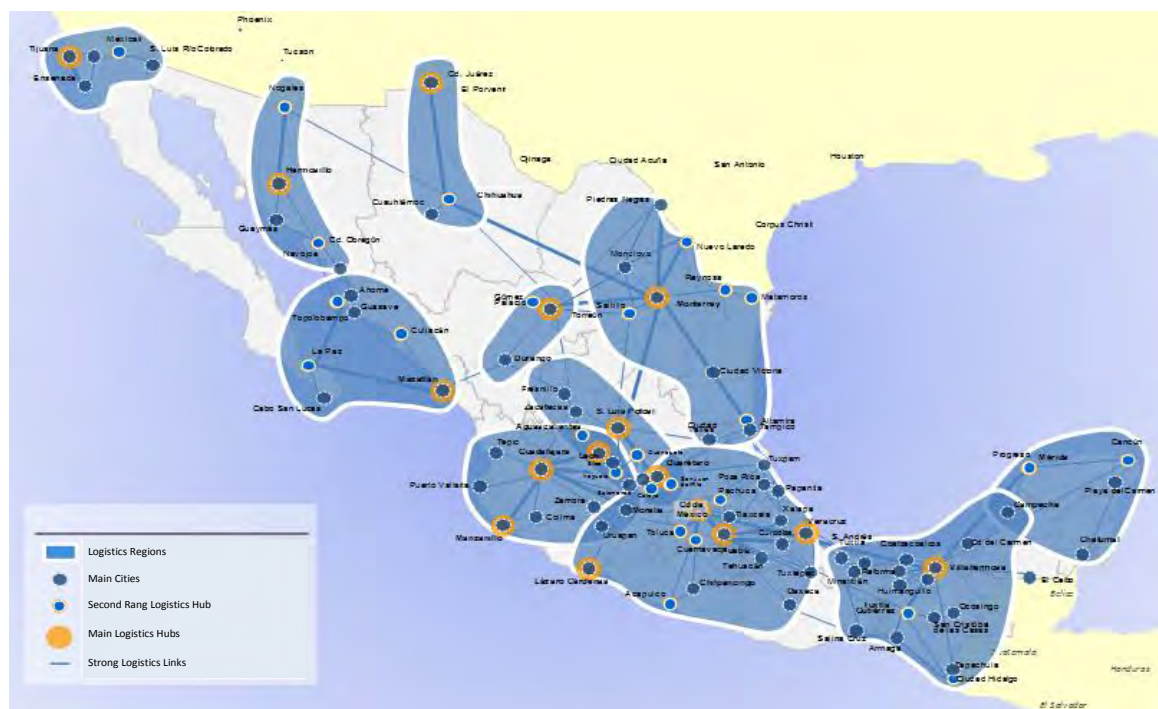
Every day, the industrial manufacture becomes a more global sector. Competition moved from between countries to between companies and their supply chains, and nowadays, between global supply networks and their local components operating inside the regional industrial clusters.

The SCC can be identified when they show three fundamental features: 1) physical proximity; 2) common processes, activities, products and/or services to different supply chains operating within a same cluster; and 3) collaboration relations between providers. The supply chain cluster provides opportunities for organizations that try to ease and shorten their supply chain making it more resilient, and as a consequence, more reliable. This implies interacting with partners and resources on a specific region. Companies operating in a supply chain cluster scheme can take advantage of the economies of scale, without being compelled to deal with the inflexibilities of a vertical integration.

In this sense, a supply chain cluster (SCC) is defined as a geographical concentration of processes, activities and/or services that can be put together to add value to one or more supply chains. It mainly focuses on three aspects (Figure 4.4):

- Global-Local integration of flows.** Designing and operating local hubs enabling the global-local integration products, services, and information flows is one of the key factors to the effective development of a SCC. Thanks to a local logistics hub, the members of a SCC become more efficient regarding operation and coordination costs of their global supply chain. At the same time, they boost the cluster's competitiveness, trust, and innovation.
- Global-Local collaboration network.** In a SCC, most organizations are directly or indirectly related to one or various industrial systems that are close (for example: the automotive industry, the electronic and the aerospace ones are industrial systems highly based on technological innovation as well as on logistical competitiveness for the assembly activities). There is then a relation between companies inside one supply chain, but also a relation of competition-collaboration inside similar companies that collaborate with other supply chains. As such, each member of a SCC can take advantage of economies of scale for buying, financial support, and technological development (with other similar organizations), as well as economies of scope when identifying and satisfying specific niches based on their size and flexibility.
- Focus on the differentiated competitive advantages.** By introducing a cluster model, Porter (1998) suggested that in the future, the competitive advantages would not be determined by a major efficiency in providing products, but rather by the companies' ability to explore the resources available in the environment they are operating in. By doing so, he suggested that a main competitive advantage could derive through assessing the immediate environment outside the company instead of focusing only on what happens inside the supply chain the company participates. The support service system a SCC can provide enables collaborating more productively in the local development of the inputs which are required by the global supply chain when going through local clusters, as well as access to information and coordination between related companies.

Figure 4.4. Potential supply chain clusters in Mexico



Source: IDB, 2013

Since a diversity of the companies can be located in an industrial cluster (Figure 4.5), gathering processes, activities and/or services in common to different supply chains, reduce complexity of operations in the cluster and enables mitigating the variability in competitiveness (Figure 4.6).

Hence, the regions go through different tensions, derived from the different competitive cycles of each industrial sector located in them. This implies two main challenges for them: a) to ease the productive linking within the cluster, looking for common processes or services that would link the companies without worrying about the industrial system they are in; b) to design a local flow system that would interact with the global flow system.

Considering the integrative role logistics platforms play in the Global-Local flows, they could potentially become the ideal location around which supply chain clusters could be operate (see Figure 4.7). As such, not only common processes would be integrated to different supply chains, but logistics platforms would also support a reduction in logistics by taking advantage of the economies of scale that intermodal corridors can offer to companies.

Figure 4.5. **Global supply chains interacting in a local industrial cluster.**

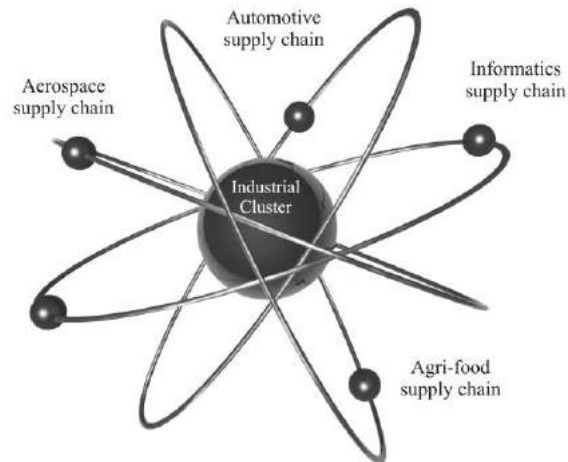


Figure 4.6. **Competitive variability in the local industrial clusters, induced by the variability of the global supply chains.**

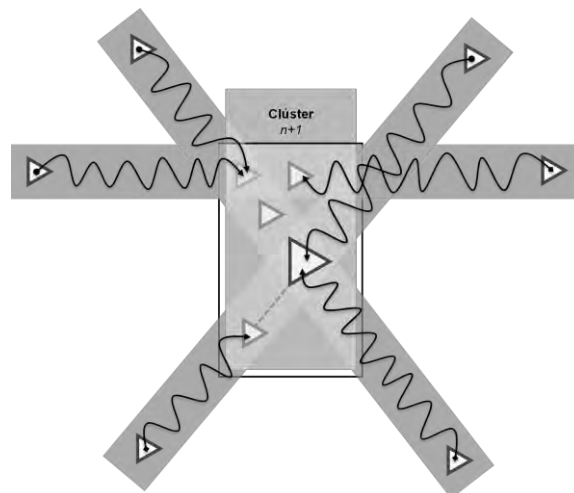
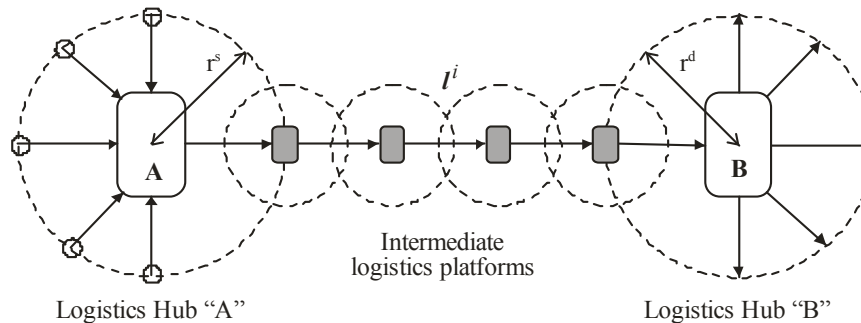


Figure 4.7. **Logistic platforms as supply chain clustering hubs**

Nowadays it is a fact that when a company is looking for an effective global integration of the supply chain, the capabilities of the local environment in which the plant is located can become crucial. In successful SCC such as Silicon Valley, although the companies' supply chain must respond to global requirements, the local capabilities have enabled them not only facing the challenges, but also innovating to propose better responses.

In this sense, and based on the analysis of different cases studied by several authors (De Banville and Chanaron, 1991; Chanaron, and De Banville, 1996; Storper, 1997; Carrie, 2000; Cedillo-Campos, 2001; Theo and Roelandt, 2000; Li and Cai, 2004; Sturgeon et al., 2007; Sanchez et al., 2008; Sturgeon and Biesebroeck, 2010), we could verify that when the industrial cluster and the supply chain approach are integrated in the analysis to build a "supply chain cluster", then positive interactions appear:

- The resources are organised on one specific geographical area, creating opportunities for achieving agility to ease and shorten the supply chains.
- The geographical proximity enormously reduces the complexity of the supply chain.
- The mutual interdependence and trust are intensified between the companies that are member of the same supply chain. In that sense, regional elements, such as long-term perspective inside the cluster's company improve directly the performance of the supply relationships. An improved interdependence also increases the mutual trust, strengthening the levels of commitment and reducing conflicts.
- Motivate and accurately measuring performance of supply chain cluster partners become achievable.
- Visibility of the processes is improved, thanks to the advantages of the technological, relational, organizational and cultural proximity.
- Flexibility increases when supply chain partners are located in the same industrial cluster.
- Disruption risk in the supply chain flows is reduced thanks to the gathering and line up of the efforts.
- The information is shared faster and more efficiently. The partners of a same cluster promote faster some information about new opportunities.
- The feedback cycles are shorter, enabling a faster transformation of the supply chain, creating substantial savings.

Actually, in an integrating process of highly effective providers, the local business environment in which the location is settled becomes crucial to get a sustainable competitive advantage. This is

especially true in cases in which the company faces complexity due to dynamic interactions between the local environment and the global pressures from the market.

In fact, a clear example of a supply chain clustering configuration in progress is the automotive supply chains in North America. Over the past two decades, automotive supply chains have been organizing their processes all along the north-south corridor that links different automotive clusters in the NAFTA (North American Free Trade Agreement) zone (Klier and Rubenstein, 2010). Actually, by 2011 Mexico accounted for 31% of U.S. motor vehicle parts imports. At the same time, Mexico was the third exporter (it is today the second one) of light vehicles to the U.S. market. This suggests a unique co-production relationship based on supply chain clustering corridors between the two economies (Figure 4.8).

Figure 4.8. NAFTA supply chain clustering corridors.



Source: Based on Parrilla and Berube (2014).

Thus, accumulations of flows in certain geographic zones along NAFTA's transport corridors are emerging. Those transport corridors are structured along supply chain clusters (SCC) that regulate the flows at the local and regional level. In that sense, NAFTA supply chains clustering corridors could be structured around three main elements:

- Logistics platforms located along the main transport corridors allowing the use of intermodal technology.
- Supply chain clusters organised around logistics platforms, which as control towers regulate freight, and information flows inside their hinterland.



- Transport corridors as a “*pipeline*” that not only links supply chain clusters between them, but as platform of services, provide value added logistics services (high technology security services based on tracking and tracing of vehicles, etc.).

Thus, given the increasing economic globalization structuring the global network economy, in the future it is very likely that logistics platforms will not only play an important part as modal interchange points by increasing the efficiency of logistical flows or as tools of the territorial development, but also favored points to drive innovation in logistics and supply chain processes. On the other hand, from an information technologies approach, there is an opportunity to pass from enterprise applications software (ERP – Enterprise Resources Planning) to supply chain clusters applications software. Accordingly, technologies responding to a “real time” demand will move from an operations management (OM) perspective based on individual companies to a “4D approach” that considers at the same time:

- optimization of the internal company’s operations
- design and operation of the company’s global supply chain
- coordination of the company's interactions with the local industrial cluster
- tracking the freight flows and measuring “*supply chain fluidity*” (Eisele et al, 2011) along the supply chain clustering corridors.

### ***Data availability and coverage***

As Chopra and Meindl (2013) argue, supply chain performance measurement depends on the competitive strategy related to it. Supply chain is not an end in itself. Countries and organizations should define its competitive strategy and then decide what their supply chain strategy ought to be. Thus, the supply chain strategy determines how the supply chain should perform.

Currently, in most of the Latin American countries, there is not a clearly stated national competitive strategy, and consequently, a national supply chain strategy neither. For some public decisions makers, since supply chain is currently an umbrella term for different understanding of the concept, it “allows” the application of any performance measurement approach regardless a wide range of methodological considerations. However, if at an academic level, the risks of a wrong measurement are mitigated, since the analyzed problems could be bordered, at the national level, the risk is higher. Based on the Lord Kelvin’s paradigm, if we only improve what we can measure, incorrect measurement could be transformed in fact in an attack on competitiveness.

In Mexico, a wide variety of supply chain performance measurement studies exists. Most of them are performed by consulting companies with strong supply chain background from the business perspective of the topic. They perform survey studies trying to cover an important information lack on this matter. Thus, important efforts to enlarge data collection in order to achieve reliable studies have been done by them. Nevertheless, even if the growth of digital technologies has enabled companies to collect increasingly massive amounts of data, they require powerful capabilities in statistics and “Big Data” technologies to make sense of that data.

Currently, most of the studies performed in Mexico do not clarify a national supply chain strategy or paradigm on what they are based, and no information about the statistical robustness of the studies are exposed and neither discussed. Therefore, results do not have a real link with the national supply chain landscape. Thus, to provide an update to all supply chain actors, reliable and nationally exposed study is becoming challenging.

Hence, it is today clear that this kind of efforts could be performed by/or under supervision of recognised research centers with strong methodological capabilities. For doing this, a clear identification of a national supply chain strategy is needed. Subsequently, under a high-qualified supervision, to define metrics and the method to measure it could be more reliable.

However, regardless of the strategy or strategies adopted for performing those studies, organisations performing these types of studies need to provide a rationale for their choices by articulating the expected benefits and weaknesses of any strategy, method, or sample size they choose.

## Conclusions

Through our review of the literature on supply chain performance measurement, a statistical comparison of supply chain techniques and attributes was exposed. The most used methodology is multivariate analysis and the most used technique approach is structural equation. However, it was also notice that hybrid methodologies and combined techniques are widely used to achieve a better understanding when measuring supply chain performance.

At the same time, it was possible to understand that – although there is a number of important studies related to supply chain performance measurement – in many cases only a few attributes are taken into account. The importance of the local factors in building the dynamic competitive advantage of global supply chains is still not fully appreciated.

Thus, implementation of systemic approaches for an efficient supply chain performance measurement has become one of the main challenges to take advantage of business opportunities of globalization. In this regard, logistics costs represent the main challenge and play a key role especially in emerging markets as the Latin American one. In the region, logistics costs currently account for a bigger percentage of the total cost of a product with respect to duties and tariffs.

Furthermore, this document exposed a framework for logistics costs assessment based on an integral vision that differs to the traditional approaches found in the current literature. The proposed framework considers a sequential analysis of the foreign trade processes to identify inefficiencies and over costs. Furthermore, a temporal dimension is also incorporated to the analysis. A systematization of the framework proposed on a long run term can be the base for econometric studies that may be further implemented to validate results.

Finally, this work presented a potential new paradigm called “Supply Chain Clustering” that could serve as a tool to identify factors that allow the articulation of dynamic competitiveness. The tendency towards flexible organization in production obliges companies as well as governments to adopt a systemic approach in which supply chain competencies are a strong differentiation factor.

Thus, logistics platforms must be seen as logistical elements that enable mitigating the global variability transmitted by different supply chains to the regions, and then, improve supply chain performance. They should also be considered as a co-ordination, and innovation element since they enable identifying the “best logistics practices” developed by the industrial cluster, which are susceptible of being standardised and propagated as “local” standard.

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## **Chapter 5. Performance measurement for intermodal corridors: a methodological approach**

Carlos Martner, National Researcher, National Council of Science and Technology

Gabriela Garcia, Researcher of Instituto Mexicano del Transporte

This chapter outlines the development of intermodal container transport in Mexico. Container transport accounts for a large share of trade and indicators of container transport activity are a good early indicator for the development of the economy as a whole. In Mexico international container traffic by rail is also an important factor in the attractiveness of inward investment in key industrial sectors. In the absence of direct monitoring of container traffic this chapter sets out an effective methodology for quantifying and analyzing container transport flows on the main intermodal corridors. It concludes by proposing suitable indicators for monitoring intermodal logistics in Mexico.



## Introduction

Between the years 1996-97, restructuring of rail and intermodal transport in Mexico began, giving several positive effects in terms of land freight movement in the country and certainly beneficial and also with encouraging results shown in the gradual but steady increase of the cargo volumes by rail, which has happened in the period 1995-2012, changing from 18.5% to 25.4% of the tonne-kilometres moved by surface transport in the country. Meanwhile, the road freight transport remains dominant, but their participation in the indicated period fell nearly 7% in relative terms going from 81.5% to 74.5% of the surface cargo transportation.

Nevertheless, for reasons of uncertainty in the liability to provide reports and data relating to the operation of rail and intermodal transport, as well as the confidentiality of information referred on the legal frameworks of the securities or agreements concession granted by the government of the Republic, the companies that own them have no obligations to provide information on the origin-destination of the cargo, the boxcars utilized, distances travelled on corridors, etc., so a big gap was produced regarding the availability of detailed data to allow out regular monitoring of the behaviour of the rail freight sector and in particular, intermodal transport, one of the most dynamic sub-sectors over the past decades.

This occurred in the period 1997-2011, being the latter year in which the Technical Specialized Committee on both Economic and Operative Information from Transport (CTE-IEOST), created by the SCT and INEGI, started up, with a specialized group devoted to develop a methodology to build an origin-destination matrix for rail freight, with collaborating staff from the Directorate General of railways and Multimodal Transport (DGTFM-SCT) and researchers from the Mexican Institute of Transportation (IMT). This working group provided data and statistical information for the 2010-12 period thus initiating the knowledge of the spatial distribution of the flows origin-destination intermodal freight in Mexico (García et al, 2012).

It is worth noting that the concept of intermodal transport includes mainly those cargo flows of containers moved in the land part, both by rail and by road transport, the latter in what is known as "the last mile". By using different modes of transportation, intermodal transportation utilizes varying combinations, such as:

- Ship - rail - road transport
- Road transport - rail - road transport

Given the importance of this sector, this chapter aims to make a methodological proposal to the regular and systematic analysis of intermodal corridors, by collecting hard data of origin-destination of the cargo, as well as the identification and the spatial representation of flows transported across the Mexican intermodal network, and the modelling into a georeferenced territorial system, as well as the development of performance indicators with a comprehensive and integrated approach to measure consistently and periodically the performance and efficiency of the corridors, in order to provide inputs for planning and decision-making for institutions and businesses in the areas of transport and logistics.

## Importance of intermodal transport in Mexico

Intermodal transport is still an incipient sector in the country, but its importance and growth potential is recognized to such an extent that it is given priority status within the National Development Plan 2013-2018 (Plan Nacional de Desarrollo, 2013).

It is clear that the development of intermodal transport reflects a trend towards the integration of functions and system optimization. This does not mean that the efficient operation of each of the modes is not important in itself, but it becomes secondary in relation to the efficiency of the system itself (Burkhalter, 1999)

Intermodal transport involves in the land segment mainly rail transport, which is able to mobilize significant volumes of cargo, making it highly sustainable compared to trucking (Martner, 2008). From the economic standpoint, the intermodal cost is lower and therefore the competitiveness is favoured; from the social perspective vehicular load is diminished on the roads, accident rates are reduced and therefore the mortality rates due to road accidents; and in environmental terms, the generation of emissions is significantly lower.

As San Martín (1997) states: "It is proven that the railroad has significant comparative advantages over the truck for transportation over long distances. Thus, to maximize the benefits of the container, it was necessary to integrate to the railroad as one of the major players in intermodal transportation system (...) The tremendous technological innovation that created the rail cars capable of carrying double container on a platform, "Double stack train" substantially improved the efficiency of land bridges and intermodal corridors, revolutionizing international trade logistics" (San Martín, 1997:12).

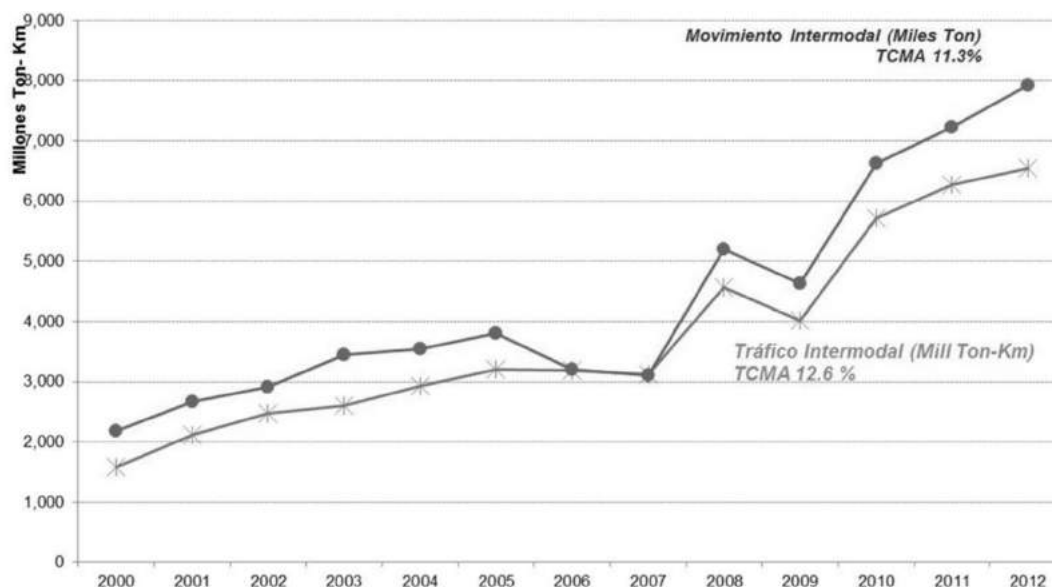
The recent trend in Mexico's intermodal transportation shows a high dynamism despite having gone through a strong global economic crisis between 2008 and 2009. Indeed, from 2000 to 2012, intermodal cargo moved by rail quadrupled, going from 2-8 million tons and from 1 600 to 6 500 million tons-kilometre.

This meant that the average growth rate for the period was 11.3% per year measured in tonnes and 12.6% per annum on the tonne-kilometres (Figure 5.1). Incidentally, both are far superior to the growth rates of trucking and rail, which were 1.5% and 4.2% annually respectively.

## Conceptual design of the methodology for analysis of intermodal corridors

One of the difficulties in conducting studies and systematic analyses of the behaviour and evolution of intermodal transport was for a long time, the lack of detailed information of rail and truck, due to the cancellation of published data on supply- demand fluctuations, as well as on origins and destinations of freight flows, the generator and attractor nodes according to cargo type, the major regional and national routes, etc.

Figure 5.1. Movement and intermodal traffic, 2000-12



Source: Created by IMT based on data from the Directorate General of Railroads and Intermodal Transportation, SCT.

Moreover, not either was available a methodological tool to help know the movement of cargo in the terrestrial network, a necessary condition to identify intermodal corridors (Garcia et al, 2013). So, the proposed methodology represents a breakthrough in a clearly deficient aspect: the identification and the spatial representation of freight flows carried by rail and by the intermodal network and proposing a set of performance indicators currently available data are not used with an integrated approach.

This seeks to provide a method and an innovative tool for understanding this phenomenon, which integrates topology and roughness of the territory (Santos, 2000) with the quantitative and qualitative analysis of intermodal corridors, unlike existing approaches at present, generally with a purely qualitative focus, or at the best case, based on economic modelling, but lacking the spatial dimension (Rodrigue, 2012), except in the urban environment, also known as network's last mile, where a great variety of methodological proposals and refined models of urban freight distribution exist (Cedillo et al, 2014 y González et al, 2014).

Indeed, current metrics and methods in this issue, both in Mexico and in Latin America, usually reach aggregate data on flows transported and in the best case, examples of econometric models are found, whose refining can be important for economic and demographic data projections, but lacking of a basic dimension of freight flows, i.e. the territorial dimension (Fujita et al, 2000), where it is possible to verify the routes and the corridors, the infrastructure capacities, the modes used, the types of vehicles, the location of nodes for freight exchange or transfer and the more detailed characteristics of shipments moving between diverse regions.

For this reason both the approach as the proposed tool not only imply a practical contribution, but a conceptual one to measure the evolution of a theme as relevant today, nevertheless scarcely studied with hard data, such the transportation and intermodal corridors (Boske et al, 2003).

On the matter, it is intended that in the short term this methodology allows the generation of new information useful for diverse studies such as trip generation models or load distribution; the

competitiveness in costs or travel times between the arrangements of the intermodal chains; the analysis of logistic or regional efficiency of supply chains, among others.

The methodological development that is presented is structured around two key information inputs:

- Data on freight movements, which are the numerical records describing the reality on intermodal transport.
- Georeferenced information from the intermodal network in the country, i.e., roads, railways, stations.

Since that the spatial representation of both the exchanges recorded at the origin- destination matrix of intermodal cargo and the flows that lead to the conformation of intermodal corridors is the central part of the methodology, it was necessary first to structure the geographical base, core on which the methodology operates.

This task implied the revision of the lines representing the railway infrastructure, the addition of a large number of nodes or stations not included in the geographic base from which it split and construction of the connectivity properties of the network, necessary to meet the methodology's working purpose.

The application of the methodology, which is based on the operational functions of TransCAD and in the cartographical functions of a GIS, specifically ArcGIS, (García et al, 2012), allows:

- Differentiate nodes depending on the volume of interchange, whether of origin or destination.
- Identify the key nodes, i.e., those busiest regarding to volume, both in tonnes and tonne-kilometres.
- Highlight the major origin-destination pairs.
- The cartographical representation of origin-destination pairs by tons and ton-kilometre through desire lines.
- Define load distribution scenarios on the intermodal network, based on a model of freight assignment.
- Compare the use of intermodal infrastructure according to the flow density by tonnes or tonne-kilometres.
- Present through maps, the location and distribution of intermodal corridors and/or the formation of prospective corridors (by tonnes or tonne-kilometres).

## Current status of intermodal corridors in Mexico

According to data analysis from intermodal cargo in 2011, 17 nodes with movements exceeding 50 000 tonnes per year were found, which concentrated 95% of interchanged volumes. Among these the Pantaco intermodal terminal in Mexico City stands out with the largest cargo volume, about 2.5 million tons (considering the volumes of incoming and outgoing cargo); followed by Pacific ports, Manzanillo, with nearly 2.3 million and Lazaro Cardenas with 1.8 million tonnes and Nuevo Laredo with about 1.8 million tonnes in the northern border (Table 5.1).

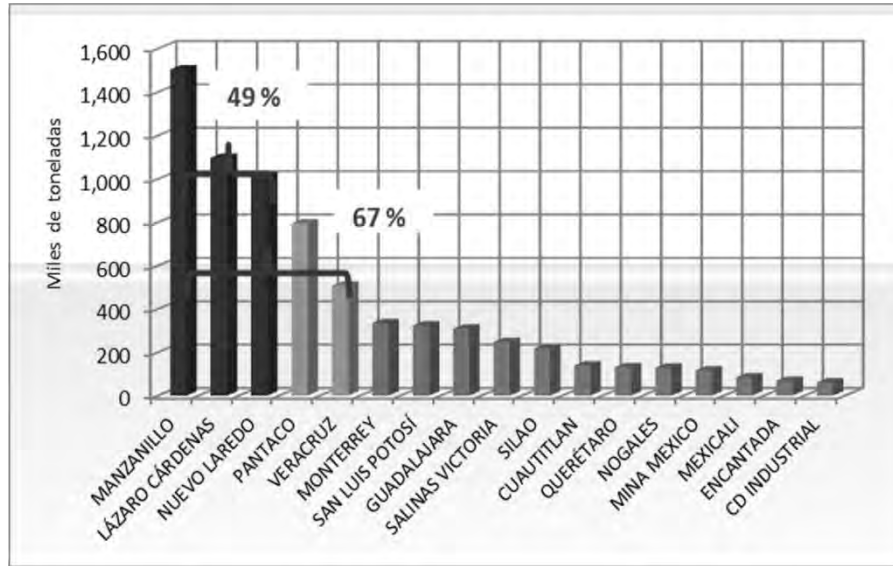
Table 5.1. **Main nodes participating in the movement of intermodal freight, 2011**

<b>Node</b>	<b>Origin</b>	<b>%</b>	<b>Destination</b>	<b>%</b>	<b>Total</b>
PANTACO	794 616	11	1 775 207	24	2 569 835
MANZANILLO	1 504 080	20	786 064	11	2 290 164
LÁZARO CÁRDENAS	1 096 963	15	768 848	10	1 865 825
NUEVO LAREDO	1 011 497	14	785 028	11	1 796 538
VERACRUZ	507 242	7	210 254	3	717 503
GUADALAJARA	309 365	4	316 098	4	625 468
MONTERREY	334 766	5	263 314	4	598 085
SAN LUIS POTOSÍ	323 716	4	242 158	3	565 879
SILAO	217 109	3	287 091	4	504 203
SALINAS VICTORIA	247 386	3	191 454	3	438 843
QUERÉTARO	131 022	2	306 716	4	437 740
CUAUTITLAN	138 644	2	236 183	3	374 829
MINAMÉXICO	116 712	2	201 765	3	318 479
ENCANTADA	68 345	1	209 976	3	278 322
MEXICALI	83 918	1	184 909	3	268 828
CD INDUSTRIAL	61 310	1	176 619	2	237 930
NOGALES	129 136	2	47 532	1	176 670
<b>SUBTOTAL</b>	<b>7 075 827</b>		<b>6 989 216</b>		<b>14 065 139</b>
<b>%</b>	<b>96</b>	<b>96</b>	<b>95</b>	<b>95</b>	<b>95</b>
<b>TOTAL</b>	<b>7 395 078</b>		<b>7 395 078</b>		<b>14 790 157</b>

Source. Created by IMT based on 2011 data from the Directorate General of Railroads and Intermodal Transportation, SCT.

From the perspective of the load generated (Figure 5.2), the sorting shows among the top five positions very important nodes of Mexican foreign trade: Manzanillo, Lazaro Cardenas, Nuevo Laredo and Veracruz, plus Pantaco in Mexico City, which is the big concentrating hub of intermodal freight in the country. These nodes together concentrate 67% of the load Intermodal volume (Morales, 2014).

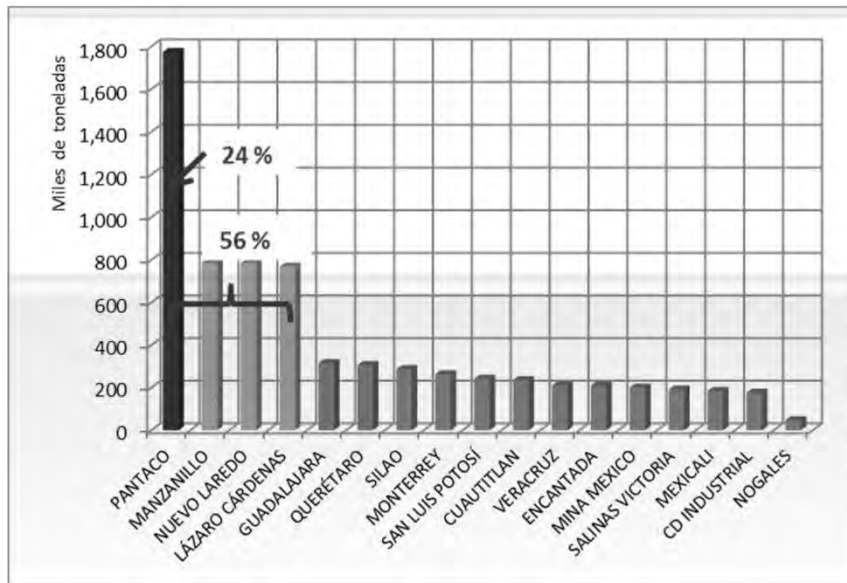
Figure 5.2. Main originating nodes of intermodal cargo, 2011



Source: Created by IMT based on 2011 data from the Directorate General of Railroads and Intermodal Transportation, SCT.

From the perspective of the nodes attracting freight (Figure 5.3), Pantaco receives by itself, almost a quarter of the containerized cargo, and adding to this the node movements from Manzanillo, Nuevo Laredo and Lazaro Cardenas volume equals to 56%.

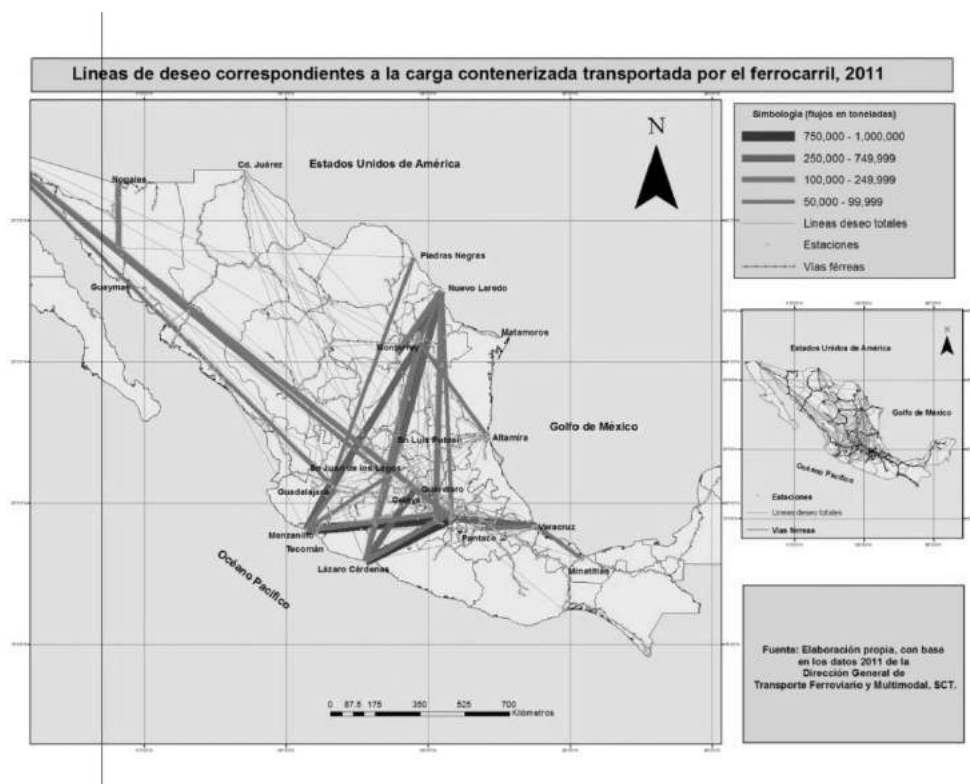
Figure 5.3. Main receiving nodes of intermodal cargo, 2011



Source: Created by IMT based on 2011 data from the Directorate General of Railroads and Intermodal Transportation, SCT.

The main trade relationships are limited to intermodal cargo flows from the ports of Manzanillo, Lazaro Cardenas and Veracruz to the centre of the country (Figure 5.4). A significant density flows also between the northern border and the northeastern states and the centre, such as Nuevo Leon, San Luis Potosi and the Bajio region. To a lesser extent, stand out the flows Mexicali to Guadalajara, San Juan de los Lagos and the centre of the country.

Figure 5.4. **Desire lines for intermodal cargo in Mexico**

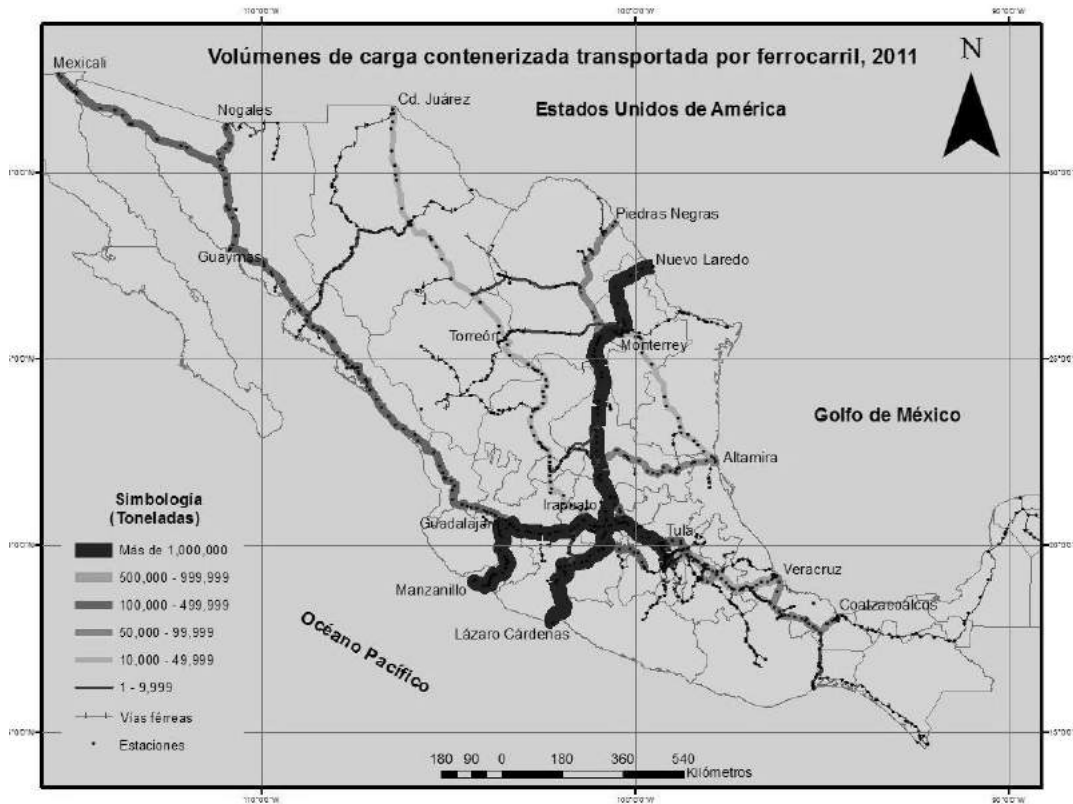


Source: Created by IMT based on 2011 data from the Directorate General of Railroads and Intermodal Transportation, SCT.

An important contribution of the proposed methodology is the ability to model flows with geographical representation to detect in a hierarchical way, by ranks of flow densities, major intermodal corridors operating in the country and as well its variation over time. The assignment model on the intermodal network allows to conclude that in Mexico there are only three high density corridors consolidated, i.e. that mobilize more than one million tonnes annually; two of them are from the Pacific coast to the geographic, demographic and economic centre of the country, the metropolitan area of Mexico City (MAMC), and the third corridor is from north to south (Figure 5.5), these are the following:

- Manzanillo–Guadalajara–Silao–Queretaro–MAMC (figure 7) on this corridor, load is greater than 2 million tonnes.
- Lázaro Cárdenas–Celaya–Queretaro–MAMC.
- Nuevo Laredo–Monterrey–San Luis Potosi–Queretaro–MAMC.

Figure 5.5. Main intermodal cargo corridors in Mexico, per tonne (assignment model-IMT).



Source: Created by IMT based on 2011 data from the Directorate General of Railroads and Intermodal Transportation, SCT.

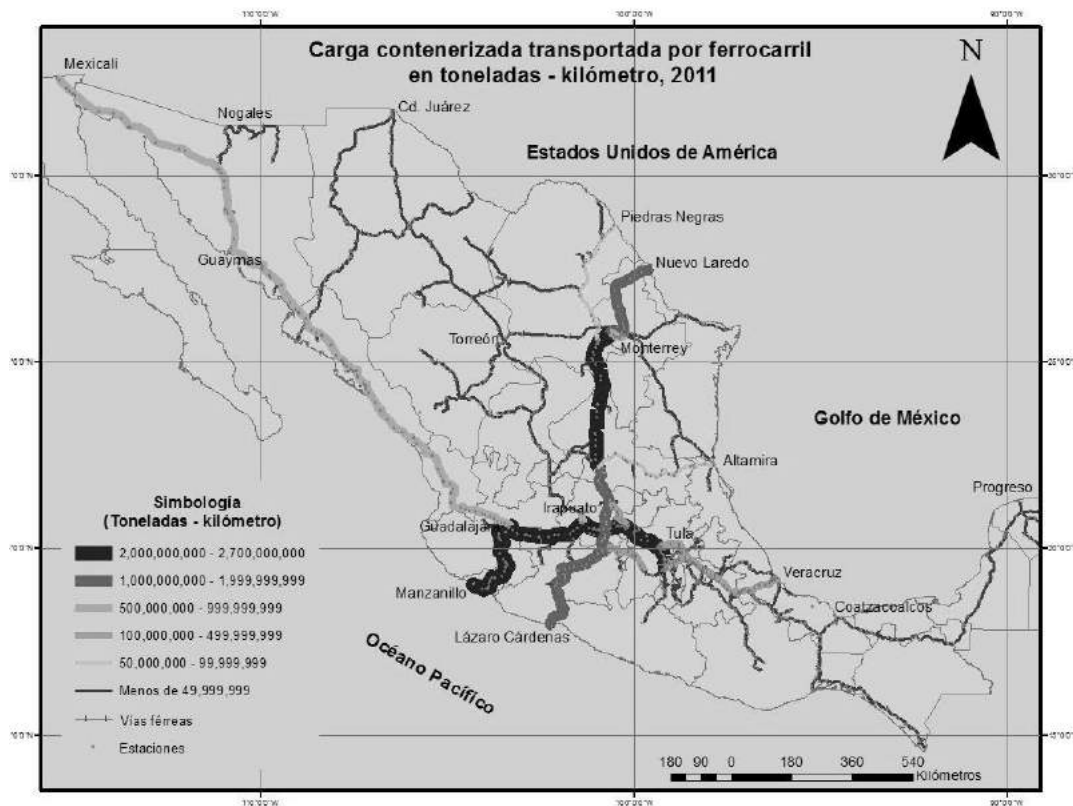
It is important to note that when comparing the spatial representation of intermodal cargo flows of 2010 with that of 2011, the definition of runners is consistent, despite the increase in the annual volume of cargo.

An intermodal corridor that is emerging is the route Veracruz–MACM, where the charge density is between 500 000 and one million tonnes (Figure 5.5). However, it might seem that evolution is fast considering that the intermodal volume on this route in 2010 was below 500 000 tonnes.

From the standpoint of tones-kilometre, the corridor Manzanillo–Guadalajara–Irapuato–Querétaro–MAMC is the busiest and the tone-kilometre level remains higher than 2 000 million along its path. Not so in the corridor that runs from Nuevo Laredo to the centre, where the t-km level varies along its course, the higher is located between Monterrey and San Luis Potosí, and then between Querétaro and the MCMA which alternates with lower load intensity as shown in Figure 5.6.



Figure 5.6. **Main intermodal cargo corridors in Mexico, per tonne-kilometre.**  
(assignment model-IMT).



Source: Created by IMT based on 2011 data from the Directorate General of Railroads and Intermodal Transportation, SCT.

Finally, since the chosen method has proven its functionality and usability, and the database showed consistency, it will intend to expand the possibilities of the methodology by generating performance indicators both for transportation as for intermodal corridors, aiming to enrich the systematic analysis of the evolutionary behaviour of this sector with periodical contributions of highly relevant inputs to decision making.

### **A preliminary proposal of performance indicators of intermodal corridors**

In previous analyses of IMT (Martner et al, 2014), a series of tools for developing indicators data were identified. Besides those mentioned above, related to the volume of cargo, such as tones moved by the nodes of the network, the main origin-destination pairs of cargo and intermodal corridors of higher density (in tonnes and tonne-km); currently available data are presented as dispersed and unsystematic, but that develop sets of indicators on the operation, efficiency and competitiveness of intermodal corridors in

Mexico and eventually consider that this basis of analysis could be replicated in other emerging countries in the region

In this regard, the proposal is to create a method or tool to measure consistently and periodically the performance and efficiency of the corridors, with a comprehensive vision, that is to consider the development of indicators covering the various links in the chain or intermodal network.

A general example of indicators that could be formalized in the analysis of a chain or intermodal corridor linking flows mobilized since the arrival of a ship to a seaport to the final destination in any city of the country is presented in the following paragraphs.

Generally, when a vessel arrives in port is directed to a dock to start the loading and unloading of goods transported. But sometimes must wait in the anchorage area before docking. To measure the performance of this phase, you can develop, with data available, indicators on the percentage of ships anchored by type of cargo and anchorage of the total time measured in hours or days, among others

When anchorage times higher load because the docks are busy are recorded, means that there is saturation in the port, so it will have to implement improvements in operation or expand the available for docking vessels infrastructure.

In Table 5.2 on the anchoring of ships in Veracruz, a high percentage of agricultural bulk vessels must anchor for many hours, due to the occupation of docks is observed.

Table 5.2. **Time anchoring of ships in the port of Veracruz, January-August, 2014**

Type of freight	Ships at anchor	% of ships at anchor	Time anchoring (hours)	Anchoring per vessel (hours)	Anchoring per vessel (days)
Grains	50	<b>38%</b>	<b>4 958.00</b>	<b>99.16</b>	<b>4.13</b>
General loose cargo	47	17%	<b>1 648.00</b>	<b>35.06</b>	<b>1.46</b>
Containers	38	8%	790.00	20.79	0.87
Automobiles	17	14%	866.00	<b>50.94</b>	<b>2.12</b>
Other	21	26%	527.00	25.09	1.05
Total	173	15%	<b>8 789.00</b>	<b>50.81</b>	<b>2.12</b>

Source: Created by IMT based on data from API Veracruz.

The second set of indicators that can be constructed with the available information corresponds to loading/unloading operations at the harbour. In this sense, indicators like the number of containers downloaded per each occupied crane or the number of containers per hour of each operated vessel are common data from the port's statistics for all countries in the region.

An improvement in these indicators has a favourable impact on others directly related. Indeed, the greater the numbers of loaded/unloaded containers per hour, ships spend less time at docks.

Table 5.3. Selected port loading efficiency indicators, first half of 2014

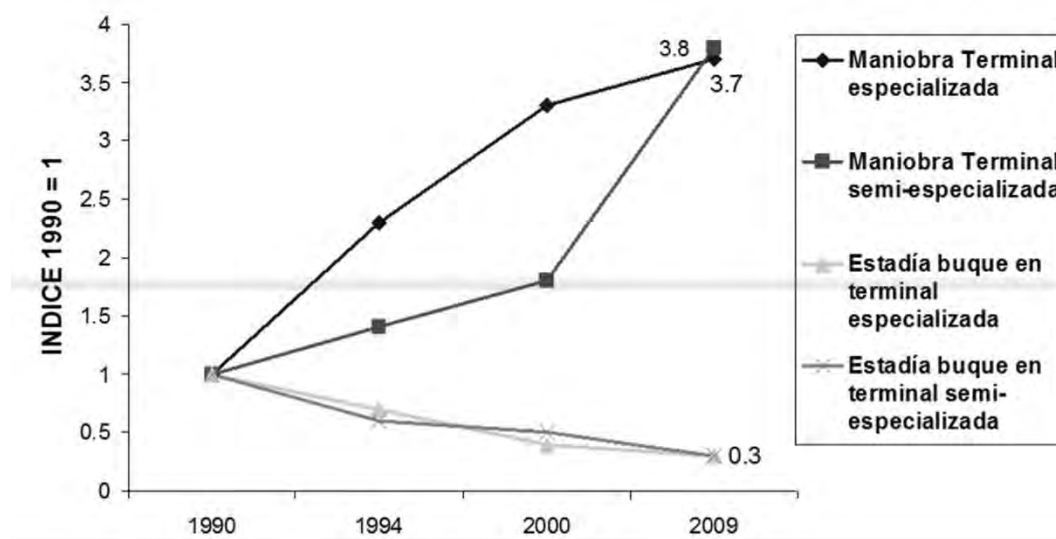
Port	Container per hour per crane	Container per hour per vessel in operation
Lázaro Cárdenas	38	113
Progreso	30	80

Source. Author's own elaboration with data from CGPMM.

It should be noted that, since starting the port restructuring in Mexico (1993), the return indexes on loading and stay of the ship in the docks have substantially improved, that is why it is said that one of the main achievements of this structural transformation is in the high efficiency achieved in the first movement (yardship and vice versa).

Figure 5.7. Port of Veracruz.

Performance index loading/unloading container vessel and index container vessel stay time at Port



Source. Author's own elaboration with data from CGPMM.

However, a critical datum is the residence time of cargo at the port, before being sent to its destination. At this stage, also called second manoeuvre (storage yard to terrestrial vehicle or vice versa), concur lot of actors and activities related goods inspection, sorting of cargo, the payment of duties, customs inspection and clearance of loads.

All these activities, which are or should be related to trade facilitation issues, represent a huge window of opportunity to improve the regulation and practices that currently predominate.

Indeed, the average time spent cargo container terminals in major national ports fluctuate around 7 days except Lazaro Cardenas that reports about 5 days on average.

**Time spent in the container terminal**

- $\Sigma$  stay time in container yards /  $\Sigma$  Total operated containers
- Puerto Manzanillo 2013 = 5.77 days
- Puerto Manzanillo 2014 = **6.88** days
- SSA Manzanillo 2014 = 6.42 days

Previous analyses (Martner et al, 2013) have mentioned the factors that affect this indicator. Among these stand out:

- A complex circuit of revision causing the extension of cargo stay at port.
- The resulting tension between the imperatives of fluency in foreign trade and security imperatives.
- An information and documentation circuit poorly integrated to the “second manoeuvre” logistics.
- Inadequate logistics practices from small and medium exporters.
- Lack of integration of the logistics port node to the land modes.

On the other hand, the load's stay time directly influences on the dynamic capacity of storage yards and on port occupancy percentage. Indeed the more stay time, the less is the dynamic capacity and more the occupancy rate of port's storage areas.

**Dynamics Capacity (DC) in the maritime terminals**

**DC = (365 / Average stay) \* static capacity**

Puerto Manzanillo 2014 = 2.90 million TEUs

SSA Manzanillo 2014 = 1.42 million TEUs

Finally, it is important to measure the evolution of the efficiency and competitiveness of the connections with the hinterland. According to recent studies (Notteboom, 2008, Rodrigue et al, 2010), proper connection to the hinterland is key to the development of ports. In fact it is considered that, largely, the competitive battle between ports is increasingly fought on land. Therefore, the hinterland connections through the development of corridors and intermodal services are a key area for competition and coordination between actors (Notteboom, 2008).

### **Indicators of the intermodal chain**

There are several potentially suitable indicators for the efficiency of the intermodal supply chain:

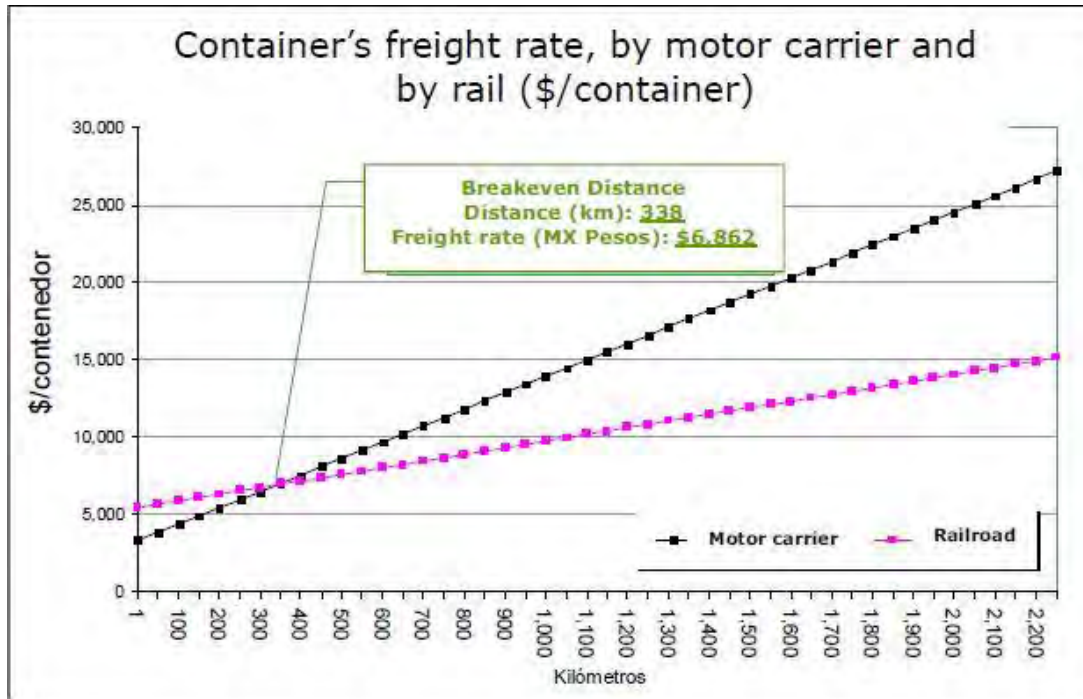
- Competitiveness of intermodal vs. truck
- Cost of inland transport
- Travel time indicators (truck-FFCC)
- Commercial speed
- Frequency and reliability of service
- Percentage on-time delivery

In Mexico, the consolidation of corridors and the services of intermodal double stack trains have greatly improved connectivity to the main national ports, continually expanding their hinterlands.

The following example shows the competitiveness of double-stack rail on relatively short distances. Indeed, Figure 5.8 shows that around 340 km of rail transport can compete successfully with the truck in the movement of containers. Therefore, there is a very large potential of development of such services not only in the Pacific coast but also in the Gulf coast in view that Veracruz and Altamira have their main markets at distances ranging from 400 potential and 500 kilometres.

This level of competitiveness corresponds to data for major intermodal corridors where double stack trains operate with capacity near 300 TEUs, in convoys of 80 or more cars.

Figure 5.8. Technological, operational and infrastructure changes in intermodal transport shift the equilibrium boundary down (to left)



Source: IMT's own elaboration with field gathering data and logistic operator's information. In Mexican pesos \$, 2010.

Other indicators to analyse the performance of intermodal corridors respect to the linking their hinterland are the travel times of the terrestrial modes of transportation (truck-railroad), the commercial speed at freight corridors, as well as the frequency and reliability of the intermodal services. To do this, the participation of the new regulatory agency for rail and multimodal transport in Mexico and other government or private agencies that collect information on the operation of transport in Mexico is required.

### Final thoughts

While it is true that the formation of intermodal corridors can be seen as an emerging industry in Mexico, the same occurs for the high potential of their development in the immediate future (Martner, 2007).

However, currently there is no tool allowing a constant analysis of intermodal transport in Mexico. In the best case, there are only segmented and isolated data on the phenomenon in question and many of them are not collected on a systematic or continuous way along the time.

The conceptual and methodological contributions have been insufficient in this topic. Recent efforts to study the behaviour and evolution of intermodal transport are performed in the best case, based on econometric models that estimate volumes and types of goods that could be switch between different regions, but lacking the ability to localize flows geographically in particular spaces, nodes or networks, or under certain multimodal combinations. This diminishes the analytical strength when, for example, there is interest to evaluate the operation of an intermodal corridor, establish its hierarchy within the

national network, determine its saturation horizon, the need for capacity expansion or construction of new infrastructure, among other aspects.

By contrast, from the conceptual view, the proposed methodology represents a progress in a clearly deficient aspect: the identification, representation and spatial analysis of cargo moving through the Mexican railways and intermodal networks, providing a method and a new tool in Mexico and countries in the region, which integrates the topology and roughness of the territory with the modelling and quantitative analysis of intermodal corridors, unlike existing approaches at present which are either only qualitative type or at the best case, are based in economic modelling, but lack the spatial dimension.

Thus the preparation and implementation of a robust methodology with a quantitative focus acquires relevance, because allows a regular and continuous analysis of developments and trends in this sector and, in this way, promote the planning instruments and the public policies to help drive the competitiveness of nodes and arcs of the network, because it cannot be forgotten that consolidating of corridors depends on the efficiency and competitiveness of intermodal systems versus single-mode systems, dominated by road transport today.

No less important is the fact that the proposed methodology proposes the development of a set of indicators to periodically measure the performance of intermodal corridors in Mexico. This implies, in a second phase, the need to create a National Observatory of Transport and Logistics as the institutional framework for the use, development and dissemination of the proposed methodology.

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## List of roundtable participants

<p>Pablo GUERRERO          Transport Specialist          Inter American Development Bank          Infrastructure and Environment Sector          1300 New York Avenue, N.W.          Washington, D.C. 20577          USA</p>	<p>Chair</p>
<p>Gaston CEDILLO          University of Nuevo Leon /          IMT- Logistic and Supply Chain Senior Researcher          Instituto Mexicano del Transporte          Carretera Qro - Galindo Km 12          76703 SAN FANDILA -Queretaro          Mexico</p>	<p>Rapporteur</p>
<p>Dilay CELEBI          Istanbul Teknik Üniversitesi          34367 Maçka          İstanbul Türkiye</p>	<p>Co-rapporteur</p>
<p>Dr. Lauri OJALA          Professor of Logistics          Operations &amp; Supply Chain Management          Turku School of Economics          FIN-20014 Turun yliopisto          Finland</p>	<p>Co-rapporteur</p>
<p>Carlos MARTNER          Transport Integration Research Coordinator          Instituto Mexicano del Transporte          Carretera Qro - Galindo Km 12          76703 SAN FANDILA -Queretaro          Mexico</p>	<p>Rapporteur</p>
<p>Alan C. MCKINNON          Kuhne Logistics University          Wissenschaftliche Hochschule für          Logistik und Unternehmensführung          Großer Grasbrook 17          20457 Hamburg          Germany</p>	<p>Rapporteur</p>

Roberto AGUERREBERE  
Operational Coordinator  
Instituto Mexicano del Transporte  
Carretera Qro - Galindo Km 12  
76703 SAN FANDILA -Queretaro  
Mexico

Juan Pablo ANTÚN CALLABA  
Universidad Nacional Autonoma de Mexico, UNAM  
Circuito Interior S/N  
Coyoacán, Cd. Universitaria  
04510 Ciudad de México, D.F.  
Mexico

Jean-François ARVIS  
World Bank  
1818 H Street NW  
20433 Washington DC  
USA

Eduardo Asperó  
Dirección de Proyectos Ferroviarios Grupo CENPORT, consultores Portuarios, S.C.  
Torre World Trade Center,  
Piso 6, Oficina 19  
Montecito número 38, Col Nápoles,  
Delegación Benito Juárez,  
03810 Mexico City  
México, D.F., C.P.03810

José BARBERO  
Specialist in transport planning and policy  
World Bank  
1818 H Street NW  
20433 Washington DC  
USA

Mary BROOKS  
Dalhousie University  
Rowe School of Business  
PO BOX 15000  
B3H 4R2 HALIFAX NS  
Canada

Alfredo BUENO SOLANO  
Instituto Mexicano del Transporte  
Carretera Qro - Galindo Km 12  
76703 SAN FANDILA -Queretaro  
Mexico

Rodrigo CARRANZA  
Subdirector de Tratamiento de Explotación de Encuestas de Transportes (INEGI)  
Inegi Instituto Nacional De Estadisticas Geografia E Informatica  
Avenida Ricardo Flores Magon 44,  
06300 Mexico City  
Mexico

Trinidad CARRILLO  
Director de Edición de Información Geográfica (INEGI)  
Inegi Instituto Nacional De Estadisticas Geografia E Informatica  
Avenida Ricardo Flores Magon 44,  
06300 Mexico City  
Mexico

Mauricio CASANOVA  
División de Desarrollo Logístico  
Ministry of Transport  
Ministerio de Transportes y Telecomunicaciones  
Amunategui 139, piso 7°  
Santiago  
Chile

Ms Sissi DE LA PENA MENDOZA  
Sissi De La Peña Mendoza  
Asesora de asuntos internacionales  
Coordinación de la Estrategia Digital Nacional  
Oficina de Presidencia del Gobierno de México  
México D.F  
Mexico

Iker DE LUISA  
Director General  
Asociación Mexicana de Ferrocarriles, AMF  
Alfonso Esparza Oteo 144 - Ofna 702  
Col. Guadalupe Inn,  
Del. Álvaro Obregón  
01020 Mexico City  
Mexico

Stephen S. FITZROY  
Senior Vice President  
EDR Group Economic Development Research Group Inc.  
155 Federal Street, Suite 600  
Boston, MA 02110  
USA

Ricardo FLORES  
Idom Consulting  
Avenida monasterio del escorial 4  
28049 Madrid  
Spain

María Gabriela GARCÍA ORTEGA  
Instituto Mexicano del Transporte  
Carretera Qro - Galindo Km 12  
76703 SAN FANDILA -Queretaro  
Mexico

Jan HAVENGA  
Centre for Supply Chain Management –  
University of Stellenbosch  
Private bag x1  
Matieland  
7602 Stellenbosch,  
South Africa

Willem HEEREN  
Dinalog  
Jan de Rijk Logistics  
Majoppeveld Noord, Leemstraat 15  
P.O. Box 1086, 4700 BB Roosendaal,  
The Netherlands

Rodolfo HERNÁNDEZ CASANOVA  
Director de Modernización del comercio y los Servicios  
Secretaria de Economía  
Av Insurgentes Sur 1940, 4ºPiso  
Col Florida , Del Alvaro Obregón  
CP 01030  
MEXICO D.F.  
Mexico

Jan HOFFMANN  
Chief, Trade Facilitation Section,  
United Nations Conference on Trade and Development – UNCTAD  
Office E 7044, Palais des Nations, 1211 Geneva,  
Switzerland

Victor Manuel ISLAS RIVERA  
Instituto Mexicano del Transporte  
Carretera Qro - Galindo Km 12  
76703 SAN FANDILA -Queretaro  
Mexico

José Elías JIMÉNEZ  
Logistics and Transport Senior Researcher  
Instituto Mexicano del Transporte  
Carretera Qro - Galindo Km 12  
76703 SAN FANDILA -Queretaro  
Mexico

Reyes JUÁREZ DEL A.  
President and CEO FOA CONSULTORES, S.C.  
Ricardo Castro 54 PH2  
Col. Guadalupe Inn  
Del. Alvaro Obregón  
México D.F. C.P. 01020  
Mexico

Carmen Guadalupe MORALES PÉREZ  
Instituto Mexicano del Transporte  
Carretera Qro - Galindo Km 12  
76703 SAN FANDILA -Queretaro  
Mexico

Rolando OCAMPO  
INEGI  
Inegi Instituto Nacional De Estadisticas Geografia E Informatica  
Avenida Ricardo Flores Magon 44,  
06300 Mexico City  
Mexico

Fernando PÉREZ  
Banco de Mexico  
Avenida 5 de Mayo 2,  
Colonia Centro,  
06059 Delegación Cuauhtémoc  
Mexico City  
Mexico

Jospé Arturo PÉREZ SÁNCHEZ  
Instituto Mexicano del Transporte  
Carretera Qro - Galindo Km 12  
76703 SAN FANDILA -Queretaro  
Mexico

Salvador SAAVEDRA C  
KG Industries, Ltd.  
Self Steer and Specialty Axles  
P.O. Box 1157, Osoyoos, BC,  
Mexico

José SAN MARTÍN  
Director General  
Instituto Mexicano del Transporte  
Carretera Qro - Galindo Km 12  
76703 SAN FANDILA -Queretaro  
Mexico

Mikel SANTOS  
Director de Sistemas  
Idom Consulting  
Avenida monasterio del escorial 4  
28049 Madrid  
Spain

Michel SAVY  
professeur à l'Université Paris-Est  
Ecole d'Urbanisme de Paris et Ecole des Ponts-Paris Tech  
12 Villa de Lourcine  
75014 Paris  
France

Çağlar TABAK  
Transport and Communicatons Expert  
Ministry of Transprt Maritime Affairs  
Hakkı Turaylıç Caddesi No:5 Emek Çankaya  
Ankara  
Turkey

Guillermo TORRES VARGAS  
Instituto Mexicano del Transporte  
Carretera Qro - Galindo Km 12  
76703 SAN FANDILA Queretaro  
Mexico

Juan Carlos VILLA  
Regional Manager Latin America  
Texas A&M Transportation Institute  
Shakespeare 15, Suite 1002  
11590 Mexico City  
Mexico

Cajeme VILLARREAL CAMERO  
Adviser to the Undersecretary of Transportation  
Subsecretaría de Transporte  
Secretaria de Comunicaciones y Transportes - SCT  
Avenida Xola, esquina con Eje Central, S/N,  
Col. Narvarte, Del. Benito Juárez  
Distrito Federal CP. 03020,  
Mexico

Gordon WILMSMEIER  
Economic Affairs Officer  
Infrastructure Services Unit  
Natural Resources and Infrastructure Division  
ECLAC  
Dag Hammarskjold 3477  
Santiago  
Región Metropolitana  
Chile

**International Transport Forum**

Mr Stephen Perkins  
Head of the Joint Transport Research Centre  
OECD/ITF, 2 rue André Pascal, F-75775  
Paris Cedex 16



## Logistics Development Strategies and Performance Measurement

Logistics performance is a strong determinant of national income and policy-makers are interested in logistics performance indicators because of the potential for improved transport services to promote economic development. The World Bank's Logistics Performance Index, for example, is regularly cited by Ministers. Key performance indicators are nevertheless open to misunderstanding and misuse in this sector as much as any other.

The roundtable meeting was convened to improve understanding of logistics performance and measurement and exchange experience in developing comparable methods of assessment internationally. It examined how careful use of indicators can drive improvement, making recommendations for public sector organisations developing logistics performance indicators. Discussions also addressed issues particularly relevant to the establishment of a dedicated logistics observatory in Mexico.

### **International Transport Forum**

2 rue André Pascal  
75775 Paris Cedex 16  
France  
T +33 (0)1 45 24 97 10  
F +33 (0)1 45 24 13 22  
Email : [contact@itf-oecd.org](mailto:contact@itf-oecd.org)  
Web: [www.itf-oecd.org](http://www.itf-oecd.org)