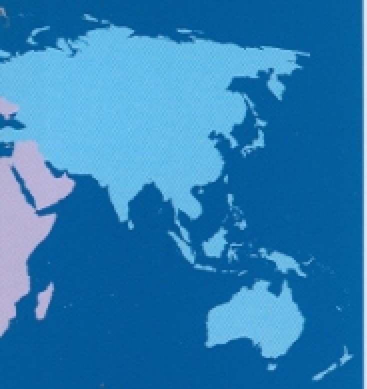


WP/07/02

UNESCAP Working Paper

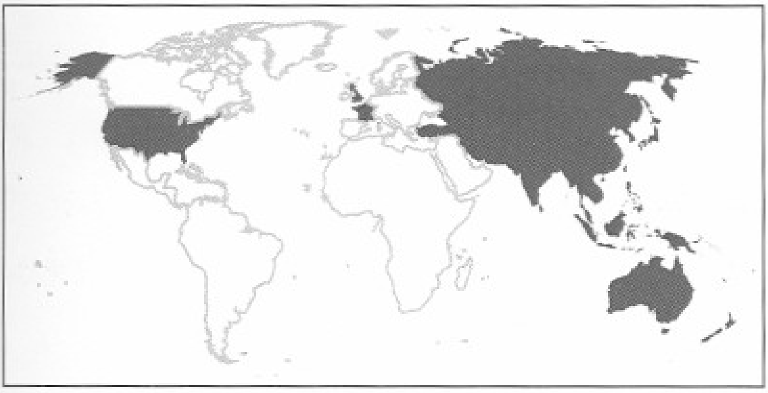
Longer Combination Vehicles (LCV) for Asia and the Pacific Region: Some Economic Implications

Philipp Nagl

United Nations
ESCAP

ECONOMIC AND SOCIAL COMMISSION FOR ASIA AND THE PACIFIC

ESCAP is the regional development arm of the United Nations and serves as the main economic and social development centre for the United Nations in Asia and the Pacific. Its mandate is to foster cooperation between its 53 members and 9 associate members. ESCAP provides the strategic link between global and country-level programmes and issues. It supports Governments of the region in consolidating regional positions and advocates regional approaches to meeting the region's unique socio-economic challenges in a globalizing world. The ESCAP office is located in Bangkok, Thailand. Please visit our website at www.unescap.org for further information.



The shaded areas of the map represent ESCAP members and associate members.

Longer Combination Vehicles (LCV) for Asia and the Pacific Region: Some Economic Implications

Philipp Nagl

United Nations

ECONOMIC AND SOCIAL COMMISSION FOR ASIA AND THE PACIFIC

Series Editor:
Amarakoon Bandara
Economic Affairs Officer,
Poverty and Development Division
Economic and Social Commission for Asia and the Pacific
United Nations Building, Rajadamnern Nok Avenue
Bangkok 10200, Thailand
Email: amarakoon@un.org

WP/07/02

UNESCAP Working Paper

Longer Combination Vehicles (LCV) for Asia and the Pacific Region: Some Economic Implications

Prepared by Philipp Nagl*

Authorized for distribution by Ravi Ratnayake

January 2007

Abstract

Road transport is the most important mode of freight transportation in terms of transportation output in almost all countries in the world, in particular in Asia and the Pacific region. For many years, the dimensions of road vehicles for freight transport have remained fixed, although road infrastructure in many countries has improved considerably and technical progress in vehicles has made them safer, quieter and more powerful. However, a number of countries, including Australia, Brazil, Canada, Finland, Sweden and the United States of America, have successfully demonstrated the use of road vehicles with extended dimensions for freight transport. Longer combination vehicles or vehicles with extended length and weight limits have the potential to make freight transport more efficient and environmentally friendly. The objective of this paper is to analyze the economic implications of permitting the use of longer combination vehicles.

JEL Classification Numbers: *O10, R40, O53*

Keywords: *Longer combination vehicles, LCV, Container Transport, road freight transport*

Author's E-Mail Address: philipp.nagl@wu-wien.ac.at

* Institute of Transport Economics and Logistics, Vienna University of Economics and Business Administration. Tel: +43 1 31336 4897; Fax: + 43 1 31336 716

This paper is based on research that conducted by the author during an internship at the Transport Policy and Tourism Section of the United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP), Bangkok, Thailand. The author is grateful to the UNESCAP Transport Policy and Tourism Section for the warm welcome and the excellent working conditions and would like to give a special thanks to Richard Alexander Roehrl of UNESCAP for his helpful comments and suggestions, as well as to Professor Sebastian Kummer (Vienna University of Economics and Business Administration) for making this research possible.

CONTENTS

ABBREVIATIONS

1 INTRODUCTION………………………………………………………………………… 1

2. INCREASING THE PRODUCTIVITY OF TRANSPORT SYSTEMS…………………….. 1
   2.1 General considerations……………………………………………………………... 1
   2.2 Economies of scale of transport vehicles………………………………………… 3
      2.2.1 Maritime shipping………………………………………………………… 3
      2.2.2 Land transport……………………………………………………………. 4

3. ROAD TRANSPORT VEHICLES……………………………………………………….. 5
   3.1 Classifying road freight vehicles…………………………………………………… 5
   3.2 Standards for intermodal transport (containers) ………………………………… 7
   3.3 Longer combination vehicles (LCVs) ……………………………………………….. 8

4. IMPACTS OF THE INTRODUCTION OF LONGER COMBINATION VEHICLES (LCVS) ……………………………………………………………………………… 11
   4.1 Lower external effects of road freight transport through longer combination vehicles……………………………………………………………………….… 11
      4.1.1 Congestion……………………………………………………………….. 13
      4.1.2 Accidents………………………………………………………………… 13
      4.1.3 Noise……………………………………………………………………… 14
      4.1.4 Natural resources and pollution………………………………………… 14
   4.2 Effects of the permission of longer combination vehicles (LCVs) on common carriers…………………………………………………………………………….. 14
      4.2.1 Transport cost function…………………………………………………….. 14
      4.2.2 The operational fleet composition………………………………………… 15
      4.2.3 Measures to increase the acceptance of modular combination vehicles…………………………………………………………………… 17
   4.3 Dynamic effects of longer combination vehicles (LCVs).…………………………. 17

5. APPLICATION OF LONGER COMBINATION VEHICLES (LCVS) IN THE UNESCAP REGION……………………………………………………………………………… 18
   5.1 General considerations……………………………………………………………... 18
   5.2 Case study: Connecting Chinese Guanlan intermodal container depot (ICD) with seaports………………………………………………………………………… 19

6. CONCLUSION…………………………………………………………………………. 22

REFERENCES……………………………………………………………………………….. 24

TABLES

Table 3.1 Truck weight and dimensions for selected countries ……………………………… 6
Table 3.2 Weight and dimension limits of 20, 40, 45 and 53 ft container……………………. 8
Table 5.1 Parameter values for the case study………………………………………………… 21

FIGURES

Figure 2.1 Size of the largest containerships from 1968 to 2010……………………………… 4
Figure 3.1 Systematization of road freight transport vehicles according to size…………….. 6
Figure 3.2 Systematization of heavy freight transport vehicles…………………………….…. 9
Figure 3.3 Different configurations of heavy vehicles………………………………………….. 12
Figure 4.1 Movements in crude oil price 2000-2006…………………………………………… 15
Figure 4.2 Cost curve of haulage firms related with two types of vehicles…………………….. 16
Figure 5.1 The Guanlan ICD – Satellite picture ………………………………………………….. 20
Figure 5.2 Effects of LCVs regarding, CO_2, diesel fuel, transport costs and traveled kilometers……………………………………………………………………………….. 22

Abbreviations

ABS	Antiblock System
ESP	Electronic Stability Program
ICD	Intermodal Container Depot
ISO	International Organization for Standardization
LCV	Longer Combination Vehicle
MPGW	maximum permissible gross weight
TEU	twenty feet equivalent unit
USD	United States Dollars

1. Introduction

Many UNESCAP members and associate members[1] have experienced rapid economic growth in recent years. Along with this economic development, there is a growing demand for freight transportation. This gives rise to a wide range of problems with respect to road safety, environment, resource consumption, land use and transport efficiency. In many cases, it is not sufficient or even possible to expand road infrastructure to fulfill the requirements of increasing transport demand. Therefore, it is necessary to undertake measures to develop new forms of land transportation.

This paper examines the question of how road freight transport can be made more effective and efficient by exploiting the economies of scale of the vehicles. Over the past 40 years, the trends in increasing sizes of ships and aircraft[2] have been most obvious. Similarly, the railway sector has increased its efficiency through double-stacking of containers, the introduction of double-decker passenger coaches[3] and increasing train length. In all these cases, economies of scale have motivated increasing sizes. In contrast, only few attempts have been observed in increasing the dimensions of road vehicles for freight transport. This is despite the fact that road transportation causes by far the most serious environmental problems.

This paper explores the option of permitting longer and heavier vehicle combinations for road freight transport than allowed by the current standard regulations in most countries (see Table 3.1). In particular, the potential costs and benefits of using these vehicles in countries of the UNESCAP region are analyzed in more detail.

Section 2 discusses economies of scale in transportation in general. Section 3 introduces the concept of road transport vehicles with extended dimensions and weight[4] and Section 4 discusses their effects. Section 5 discusses the potential use of road transport vehicles with extended dimensions in the UNESCAP region and illustrates the issues with three specific examples. Section 6 concludes the paper.

2. Increasing the productivity of transport systems

2.1. General considerations

To satisfy growing transport-demand, the two main ways to increase transport output are either to employ more inputs (labor, capital) or to improve productivity (technology). The following factors generally influence the effectiveness of a transport system on various levels:[5]

[1] The United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP) has 53 member countries an 9 associated members in the region, see http://www.unescap.org/about/member.asp

[2] For example, the new Airbus A380 entering regular service.

[3] An example is the TGV Duplex in France.

[4] The term mass is scientifically more appropriate than weight. In everyday usage and in this article mass and weight are used as synonymous.

[5] For a different systematization, see Lakshmanan/Anderson (2001), p. 8ff.

1. Infrastructure
   - Traffic routes
     - Build new routes
     - Extend existing routes (e.g. adding new lanes)
     - Utilization of routes (traffic organization and coordination)
   - Traffic stations
     - Build new stations
     - Increase the capacity of existing stations
     - Utilization of stations (organization and coordination)
2. Legal restrictions, interoperability conditions and transport market structure
3. Transport vehicles
   - Additional vehicles
   - Increase capacity of vehicles
   - Improve the utilization of vehicles (organization and coordination)
4. Transported passengers and goods

In many countries, the extension of existing infrastructure and the construction of new routes is becoming more and more difficult and expensive. Various permits must be obtained (in particular concerning environmental issues), space is limited, and in some cases expensive routes with a large share of tunnels and bridges have to be chosen. Infrastructure projects are frequently opposed by local politicians and various interest groups. Furthermore, implementation of infrastructure projects takes a long time and involves considerable risks including frequent unexpected escalation in costs.[6]

The importance of infrastructure equipment has been rapidly increasing in recent years. For example, telematics features have become more and more important. Road telematics systems can influence traffic flows (also through electronic toll collection) or they can provide information about traffic jams and alternative routes to the drivers. Technical equipment also deserves closer attention in railways. In the European Union (EU), regulations are passed to define common standards for railway equipment.

From a microeconomic viewpoint, telematics applications play an important role in improving capacity utilization of stations (e.g. container handling) and/or increasing the utilization of transport vehicles.[7] Examples are the planning of airplane fleets or road vehicle fleets.[8]

In railway transport, interoperability restraints and restrictions which prevent private railway companies operating their services are seen as one of the main reasons

[6] Flyvbjerg et al. (2004)

[7] Clausen/Kraft (2004)

[8] See e.g. the broad literature on fleet planning.

for the continuous decreasing share of the goods market carried by railway in Europe.[9] The entrance of new firms may be a powerful method to break monopoly structures and to benefit from the advantages of competitive markets. In South-East Asia, the railway networks are not very dense and are barely connected (e.g. there is no connection between the railway networks of Myanmar and Thailand or between Cambodia and Thailand). Railway transport between these countries and China is complicated due to different track gauges.

On the level of transported goods, wrappings can be designed in a way to minimize volume requirements or even the products itself can be designed in a way to improve its logistic properties. These types of measures are summarized under the term 'design for logistics'. Also passenger transport could be optimized, for example, through improved information for passengers to prevent delays at airports.

2.2. Economies of scale of transport vehicles

Different economies in transportation have been a subject of interest for a long time for all modes of transport. Furthermore, economies of scale (e.g. economies of density or economies of massed reserves) are of interest in transportation.[10]

Economies of scale appear when a cost function exhibits -- at least in a certain section -- decreasing marginal costs for producing an additional output. Economies of scale have been of immense importance in many industries, including vehicle manufacturing and transportation, and have thus contributed to the development of modern transport systems. In urban passenger transport, a well-know example where road vehicles of increased dimensions are successfully operated on dedicated lanes is the bus rapid transit (BRT).[11]

2.2.1. Maritime shipping

The exploitation of economies of scale is particularly obvious in maritime container shipping, where the capacity of container ships has increased rapidly over the past 40 years. This development is a significant factor, fuelling the recent wave of economic globalization.[12] The larger ships allow higher capacity and thus low transport costs.

Figure 2.1 shows the development of the vessel sizes in maritime shipping. The advent of Post-Panamax ships between 1995 and 1996 came as a result of increasing trade between Asia and Europe/North America. The interest in increasing ship sizes continues to be a driving force, as illustrated by the recent order of Cosco (the Chinese state-owned shipping company) for four container vessels with a capacity of 10,000 TEU by 2008.[13] Container vessels with more than 8,000 TEU are

[9] KOM (2001), p. 26ff

[10] Baumol/Panzar/Willig (1988)

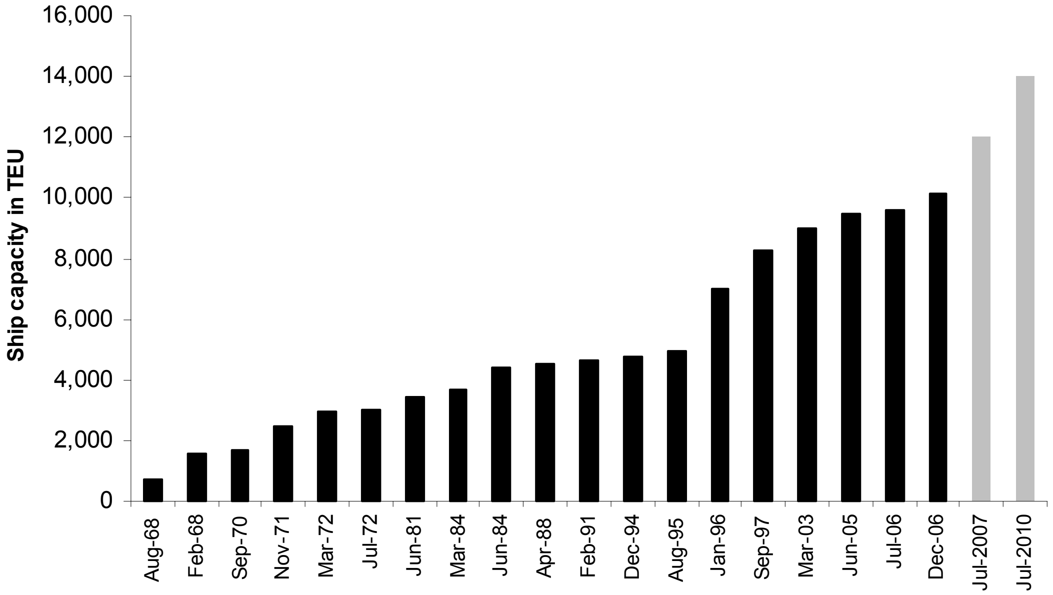
[11] Garcia/Azan (2005), p. 36.

[12] Levinson (2006)

[13] DVZ (Deutsche Verkehrs Zeitung), 2005-02-18, p. 9.

already in operation today.[14] In 2010, ships with a capacity of approximately 14,000 TEU can be expected.

Figure 2.1: Size of the largest containerships from 1968 to 2010



2.2.2. Land transport

In contrast, in road and railway transport exploitation of potential economies of scale has been rather limited. As both modes also serve maritime shipping in pre- and onward carriage, their share in total transport costs for intermodal transport has increased over the last few decades. In addition, in particular in road transport, the number of vehicles and the kilometers travelled to achieve the higher transport output caused by economic growth (measured usually in tonne-kilometers) increased tremendously.

Railways

In railway transport, China, Russia and India have made some effort to establish double-stack container train services in recent years, similar to the successful services in the US.[15] China has increased the maximum possible length for some freight train services, e.g. the coal freight trains on the Daqin Railway (linking Datong in Shanxi Province to Qinhuangdao in Hebei Province), making it possible now to operate trains with 20,000 tonnes[16] of coal.[17] Most of these operations (in particular double-stacking of containers) are currently under investigation or in a start-up phase.

---

[14] For the determination of optimal ship size see Kendall (1972), Jannson and Shneerson (1982).

[15] Railway Gazette International (2006a), p. 241; Railway Gazette International (2006b), p. 113; China Daily (2004)

[16] In figures in tables tonnes is abbreviated with “t”.

[17] People’s daily online (2006)

Road transport

In road transport, potential economies of scale have hardly been exploited at all over recent decades. Freight transport vehicles' weight and dimensions are reasonably homogenous worldwide and, apart from a few exceptions, changes rarely occur. Although reasons vary among the countries, they generally include the following:

- truck dimension legislation is on a local/regional level and achieving coherence on a federal level is difficult
- increased intermodal competition with railway transport
- existing infrastructure limits increased dimensions
- road safety concerns

Compared to developed countries, in developing countries, smaller road freight vehicles tend to be used, which is, inter alia, due to lower wages and limited access to capital (higher capital requirements for large vehicles). Furthermore, the flexibility of small vehicles is higher and the related business risks are lower. Last but not least, freight transport volume in general tends to be lower in developing countries.

However, the conditions for road freight transport have changed considerably over the past years, making it worthwhile to evaluate the prevailing regulations of road transport vehicles in the UNESCAP region. Technical progress has made freight vehicles safer (Antiblock System, Electronic Stability Program, etc.) and the power of diesel engines has increased significantly. Today, plenty of experience with larger road freight vehicles is available. Countries such as Australia, Brazil, Canada, Finland, Sweden and the USA have been operating large road freight vehicles for a considerable time. In this context, it may be useful to note that comparable systems to the LCVs in urban passenger transport, i.e., BRT systems, has already been introduced with much success in developing countries, particularly in South America.

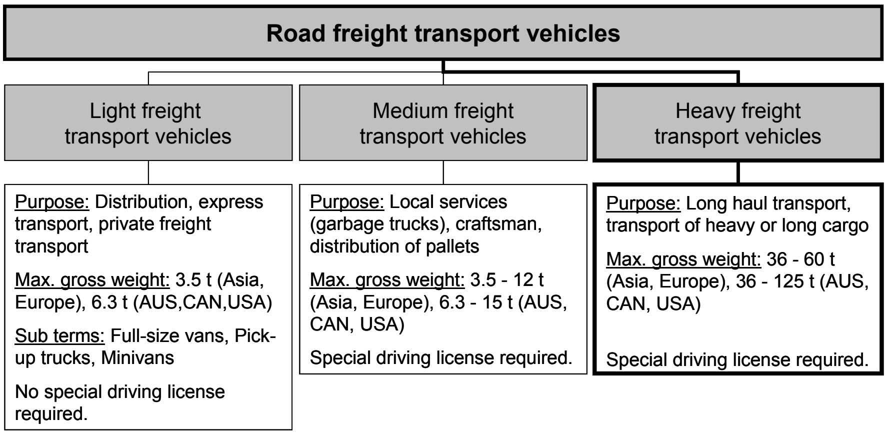
3. Road transport vehicles

3.1 Classifying road freight vehicles

The terminology regarding road freight transport vehicles and particularly longer combination vehicles is not uniform and sometimes confusing. Vehicles can be classified using various criteria, such as size, configuration (articulated vehicle, tractor-trailer), type of chassis (tank, container) or motorization (diesel, gasoline). A general classification along weight and dimensions is presented in Figure 3.1.

A wide range of road vehicles exist below the maximum permissible gross weight (MPGW) of a certain country, depending on different transport requirements. Besides customer-oriented adaptation of the road vehicles, the vehicle fleet is also influenced by a variety of regulations, such as driving licence restrictions, concessions or tax law. In this paper we focus on heavy vehicles as described in Table 3.1

Figure 3.1: Systematization of road freight transport vehicles according to size



The relevant regulations in the different countries vary considerably and Table 3.1 can only give a broad overview. Still, there are many similarities, in particular regarding axle load, height and width. A standard heavy freight transport vehicle has, on average, a maximum height of 4 meters, a width of 2.55 meters, a single axle weight of 10 tonnes, a MPGW of 40 tonnes and a length of 18 meters. Vehicles of these dimensions can be operated in most countries in the world.

Table 3.1: Truck weight and dimensions for selected countries
(The values for vehicles with extended dimensions are in parenthesis)[18]

	Permissible single axle weight *[tonnes]*[19]	***Permissible gross weight tractor + semi-trailer*** *[tonnes]*	***Maximum vehicle dimensions*** *[meters]*		
			length	*Height*	*width*
Australia	9.0	45.5 (125.2)	19.0 (53.5)	4.3	2.5
Brazil[20]	10.0	45.0 (74.0)	22.40 (30.00)	4.40	2.6
Canada	9.1	62.5	25.0 (38.1)	4.12	2.6
China	10.0	40.0	18.0	4.2	2.5
Germany[21]	10.0	44.0	18.75	4.0	2.6
India	10.2	44.0	18.0	4.2	2.7
Japan	10.0	36.0	18.0	3.8	2.5
Russia	10.0	44.0	20.0	4.0	2.55
Sweden	10.0	44.0 (60.0)	18.75 (25.25)	4.0	2.55
Thailand	9.1	37.4	10.0	4.0	2.5
UK	10.0	44.0	18.75	4.0	2.55
USA[22]	9.1	36.3 (59.45)	19.8 (35.20)	4.1	2.6

[18] Sources: Asia: ESCAP (2002), p. 7f; Brazil: RESOLUÇÃO No 68, DE 23; Canada: Schulman (2003), p. 13f; Sweden, Germany: ECMT (05-12-01): UK: "The Road Vehicles (Construction and Use) Regulations 1986" and "The Road Vehicles (Authorised Weight) Regulations 1998". European regulations can be found in EC Directive 96/53/EC; USA: Code of Federal Regulations Title 23 Part 658 (Revised as of 2005-04-01); Australia: National Transport Commission (National vehicle dimensions).
[19] Weight per bearing axle (dual tires) in tonnes (t), in some countries the weight per drive axle is permitted to be one to two tonnes higher.
[20] The weight and dimension limits in parenthesis are only allowed on certain routes.
[21] Germany allows semi-trailers engaged in intermodal container transport a maximum weight of 44.0t.
[22] In the US truck weight and truck length is determined by every State individually. The numbers in this table show the minimum values regulated by Federal law. The highest values among the State-laws appear in parenthesis.

Some countries, including Brazil, Canada, Mexico, Finland, Sweden and the USA, also allow longer and heavier vehicles. In some of the countries (e.g. Australia, Canada, USA), the legislative power of regulating freight vehicle dimensions and weight is at the local/regional level. Regulations differ considerably between the States in these countries.

The European Union has extensively harmonized road vehicle dimensions.[23] This ensures a maximum interoperability of vehicles within Europe.

Concerning the convertibility of the dimensions, it turns out that truck height, width and axle are unchangeable as they are limited by the already existing road infrastructure. The only parameters which can be changed are truck length and gross weight. Concerning weight in respect of the infrastructure, only the axle weight limits are significant. If axle weight remains constant, the gross weight of a vehicle is only of minor concern regarding infrastructure.

3.2. Standards for intermodal transport (containers)

It is highly important to coordinate the dimensions of road transport vehicles with the dimensions of intermodal transport equipment, in particular with containers. Road transport is in many cases necessary for the pre- and onward carriage of containers to a railway terminal or to a port. Table 3.2 gives an overview of the key figures of the most common types of containers used.

Besides the types of containers described in Table 3.2 also containers with a length of 48 and 49 ft are in wider use, mainly in North America.

The interaction between vehicles and containers has multiple aspects, whereas width and height are only a minor issue. Container length is restricted by the maximum length of a trailer and by the equipment used in sea shipping. The standard containers used in international trade are 20 ft and 40 ft containers. Road vehicles in Asia and in Europe are restricted to transport containers longer than 40 ft; only few countries allow 45 ft containers. Only in the USA and Canada are containers larger than 45 ft in regular use.

In conjunction with container length, weight is also an issue. The regulations of all countries allow the transport of one fully loaded 20 ft container. Most countries also allow the transport of one fully loaded 40 ft container. In contrast, transport of two fully loaded 20 ft containers is not permitted in most countries. Even though it would be possible to transport the length, maximum weight is an obstacle. As a rule of thumb, the chassis of a semi-trailer for a 40 ft container has a Tara-weight of 4 tonnes, the tractor has a Tara-weight of 10 tonnes, and together a standard semi-trailer truck has therefore a Tara-weight of 14 tonnes. This is the reason why many countries allow vehicles with 44 tonnes, as a 40 ft container has a maximum weight of 30 tonnes. What always remains constant is axle weight, so transporting heavier loading means also having more axles. In this content, it should be noted that even the possibility to transport containers which are not fully loaded or even empty improves the effectiveness of the transport system.

[23] See EU Council Directive 96/53/EC, Art. 4. (b).

Table 3.2: Weight and dimension limits of 20, 40, 45 and 53 ft container

	20 ft[24] Container		40 ft Container		45 ft Container		53 ft Container	
	imperial	metric	imperial	metric	imperial	metric	imperial	metric
Length	20 ft	6.058 m	40 ft	12.192 m	45 ft	13.716 m	53 ft	16.154 m
Width	8 ft	2.438 m	8 ft	2.438 m	8 ft	2.438 m	8 ft 6"	2.591 m
Height	8 ft 6"	2.591 m	8 ft 6"	2.591 m	8 ft 6"	2.591 m	9 ft 6 1/2"	2.908 m
Volume	1,169 ft³	33.1 m³	2,385 ft³	67.5 m³	3,038 ft³	86.0 m³	3,857 ft³	109.2 m³
Gross weight	52,910 lb[25]	24,000	67,200 lb	30,480 kg	67.200 lb	30,480 kg	67,200 lb	30,480 kg
Tara	5,140 lb	2,330 kg	8,820 lb	4,000 kg	10,850 lb	4,921 kg	11,110 lb	5.039 kg
Load weight	47,770 lb	21,670	58,380 lb	26,480 kg	56,350 lb	25,560 kg	56,090 lb	25,442 kg
Load weight / volume-ratio	40.9 lb/ft³	655 kg/m³	24.5 lb/ft³	392 kg/m³	18.5 lb/ft³	297 kg/m³	14.5 lb/ft³	232 kg/m³

One important lesson can be derived from the US case and the increasing use of larger containers. In many cases the limiting factor of a container is not *weight* but *space*. Space can be interpreted in two respects, volume and the number of pallets. For Europe, Lumsden (2005) shows that in most cases space and not weight is the limiting factor of containers. Additional evidence for this fact is the average weight of loaded containers in ports. The German container port of Hamburg exhibits an average weight for loaded 20 ft containers between 12 and 13 tonnes.[26] Like their European counterparts, ports in developing countries are also experiencing space limitations. This is illustrated by the decreasing weights of containers in the Indian port of Mumbai, where the average weight for loaded 20 ft containers is 16.3 tonnes and 19 tonnes for 40 ft. with a decreasing trend over the last ten years.

3.3. Longer combination vehicles (LCVs)

Heavy vehicles as described in Figure 3.1 can be divided into standard heavy freight transport vehicles, longer combination vehicles (LCVs) and special freight transport vehicles. (Figure 3.2).

Six groups of heavy freight transport vehicles can be identified (Figure 3.2). They are discussed in detail as follows.

Standard vehicles are permitted to operate on the whole road network without restrictions.[27] They can usually transport one fully loaded 40 ft container or two not fully loaded 20 ft containers.

[24] 1 ft (foot) = 0.3048 m (meters).

[25] 1 lb (pound) = 0.453592 kg (kilogramms)

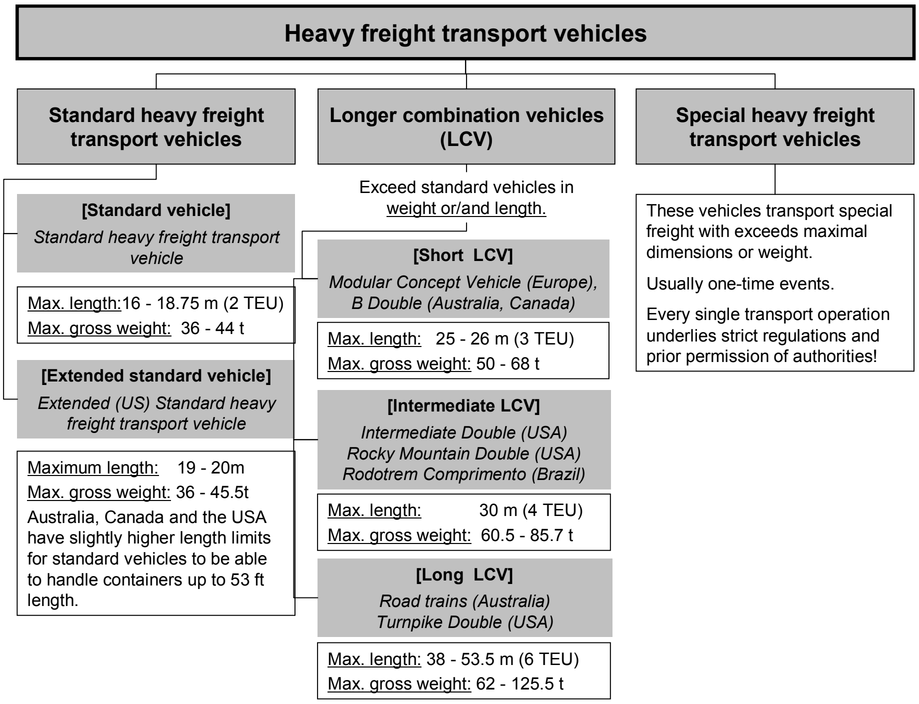
[26] See the official statistics of Mumbai Port authority and Hamburg port authority.

[27] Local restrictions are possible, e.g. within city centres or the crossings of smaller bridges.

Extended standard vehicles are used in Australia, Canada and the US and have slightly longer length to be able to handle the widely used 45 ft, 48 ft or 53 ft containers.

Longer combination vehicles (LCVs) are vehicles which exceed the dimensions of standard heavy vehicles in length and weight.[28] LCVs do not exceed the maximum width and maximum height of standard vehicles. They also do not exceed the maximum axle loads, the most important parameter for the compliance of infrastructure design road surface wear and tear. Therefore, LCVs do not stress infrastructure more than standard vehicles do today.

Figure 3.2: Systematization of heavy freight transport vehicles



LCVs can be classified further into three different groups according to their length.

The first group of LCVs with vehicle lengths shorter than 26 meters [*Short LCV*][29] has been widely operated in Australia, Canada, Finland and Sweden for many years. They are able to accommodate up to three TEU and they offer the possibility of transporting two fully loaded 20 ft containers. The transport of one fully loaded 40 ft and one fully loaded 20 ft container remains restricted, as an MPGW of at least

[28] The US Code of Federal Regulations Title 23 Part 658 (Revised as of 2005-04-01) defines longer combination vehicles as "any combination of a truck tractor and two or more trailers or semi-trailers which operates on the Interstate System at a gross vehicle weight greater than 80,000 lb."

[29] The semantics of the word 'short longer combination vehicles' or 'long longer combination vehicles' may seem illogical at first sight. But the term 'longer' in 'longer combination vehicle' means 'longer than the standard vehicle' and is therefore a denotation for all vehicles in that group. These 'longer than standard vehicles' can be of short, intermediate and long length in turn.

68 tonnes is necessary, which so far only applies to the case in Australia. Most of the other countries limit weight at 60 tonnes.

These vehicles offer the possibility of closer coupling without using a drawbar. Through this sophisticated coupling techniques their driving characteristics are given a solid basis.[30] In Australia and Canada these vehicles are called 'B Doubles' or 'B-train' in contrast to vehicles with drawbars, which are known as 'A-trains'.[31] Figure 3.3 shows them under this vehicle category on the right side. This type of vehicle seems to be the most promising for use in UNESCAP countries, as requirements for the infrastructure are low and maneuvering abilities and safety are at the highest level. Pushing back the vehicle and most other maneuvering techniques remain possible.

In particular, this type of vehicle does not need to be operated on dedicated lanes, like the long busses in a BRT-system: as they do not operate in cities and their coupling can be better as walking through the whole vehicle is not necessary in freight transport.

The maximum loading capacity in volume with Short LCVs increases by approximately 37 percent (from 96 to 136 cubicmeters)[32] and by approximately 66 percent (from 24 to 40 tonnes) in payload.

The intermediate group of LCVs shows vehicle length of less than 30 meters *[Intermediate LCV]*, which makes the transport of four TEU possible. These vehicles are almost impossible to push back, for maneuvering they usually have to be decoupled. The use of this type of vehicles makes sense for long distance transport where railway is not an alternative. One possibility would be a rough network of dedicated highway lanes and special places for coupling and decoupling on some exits.[33]

The largest road freight vehicles in the world have a length of more than 30 meters *[Long LCV]*. They are allowed only in Australia and the US and even there only on dedicated routes and with some restrictions.

Australia, Canada, Sweden and the USA have analyzed the effects of LCVs in detail.[34] In 2004, the Netherlands started a broadly based trial with 300 vehicles which permits common carriers the usage of *Short LCVs* on Netherlands roads under certain conditions. If the test run is successful, the Netherlands will permit LCVs on their road network.

The European Union has set up regulations which permit only certain types of Short LCVs. The idea behind this is to ensure that all elements of freight transport vehicles are compatible, as some countries in Europe permit LCVs and some

[30] TRB (1990)

[31] For more technical aspects of LCV see Weber (2005) or Wallentowitz et al. (2000).

[32] Loading spaces of standard vehicles: Length 15.36 meters, width 2.55 meters, height 2.46 meters. LCV: Length 21.14 meters, same width and height.

[33] For research on dedicated truck lanes, see Holguin-Veras et al. (2003).

[34] See Western Transportation Advisory Council (1993), US Department of Transportation (2000), Backman and Nordström (2002).

countries do not. This ensures easy handling at borders, where LCVs have to be detached and split into two vehicles. The vehicles are therefore called “Modular Concept Vehicles”.

Special freight transport vehicles can exceed width, height, length and weight. Special transports are usually one-time events and every single transport, the used route, the time and necessary additional measures (closing of the road, accompanying vehicles) has to be evaluated and premised by the authority.

Figure 3.3 presents a comprehensive overview with pictograms of the different types of heavy vehicles.

As Figure 3.3 indicates, standard vehicles are currently able to handle one 40 ft container or two 20 ft containers with restrictive weight limitations to 26 tonnes. (the MPGW of two 20 ft containers is 48 tonnes). To improve the capacity of road freight transport with standard vehicles in respect to containers, it is possible to change vehicles and regulations to allow for the transport

- of two fully loaded 20 ft container (MPGW of approx. 60 tonnes necessary)
- of one larger container (45-53 ft)
- of three TEU (one 20 ft and one 40 ft or three 20 ft) containers, whereby the corresponding weight limits determine to what extent they are loaded of four or more TEU

The first and third points can be handled by Short LCVs. For the larger containers (point 2), only slightly extended semi-trailers have to be used. Containers longer than 45 ft are not used in most countries and slightly longer semi-trailers would be sufficient to transport these containers; weight is a minor issue as the maximum weight limits remain constant (see Table 3.2).

Summarising the results of this section, the connection between ISO-container weight and dimensions of transport vehicles is essential. The current standard vehicles are not very efficient in transporting ISO-containers. The most important step forward is by Short LCVs, which increases capacity and efficiency considerably without high infrastructure requirements. Intermediate and Long LCVs can be used on certain (dedicated) lanes or roads, where railway transport is impossible, restricted by interoperability problems (track gauge) or where freight volume does not justify the construction of a railway line.

4. Impacts of the introduction of longer combination vehicles (LCVs)

4.1. Lower external effects of road freight transport through longer combination vehicles

The public has an interest in reducing or at least stabilizing the overall level of negative externalities of transport through the permission of LCVs.[35]

[35] A detailed analysis of economic and technical effects of changes in vehicle dimensions in the USA provides TRB (2002) and the related critics by McCullough (2003).

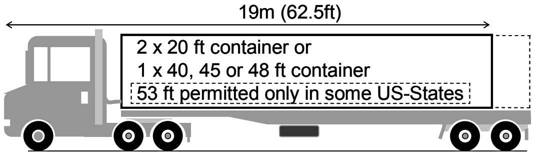
Figure 3.3 Different configurations of heavy vehicles

Standard heavy freight transport vehicle [standard vehicles]

Standard freight transport vehicles as they are allowed in almost every county in the world (see Table 3.1).

Weight: To transport one 40 ft container at full ISO-load,[36] a MPGW of 44 t is necessary. For transporting two fully loaded 20 ft containers, a MPGW of at least 56 t would be necessary. As this would in most cases lead to very high axle loads the transport of two fully loaded 20 ft containers cannot be carried out by standard vehicles.

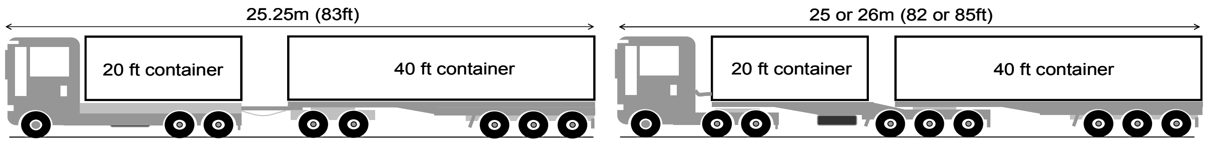
Extended (USA) standard heavy freight transport vehicle [extended standard vehicles]



Standard freight transport vehicles allowed in Australia, Canada and the US.

Weight: The US federal weight limit for these vehicles is 36.3t. This is a major source of inefficiency,[37] as fully loaded 40, 45, 48 and 53 ft containers cannot be transported. Australia and Canada allow a MPGW of 45.5 t, which makes the transport of fully loaded 40ft containers possible.

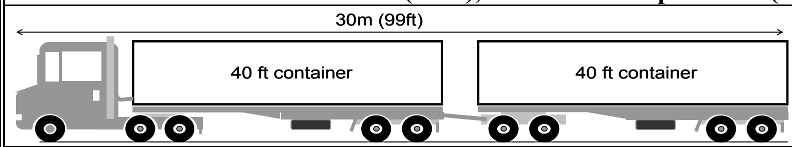
Modular concept vehicle 'MCV' (Europe), B Double (Australia, Canada) [Short LCV]



Vehicles up to 26 m. Regular use in Sweden, Finland (left picture) and Australia and Canada (right picture). These configurations are most interesting for many countries. Also other vehicle configurations are possible.

Weight: MPGW in Australia is 68 t, in Canada 62.5 t, in Europe 50-60 t, this allows the transport of two fully loaded 20 ft containers. The Australian MPGW allows the transport of a fully loaded 20 ft and 40 ft containers.

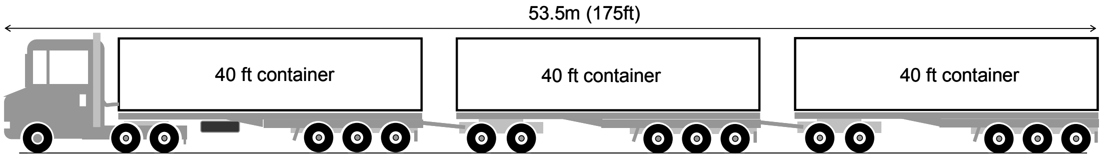
Intermediate Double (USA), Rodotrem comprimento (Brazil) [Intermediate LCV]



Vehicles allowed in Australia, Brazil, Canada, Mexico and the USA. Some US States allow the combination of a 45-48 ft and a 26-28 ft trailer ('Rocky Mountain Double').

Weight: MPGW up to 74 t (Brazil), 61 t (some US-States), 85.7 t (Australia) 60.5 t (most Canadian States)

Road trains (Australia) and Turnpike Double (US) [Long LCV]



Vehicles up to 53.5 m are only permitted in Australia, usually on dedicated roads and under strict regulation. Few States in the US allow also vehicles with two 45 or 48 ft. trailer ('Turnpike Double') or so-called Triples with three 26-28 ft trailers with vehicle length up to 36m.

Weight: In Australia up to 125.5 t. Transport of three fully loaded 40 ft containers is possible.

[36] For weight and dimension limits of containers see Table 3.2. Besides the types of containers described in Table 3.2 also containers with a length of 48 and 49 ft are in wider use, mainly in North America. The interaction between vehicles and containers has multiple aspects, whereas width and height are only a minor issues. Container length is restricted by the maximum length of a trailer and by the equipment used in sea shipping. The standard containers used in international trade are 20 ft and 40 ft containers. Road vehicles in Asia and in Europe are restricted to transport containers longer than 40 ft; only few countries allow 45 ft containers. Only in the USA and Canada are containers larger than 45 ft in regular use.

[37] Samuel/Poole/Holguin-Veras (2002), p. 12.

4.1.1. Congestion

Two main effects can be identified with respect to congestion. On the one hand, vehicle-kilometers traveled by trucks are reduced through the efficiency advantage of LCVs. Backman and Nordström (2002) have evaluated the effects of Short LCVs in Europe on the basis of three sample companies. Their results indicate that vehicle-kilometers are reduced by approximately 30 percent for the same amount of output transported.[38] On the other hand, it could be assumed that the same number of LCVs causes more congestion, as the mobility of such long and heavy trucks is restricted, for example, during a lane-changing process on highways or during the use of a crossroads. However, results from the Netherlands indicate positive effects of LCVs on congestion.[39]

It seems difficult to estimate the overall effect of LCVs on congestion. In most cases, prime responsibility for congestion lies with passenger cars, since truck traffic does not show the same intense agglomeration effects as passenger car traffic (e.g., during morning peak hours). Therefore the negative congestion effects — if there are any — can be assumed to be relatively small. This is also confirmed by a recent simulation of road performance of LCVs on highways that has shown positive effects (Sandkühler et al. (2001)).

4.1.2. Accidents

The accident probability increases with the vehicle-kilometers traveled. As the vehicle-kilometers traveled are reduced through the introduction of LCVs, the number of accidents may also decline. On the other hand, the destructive force of one LCVs with a MPGW of 60 tonnes or more is higher than of a standard vehicle with a MPGW of 40 tonnes, leading to more serious accidents.[40] This problem could be addressed by lowering the maximum authorized speed for very heavy vehicles, which would, however, slow down traffic flow.

Further problems could arise from the increased length of LCVs. This could cause problems during overtaking procedures on single-lane roads, since the time needed for overtaking procedures increases.[41]

In any case, permitting LCVs offers a great opportunity to allow only new vehicles with the newest safety features for this purpose. In addition, special driver training can be made compulsory. So far, no empirical evidence has been found to show that LCVs (in particular Short LCVs) are significantly more dangerous than standard heavy vehicles.

---

[38] Backman and Nordström (2002), p.8: In their sample, they choose haulage firms in view of routes and goods which are similar to modular concept vehicles.

[39] ACARDIS (2006)

[40] The kinetic energy, which is possessed by a body by virtue of its motion, can be described with (Newtonian approximation) $E_{translation} = \frac{1}{2} m\, v^2$, whereas *m* is the mass of a body and *v* its velocity.

[41] This problem is examined in detail by Hanley and Forkenbrock (2005) and Backman and Nordström (2002).

4.1.3. Noise

The noise emissions of road vehicles are dependent mainly on[42] (a) speed, (b) vehicle-miles traveled and (c) the noise intensity of the vehicle itself (wheels, motor). Introduction of LCVs will reduce vehicle-kilometers traveled per tonne of payload, while vehicle speeds are assumed to stay unchanged, and noise intensity will not change[43]. As a result of the reduced vehicle-kilometers traveled noise emissions could be reduced.

4.1.4. Natural resources and pollution

The essential natural resource for road transport is still crude oil and its derivatives diesel and gasoline fuel. The price of crude oil has risen over time which makes road transport in general more costly (Figure 4.1).

The use of fuel and the resulting pollution are strongly related to vehicle-kilometers traveled. That means, if the same amount of goods is transported more efficiently, then the use of natural resources and subsequent pollution is reduced. Together with the permission of LCVs use, it could be stipulated by the government that such vehicles must fulfill very strict emission-norms to make them the cleanest freight vehicles on the road. The first results of the Netherlands test with respect to fuel usage are a 10-15 percent increase in fuel usage, compared to a more than 30 percent increase in average load (see DVZ of 2005-02-15). Backman and Nordström (2002) find in their survey a reduction of overall fuel consumption between 14 and 18 percent for their three sample haulage companies. In a more technical approach, Sandkühler et al. (2001) calculated fuel savings per ton payload between 23 and 26 percent, depending on vehicle speed.

4.2. Effects of the permission of longer combination vehicles (LCVs) on common carriers

4.2.1. Transport cost function

The possibility of using LCVs has effects on the cost function of the common carriers. The authorisation of LCVs would increase the available set of technologies for the firm to reach a certain output. Thus, the common carriers are able to produce at least at the same costs compared to the situation when only standard vehicles are allowed. Private companies will not make use of the new technology, unless its use entails an economic benefit (e.g., savings of fuel, vehicle kilometers or frequency).

[42] Noise emissions depend in addition on weather condition, noise protecting facilities, and type of pavement.
[43] This is a conservative assumption, as it could also be assumed, that modular combination vehicles — as they are new vehicles — are quieter than old ones.

4.2.2. The operational fleet composition

Figure 4.2 shows the problem when the distance is fixed at 100 km[44] and the costs per vehicle kilometer traveled is 0.80 monetary units for standard vehicles and 1.00 monetary units for LCVs. The bold line shows the optimal combination of vehicles under the given constraints. In the shaded area different combinations of standard vehicles and LCVs are efficient. Common carriers have to do this optimization procedure for all of their routes y_{ij} .

Figure 4.1: Movements in crude oil price 2000-2006[45] (dotted line shows linear trend line)

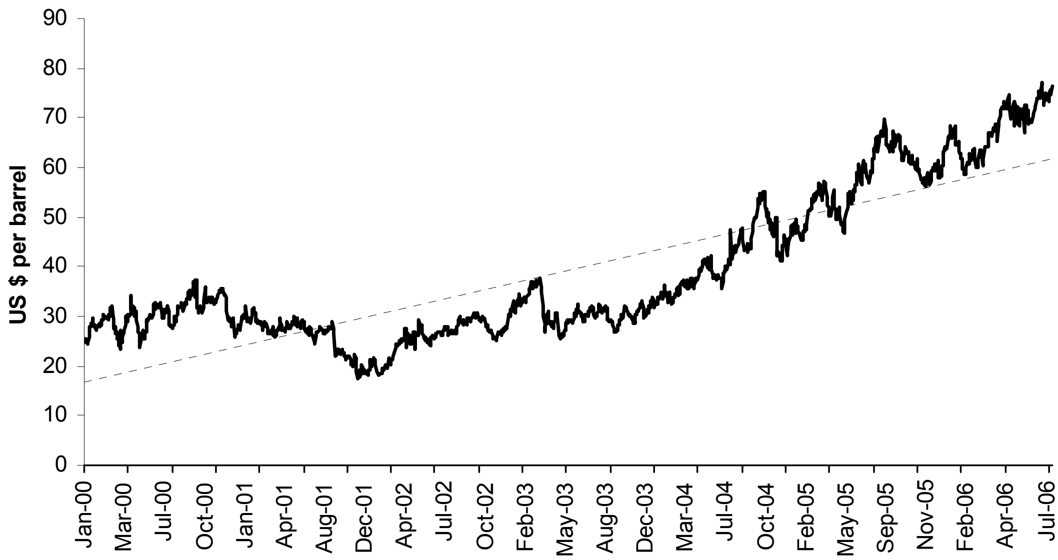


Figure 4.2 depicts an example for one route (y_{12}) for a certain period (e.g. one day). The volume of goods to be transported on this route is plotted on the x-axis; the y-axis shows the costs for transporting this amount of goods from point 1 to point 2. Take the area between 48 t and 64 t as an example: if only standard vehicles are allowed, the common carrier would need three standard vehicle trips to transport all goods and cost would be at 3 x 80 = 240. If transport with LCVs is possible, the common carrier would dispatch one LCV and one standard vehicle trip at 80 + 100 = 180.

The graph shows three interesting things:

- Standard vehicles (and also smaller vehicles) are still used when LCVs are permitted as they can transport smaller amounts of goods more efficiently
- The cost savings through LCVs are apparent when the bold line is below the cost curve of standard vehicles
- The shaded areas show the regions where LCVs and standard vehicles are used and simple conversion from LCVs to standard vehicles and vice versa has advantages

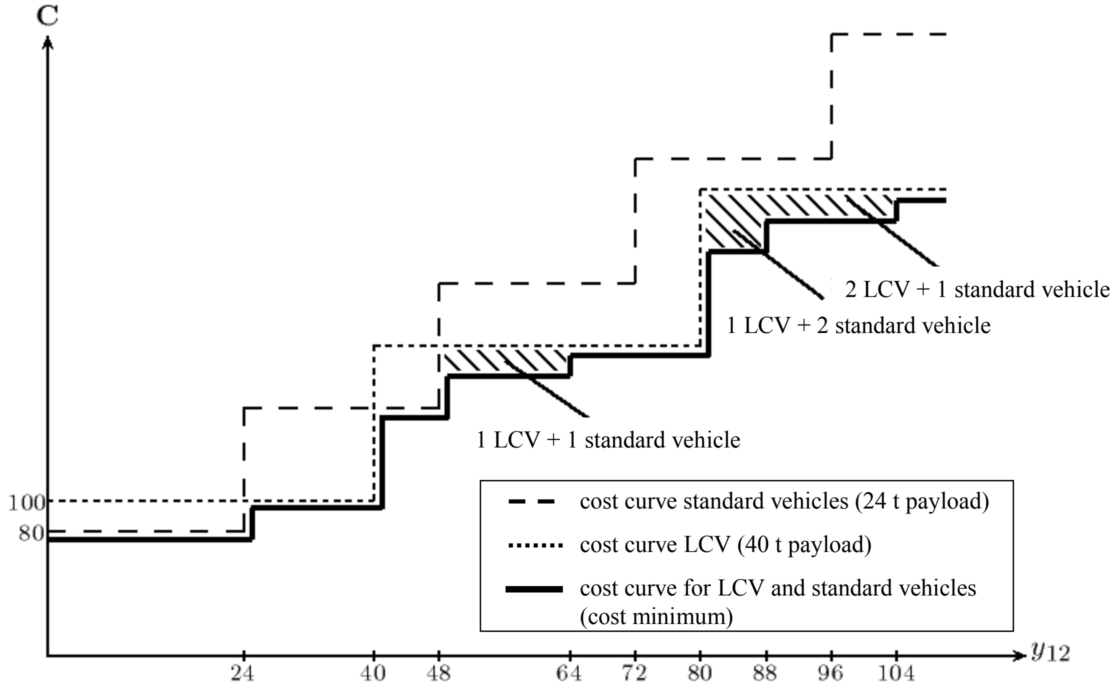
---

44 1.6093 km (kilometer) = 1 Mile

45 NYMEX (New York Mercantile Exchange), price of Light Sweet Crude per barrel.

This microeconomic approach can also be used to estimate the optimal number of LCVs from data on goods flow between different areas or cities of a country. In an extreme case, the maximum number of LCVs is the flow of goods between two areas (y_{ij}) divided by the maximum capacity of a LCV. In the real world the situation is much more complex, since different common carriers serve the special needs of many different customers.

Figure 4.2: Cost curve of haulage firms related with two types of vehicles



A further effect of LCVs, if they are used on a certain route, is a diminishing frequency of service due to their increased capacity. This could have effects on handling costs, as larger amounts of goods have to be handled all at once, which leads to lower utilization of handling facilities.

In general, routes with the following characteristics are affine to LCVs:

- Full truck loads
- Transport on routes with long distances (international transport)
- Transport on routes with a high share of highways or motorways
- Non-stop (direct) transport (terminal to terminal transport and transport between hubs)
- Intermodal transport, as loading/unloading speed could be increased

In a time-based view, routes with these characteristics will be served first with LCVs, as common carriers and enterprises with private haulage will first collect experiences on routes extremely affine to LCVs, before they employ them on other routes.

4.2.3. Measures to increase the acceptance of modular combination vehicles

In a static consideration, the effects of modular combination vehicles on noise, natural resources and pollution could be regarded as particularly positive; the effects on congestion and accidents are slightly positive or neutral.

To reduce the external effects and to increase the acceptance of modular combination vehicles, the following measures can be taken into consideration:

- Permit only LCVs applicable for combined transport (container transport)
- Increase the taxes for LCVs, probably with a transfer of the excess money to finance railway infrastructure
- Determine high environmental standards concerning LCVs with respect to noise and exhaust fumes
- Stipulate high safety standards (ESP, Brake Assistant, lane assist systems, additional security measures for other road users, special trainings for drivers)
- Require the installation of GPS for safe guiding and avoidance of infrastructure bottlenecks
- Establish a minimum level for the power of engines in LCVs to reduce congestion
- Stipulate special training for drivers of LCVs
- Restrict the usage of LCVs in cities

The main aim should be to make the LCVs safer, cleaner and quieter. The higher costs of these measures (in particular higher investment costs) could be financed by increases in productivity.

4.3. Dynamic effects of longer combination vehicles LCVs

If we look at the problem from a dynamic viewpoint, we must also consider competition towards the railway and inland waterway sector. If road freight transport is made more efficient, this mode of transport will be more attractive in the future than it currently is. As a consequence, despite a reduction of the vehicle-kilometers traveled (only goods transport is considered) today, faster growth rates could be expected in the future and, from a certain point on, more vehicle kilometers traveled than without the introduction of LCVs. The reason for this growth has two roots. On the one hand, more goods are transported via road, relative to the other modes of transport (*intra-sectoral effect*). On the other, the total amount of goods to be transported is increasing, as transport becomes more efficient. The economy as a whole is becoming more transport intensive (*inter-sectoral effect*).

In a dynamic consideration, LCVs are not able to cure all problems resulting from the external effects of road freight transport. The problems that are already visible in road freight transport will also be generated by LCVs, even though they offer the possibility of being more efficient and more environmentally friendly.

Another argument in favor of LCVs in a dynamic context is that it can be expected that future vehicles will produce fewer emissions through the introduction of newer technologies. As a consequence, the problem becomes one of valuation of external effects in different points of time.

5. Application of longer combination vehicles (LCVs) in the UNESCAP region

5.1. General considerations

While the preceding sections showed the possible costs and benefits of introducing LCVs, this section discusses the process of introducing them. We start with some general considerations and then present a concrete example by means of a case study.

In general, some options exist to permit the introduction of LCVs:

- *Permit LCVs only on certain routes*. Before LCVs are allowed to operate on certain routes, the routes are evaluated and permitted by the authorities at the request of the common carriers. The authorities can evaluate the infrastructure as well as an alternative opportunity for railway transport. This offers a high degree of control and maximum protection of railway transport. Also, special restrictions can be imposed. For example, the operation can be limited to special hours of the day.
- *Permit LCVs only on highways/motorways*. LCVs are permitted in general on intercity highways or motorways.[46] Next to the highway exits, parking spaces can be constructed to facilitate the decoupling of the LCVs to standard vehicle combinations. Alternatively the routes to/from the highway/motorway to the destination can be made subject to permission, similar to point mentioned above.
- *Permit LCVs in general with local restriction*. LCVs are permitted in general for the whole road network. Certain roads or city centers can still be restricted, e.g. via traffic signs. With the use of GPS navigation, LCV can be navigated efficiently to their destinations, even in the case of many restricted roads and other infrastructure bottlenecks.

The possible scenarios for the application of LCVs can be differentiated for Short, intermediate or Long LCVs. In the Australian example Short LCVs are allowed to operate nearly on the complete road network, whereas Intermediate and in particular Long LCVs are restricted to certain routes.

Once LCVs are permitted, the common carriers will first serve routes where they have to operate a certain number of standard vehicles per day already. The next stage of development that can be expected is unscheduled services between high density areas. In this case, high-distance routes will be served first. LCVs will not be used for local transport or distribution, as these transport operations are already carried out by smaller vehicles.

---

[46] This can be also only a certain part of the highway/motorway network.

In any case, it is necessary to gain experience with LCVs on different routes and for different purposes. It seems helpful to test the application of these vehicles on dedicated routes for dedicated purposes. In this case, the risk of negative side effects is very low, as many factors which can possibly impede a successful introduction of LCVs can be fixed in advance. In addition, it presents a competent picture of the authorities towards the public, when the introduction is carefully tested and evaluated.

Finally, controlled test runs with a certain number of vehicles on certain routes allow for detailed surveillance and good data availability in advance. The following points should be recognized for test-runs of LCVs on certain routes:

- Collect statistical data on the routes intended for LCV-use (accidents, number of vehicles, congestion) before introduction, to create a base case scenario
- Determine a framework for evaluating the success or failure of the test run
- Ensure the systematic collection of data during the test run at the companies
- Set up a procedure for the test and the possible implementation phase

Based on the results of the test run, LCVs can either be permitted with certain regulations following results of the test run or permission can be refused. In both cases the data from the test can significantly contribute to a decision process of high quality.

These theoretical considerations of the introduction process of LCVs can be implemented relatively simply. The equipment (trailers and tractors) can be used also as standard equipment and it is easy to justify the significant benefits of a test run. The case study presented in the next section shows a test application of LCVs.

5.2. Case study: Connecting Chinese Guanlan intermodal container depot (ICD) with seaports

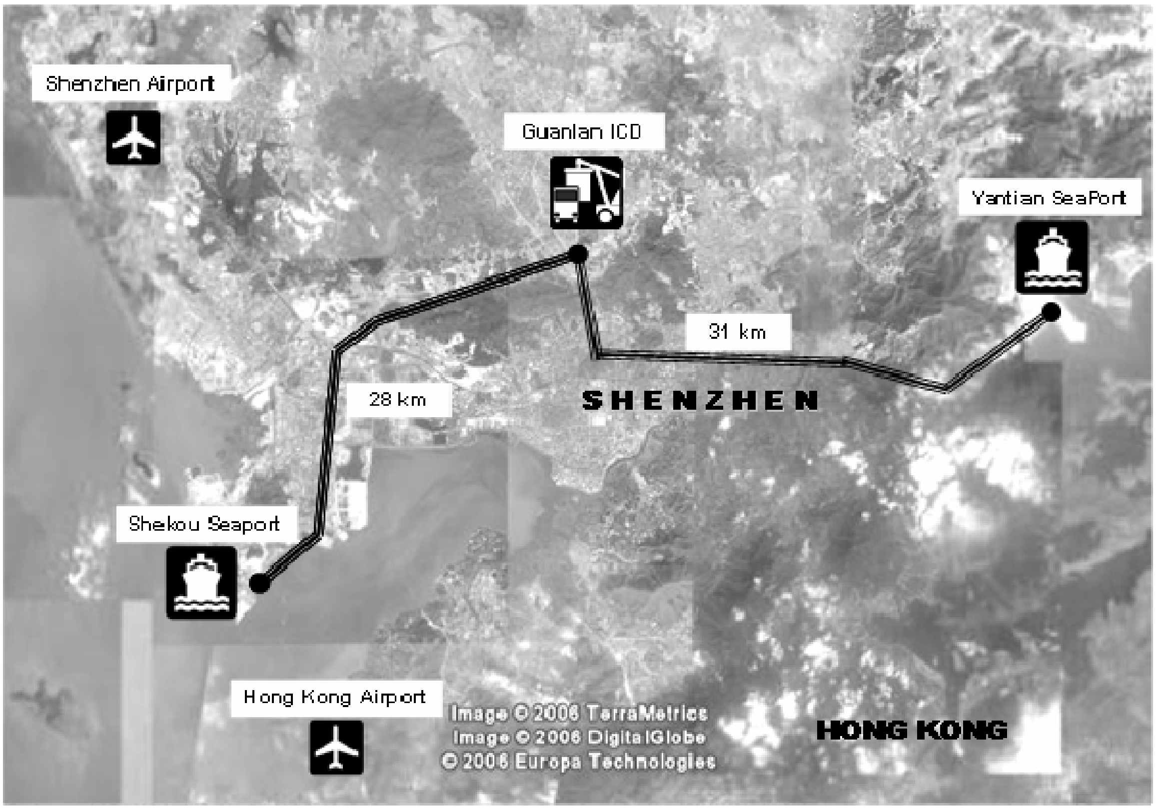
Although China has an extensive railway network, not all facilities are connected or will be connected to the railway system in the future. The case study shows one example, where the use of LCVs seems reasonable and contrivable.

The Guanlan intermodal container depot (ICD) is located near the city of Shenzhen in the Guangdong Province. The Guanlan ICD is the first ICD in China and established under a cooperative joint venture. In this joint venture, 71 percent is owned by Hutchinson Whampoa Ltd.[47] The ICD is located in a strategically optimal position between the Yantian Seaport, the Hong Kong Seaports and Shekou Seaport. The ICD offers full customs clearance and no additional customs procedures are required at the seaports. The ICD, so far, has no railway connection, which might also be due to the short distances to the seaports.

Figure 5.1 shows the locations of the ICD and the two seaports as well as the distances between the ICD and the two seaports in Yantian and Shekou.

[47] See Annual Report Hutchinson Whampoa Ltd. 2005, p. 204.

Figure 5.1: The Guanlan ICD – Satellite picture source: Google Earth



The purpose of the case study is to illustrate the impacts of permitting the use of LCVs on the two routes between the Guanlan ICD and the two seaports (approx. 60 km of road, mostly motorway). The port of Hong Kong, China, is not included in the calculations, because of the lack of appropriate information. Including Hong Kong, China, would make the result in favor of the LCVs even stronger, as the distance between the ICD and Hong Kong, China, seaport is longer and therefore more suitable for LCVs. It is assumed that currently all container traffic between the ICD and the seaports is operated by standard vehicles according to the Chinese regulations. As some information necessary for the calculation is not available, all parameters are selected carefully and are shown in Table 5.1.

The standard vehicles are restricted to one 40 ft container or two lightweight (or empty) 20 ft container, the maximum weight of the containers must not exceed 26 t.[48] For the LCV, the authorization of Short LCVs[49] with a payload of 48 tonnes is assumed.

These assumptions lead to interesting results, summed up in Figure 5.2.

The increase in efficiency and environmental friendliness is obvious. Through the introduction of LCVs, the necessary vehicle kilometers to carry out the container traffic between the ICD and the seaports drops by over 557,000 km or 36 percent per

[48] The maximum weight of one 20 ft container is 24 t, see Table 3.1.

[49] Similar to the Australian B Double type shown in Figure 3.3.

year. As a consequence, diesel fuel consumption (115,227 liters) as well as CO_2 (303 tonnes) emissions are reduced significantly. This is particularly important in view of the Kyoto Protocol and the challenge of saving natural resources.

Table 5.1: Parameter values for the case study

TEU turnover Guanlan ICD p.a. there of 20 ft container there of 40 ft container	80,000 TEU 40,000 pieces 10,000 pieces
Share of TEU shipped via Yantian and Shekou	90 %
Proportioning between Yantian and Shekou	50:50
Payload standard vehicle LCV	 1x40 ft or 2x20 ft (max. 26 t) 2x20 ft or 1x20 ft+1x40 ft (max. 48 t)
Diesel fuel consumption standard vehicle LCV	 33 lt / 100 km 40 lt / 100 km
Trip costs between Guanlan ICD and Yantian standard vehicle LCV	 47.00 USD / trip 61.10 USD / trip
Trip costs between Guanlan ICD and Shekou standard vehicle LCV	 45.00 USD / trip 58.50 USD / trip
Share of (lightweight) 20 ft container, which can be shipped together on a standard vehicle	40 %
Share of (lightweight) 40 ft container, which can be shipped together with a 20ft container on a LCV	60 %
CO_2 emissions per lt. diesel fuel	2.63 kg / km[50]

Also from an economic viewpoint, LCVs are beneficial, since transport costs can be reduced by US$157,000 (17.1 %).

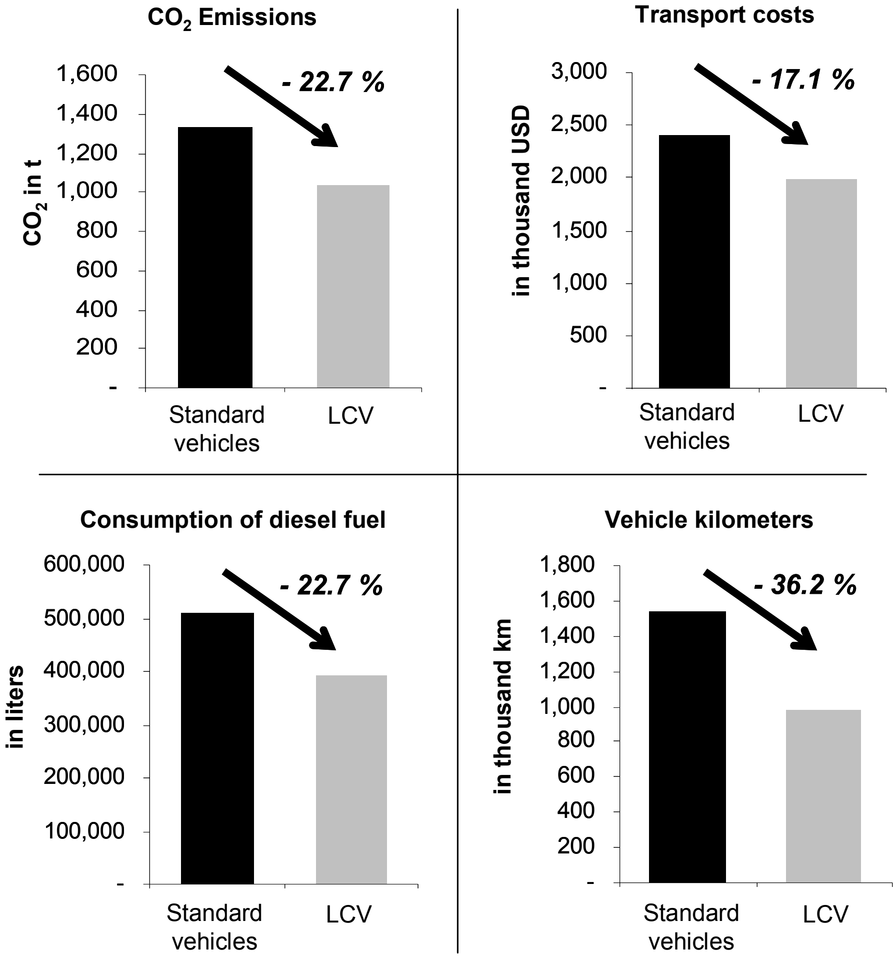
The case study leads to the following conclusions:

- The sample calculations show large possible benefits of LCVs in terms of energy efficiency and environmental friendliness
- The reduced transport costs improve the competitiveness of the Chinese economy and in particular the competitiveness of production sites away from the coast (inland)
- LCV can form an obstacle for connecting the ICD to the railway network, as the competitive advantage of railway over the road transport is reduced
- As the traffic flows between the ICD and the two seaports is exactly limited to two certain routes, this case offers an optimal opportunity for a test of LCVs.

[50] See the German Ministry of Environment.

In conclusion, for this particular case, LCVs show particularly large economic and environmental benefits.

Figure 5.2: Effects of LCVs regarding, CO_2, diesel fuel, transport costs and traveled kilometers.



6. Conclusion

This paper discussed the issue of road transport vehicles in general and LCVs in particular. In all modes, particularly in container shipping, a constant increase in vehicles size has been observed. In road transport, vehicle dimensions and weight limits have stayed relatively constant, because of the limitations of the road infrastructure as well as contemporaneous passenger traffic on the road infrastructure.

In the last 10 years, countries in the UNESCAP region have invested heavily in road infrastructure. During this time, technological progress in freight vehicle technology has been considerable. Concurrently, road transport worldwide and in particular in the countries of the UNESCAP region has experienced high growth rates, which are expected to continue in the future. Railway transport is in many cases not feasible or only offers a minor alternative, as either the railway network is of low density or non-existent, the traffic flows are too small for block trains, or

interconnectivity (interoperability) between countries is not available. This is a major issue for some ICDs that have too low freight volumes, in order to be connected by railway, which can be a problem for ICDs, particularly in the start-up phase. Once freight flows are large enough, the railway connection remains an option.

This paper demonstrates that LCVs are a serious option for making road freight transport more efficient and more environmentally friendly. Many countries have operated LCVs successfully for a long time, and a significant amount of experience and data is available for other countries considering these options.[51] In addition, LCVs allow investments in new vehicle technology. Some of the efficiency gains can be collected by governments through an appropriate tax on LCVs. The countries in the UNESCAP region may wish to consider evaluating the various benefits in pilot projects which involve test runs with LCVs. Irrespective of whether LCVs will be permitted or not for regular transport operations, knowledge about new technologies can be gained at very low costs.

As shown in this paper, the introduction of LCVs can lead to significant benefits both in terms of economic efficiency and in terms of reducing negative external costs of road freight transport. However, it should also be noted that their benefits depend on the particular application area and do not offer a silver bullet for solving the overall problem of increasing negative externalities of land transport in the long run.

One advantage of LCVs in a static as well as in a dynamic way remains: the gain in efficiency. Additionally, improved efficiency of transport is believed to have positive effects on overall economic growth.

[51] An example is the comprehensive report of the Netherlands' test run, see ARCARDIS (2006).

References

ARCADIS (2006) Monitoringsonderzoek vervolgproef LZV resultaten van de vervolgproef met Langere of Langere en zwaardere voertuigcombinaties op de Nederlandse wegen. Report of 2006-05-31.

Backman, H. and R. Nordström (2002) Improved performance of European long haulage transport. Technical Report 6E, TFK - Institutet för transportforskning, Stockholm.

Baumol, W, J. Panzar and R. Willig (1988) *Contestable markets and the theory of industry structure*. San Diego.

China Daily (2004) First double-deck container train to hit the road. China Daily, 2004-04-14. (http://www.chinadaily.com.cn/english/doc/2004-04/14/content_323317.htm)

Clausen, U. and V. Kraft (2004). Status und Perspektiven von Telematikanwendungen. Logistikmanagement, 4, 12–21.

De Palma, A., M. Kilani and R. Lindsey (2006): An economic analysis of segregating cars and trucks. Paper presented at the 3rd Kuhmo conference, Tuusula (FIN).

Doganis, R (2002) *Flying off Course*. Routledge.

Easterfield, T.E. (1964). Productivity – target or conceptual tool? Operational Research Quarterly, 16(2):177–187.

ESCAP (2002) *Review of vehicle dimensions, permissible axle loads and gross vehicle weights in the ESCAP region*. Bangkok.

Etezadi, T. and J.E. Beasley (1983) Vehicle fleet composition. Journal of the operational research society, 34(1), 87–91.

Flyvbjerg, M., K. S. Holm and S. L. Buhl (2004) What causes cost overrun in transport infrastructure projects? *Transport Reviews*, 24(1), 3–18.

Garcia, M. M. and S. Azan (2005) Integrated transport systems in Latin America. *Public Transport International*, 54(5), 36–38.

Hanley, P.F. and D.J. Forkenbrock (2005) Safety of passing longer combination vehicles on two-lane highways. Transportation Research Part A, 39A:1–15.

Holguin-Veras, J., D. Sackey, S. Hussain and V. Ochieng (2003): Economic and financial feasibility of truck toll lanes. *Transportation Research Record*, 1833, 66-72.

Jansson, O.J. and D. Shneerson (1982) The optimal ship size. *Journal of Transport Economics and Policy*, 11, 217–238.

Jara-Díaz, S.R. (1982) Transportation product, transportation function and cost functions. *Transportation Science*, 16, 522–39.

Jara-Díaz, S.R. (2001) Transportation product and the analysis of industry structure. In: Polak, J. and A. Herrtje (eds.) *Analytical transport economics*. Cheltenham, Elgar, 27-50.

Kendall, P. (1972) A theory of optimum ship size. *Journal of transport economics and policy*, 4, 128–146.

KOM (2001) *White paper - European transport policy for 2010: time to decide*. Office for Official Publications of the European Communities, Luxembourg.

Kwan, C. and K. Knutsen (2006) Intermodal Revolution. *China Business Review*, 7.

Lakshmanan, T.R. and W.P. Anderson (2001): Transport governance systems and trade expansion. *Boston University Center for Transportation Studies Working Paper*, CTS2001B.

Levinson, M. (2006): *The Box, How the Shipping Container Made the World Smaller and the World Economy Bigger*, Princeton Univ. Press, 2006.

Lumsden, K. (2005) Truck masses and dimensions. ACEA discussion paper.

Neunzig, D., H. Wallentowitz, and R. Grosspietsch (2003) Roadtrains für Europa — wie werden sie möglich? VDI-Gesamtverkehrsforum, Braunschweig.

McCullough, G. J. (2003): Trucking Efficiency Versus Transportation Efficiency, Transportation Research Record 1833, p. 24-27, 2003.

People's daily online (2006) China's coal railway starts running heavy-loading train. *People's daily online*, 2006-03-30. (http://english.people.com.cn/200603/30/eng20060330_254573.html)

Railway Gazette International (2006a) IR tries double-stack service. *International Railway Gazette*, May 2006.

Railway Gazette International (2006b) Russian Railways expects to put a prototype double-stack container wagon into revenue operation. *International Railway Gazette*, March 2006.

Roos, H.B. and B. van Herwijnen (2002) *Some effects of intensified security and safety procedures on airports and airlines - the decrease optimum airplane size*. Paper presented at the Airport Summit Conference 2002.

Samuel, P., W. Poole Jr. and J. Holguin-Veras (2002): Toll Truckways: *A new path toward safer and more efficient freight transportation*. Reason Public Policy Institute Policy Study No. 294.

Sandkühler, D., M. Laumanns, and N. Laumanns (2001) *Roadtrain-Konzept für den europäischen Güterverkehr*. 6. Internationale VDI-Fachtagung Nutzfahrzeuge, Neu-Ulm.

Schulmann, J.F. (2003*) Heavy truck weight and dimension limits in Canada*. Railway Association of Canada.

TRB (1990): New Trucks for Greater Productivity and Less Road Wear – An Evaluation of the Turner Proposal. *Transportation Research Board Report 227,* 1990.

TRB (2002): Regulation of Weights, Lengths, and Widths of Commercial Motor Vehicles. *Transportation Research Board Special Report 267*, 2002.

US Department of Transportation (2000): The US Department of Transportation's comprehensive truck size and weight study, *US Department of Transportation*, Publication No. FHWA-PL-00-029, August 2000.

Viner, J. (1931) Cost Curves and Supply Curves. *Zeitschrift fur Nationalokonomie*, **3**, 23-46.

Wallentowitz, H., D. Neunzig, and D. Sandkühler (2000) Investigation of the influence of "Roadtrain" and "Truck speed 100 km/h" on handling characteristics, fuel consumption and traffic flow. Truck Technology, June, 2000.

Weber, R. (2005) Roadtrains remedy. *Trailer Body Builders*. http://trailer-bodybuilders.com/mag/trucks_roadtrain_remedy/index.html (by 2006-08-28)

Western Transportation Advisory Council (1993): Canada's Trucking Industry, Developments and Issues Since 1986, in: *WESTAC Monitor*, **19** (1), May 1993.

United Nations
ESCAP

Economic and Social Commission for Asia and the Pacific
Poverty and Development Division
United Nations Building, Rajadamnern Nok Avenue
Bangkok 10200, Thailand
Tel: +66 2 2881902
Fax: +66 2 2883007
Email: escap-pdd@un.org
escap-publicationsoffice@un.org
Website: http://www.unescap.org/