METHODOLOGY AND EFFECTS OF HEAVY GOODS VEHICLE TRANSPORT MANAGEMENT IN URBAN AREAS

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Abstract

This paper presents an overall view on the methodology and effects of heavy goods vehicle transport management in urban areas. It includes the state-of-the-art policy making and management methodology regarding heavy goods vehicle transport in urban areas in major cities of the world including London, Paris, New York and Tokyo. The objective of heavy goods vehicle transport management is to create effective, environmentally friendly, safe and energy saving freight transport systems in urban areas. We summarise the methodology to implement heavy goods vehicle transport management. Also, we focus on the traffic safety issues caused by heavy goods vehicles with estimated reduction of traffic accidents by transport management. Finally we present the future perspectives in this area including ITS for tackling the complicated problems. The contents of this paper are based on the results of the research in TC2.4 “Freight Transport and Intermodality” of PIARC during 2004-2007.

Keywords: Heavy goods vehicle, Transport management, Urban areas, Qualitative effects, Traffic safety, ITS, PIARC.

Résumé

Cet article présente une vue d'ensemble des méthodologies et effets de politiques du transport de marchandises en milieu urbain. Il contient les expériences de choix et stratégies politiques concernant les trafics de poids lourds dans les agglomérations majeures : Londres, Paris, New-York et Tokyo. L'objectif de la politique volontariste du transport de marchandises est de créer un système efficace, respectueux de l'environnement, sûr et économe en énergie de la livraison de marchandises en zone urbaine. Nous proposons une synthèse des méthodologies mises en place dans ce domaine et leurs conséquences sur l'environnement et la population en termes de congestion, temps de parcours, émissions de gaz toxiques et taux d'accidents. Par ailleurs, nous abordons l'enjeu de la sécurité du trafic de poids lourds en ville. Finalement, nous présentons une perspective d'avenir du fret en ville avec les STI pour gérer les problèmes complexes du transport de marchandises. Cet article est fondé sur les résultats des recherches TC2.4 « Transport de marchandises et intermodalité » de l'AIPCR de 2004 à 2007.

Mots-clés: Poids lourds, gestion du transport, zone urbaine, effets qualitatifs, sécurité routière, STI, AIPCR.

1. Introduction

Freight transport inevitably involves negative impacts on the environment, traffic flow and residential life. It is usually performed by private companies, and their top priority is the efficiency of transport, not mitigating environmental impacts nor improving residential life. Therefore, government officials are taking countermeasures to minimize these negative impacts.

2. Examples of Transport Management Measures for Large Goods Vehicles

2.1 Examples of Measures Implemented by Public Authorities

Public authorities are primarily in charge of the building and management of the social infrastructure needed for transport systems built around goods vehicles.

Below are some examples of measures regarding goods vehicles that have been implemented in various countries by public authorities. In addition to measures to enhance transport efficiency of goods vehicles, measures to improve traffic safety, reduce environmental impacts, and improve the quality of life were taken.

Category: Hard Measures

Measure: Autroute Ferroviaire Ayton to Orbassano, Luxembourg to Perpignan,
Description: Moving forward with an intermodal railway-freeway inter-city transport project using the Lorry Rail system, which allows the direct loading of trailers onto railway wagons for railway transport.
Effects: Reduction in lead time and costs by skipping transshipment into another mode.
Measure: The system of Automatic Measurement for over-size or over-weight vehicles on national Highway Route 43 in Hyogo prefecture, Japan
Description: An automatic special-purpose vehicle monitoring system was established in the Hyogo area in November 1997, and conducts the 24-hour monitoring of vehicle weight and dimension (including axle load, length, width, and height) and vehicle license number.
Effects: Helping police enforcement and eventually improving road-side environment by reducing illegally heavy goods vehicle.
Measure: Logistic facility on Yamate St. in Itabashi, Tokyo, Japan
Description: In March 2005, a parking lot for freight transfer was built under the elevated portion of the Tokyo Metropolitan Expressway.
Effects: Reduction in traffic congestion by making good use of unused land.

Category: Soft Measures

Measure: International Freight Trunk Road Network in Japan
Description: In 2006, of the section now in service, a trunk road network (approximately 29,000 kilometers) capable of carrying international standard container transport vehicles (44 tons Gross Vehicle Weight, 4.1 meters high) was selected. In the future, a network of approximately 34,000 kilometers has been planned for development.
Effects: Reduction in freight traffic by increased loads.
Measure: Charter of good practice for freight transport in Paris
Description: Within the city limits of Paris, no-stopping periods have been established for two types of goods vehicle, depending on size (less than 29m^2 and 29 to 43m^2). Stopping is permitted in loading zones for thirty minutes or less.
Effects: Mitigation of environmental impacts.

Measure: Prohibition of large goods vehicles in the Tokyo central urban area
Description: In Tokyo, on weekend evenings (from 22:00 Saturdays to 07:00 Sundays) large goods vehicles (8 tons or more GVW) are prohibited within Loop Road No.7. Further details are described later in this section.
Effects: Mitigation of environmental impacts especially noise and vibration by reducing large goods vehicle traffic.

Measure: London Lorry Control Scheme in Greater London, UK
Description: Throughout the Greater London area, goods vehicles of 3.5 tons and above GVW are allowed only on designated routes between 22:00 and 06:00 on weekdays, and between 13:00 Saturday and 07:00 Monday.
Effects: Mitigation of environmental impacts.

Measure: Restricted areas for goods vehicles in Manhattan in New York City, USA
Description: Goods vehicles may not enter, park, or stop at any time in regulated areas except as required to make deliveries. And in some areas, vehicles of 10 meters or more in length are prohibited from entering, parking, or stopping except during specified times.
Effects: Improving efficiency and mitigation of environmental impacts.

Measure: Passage prohibition for goods vehicles in Paris, France
Description: In Paris, goods vehicles regardless of size are prohibited from traveling through the city area of Paris. However this excludes the Périphérique (loop motorway that circles the city), Marshal Street (a local loop road) and the access roads connecting the two.
Effects: Improving efficiency and mitigation of environmental impacts.
Measure: Truck routes in New York City, USA
Description: Heavy goods vehicles can travel only on designated truck routes. Further details are described later in this section.
Effects: Improving efficiency and mitigation of environmental impacts.

Here are the further details of some measures described above.

Case Example 1: The establishment of truck routes (New York City, USA)

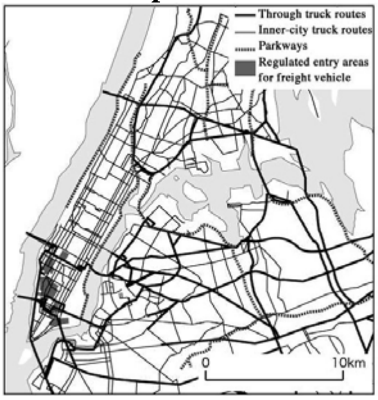


Figure 1 – Truck routes in NYC

The road network in New York has three levels: through truck routes, local truck routes, and neighborhood roads. Freight traffic management is being implemented on neighborhood roads to protect the residential environment.

Regulated area

All of New York City

Regulated vehicles

2 axle 6 wheel goods trucks, and goods trucks with 3 or more axles, and goods combination trailers.

Routes

Through truck routes: Routes for goods vehicles that have no delivery arrivals or departures within a borough area.

Local truck route: Routes for goods vehicles that do have goods delivery arrivals or departures within a borough area.

Effects: Improving efficiency and mitigation of environmental impacts.

Case Example 2: Prohibition of large goods vehicles in central urban areas (Japan)

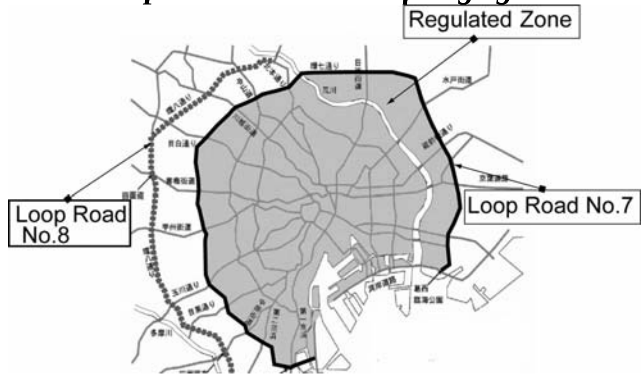


Figure 2 – Prohibition of large goods vehicles in Tokyo

In Tokyo, to prevent the noise and vibration caused by the passage of large goods vehicles, large goods vehicles are prohibited in the city center during the night on weekends.

Regulated period

From 22:00 Saturdays to 07:00 Sundays

Regulated area

The area inside Loop Road No. 7.

Regulated vehicles

Goods vehicles with a maximum load capacity of 5 tons or more, or GVW of 8 tons or more.

Effects: Mitigation of environmental impacts especially noise and vibration by reducing large goods vehicle traffic.

Case Example 3: Passage Permit System for over-size or over-weight Vehicles (Japan)

Operators of vehicles exceeding restrictions on width, length, height, or weight must apply for and receive permits from the concerned authorities prior to using the roads.

In Japan, applications for permits may be made on line via the Internet. A digital road database analyzes each request to verify weight restrictions, and road characteristics such as width, curve radii, and vertical clearances, to determine if it is possible for a given vehicle to pass. In addition, automated Measure & Weigh-In-Motion equipment is installed on an experimental basis, to verify vehicle weight and dimensions without stopping the vehicle.

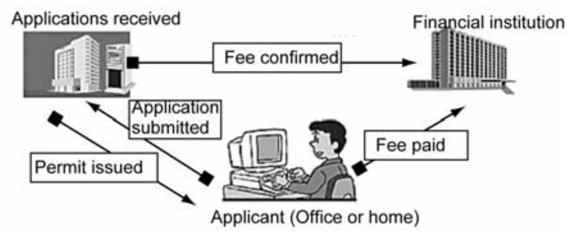


Figure 3 – Substance of regulation

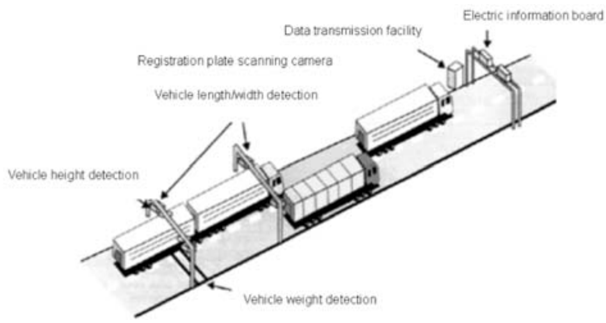


Figure 4 – Automatic measurement equipment

2.2 Examples of Measures Regarding Goods Vehicles Taken by Private Enterprise

Below are some examples of measures regarding goods vehicles that have been implemented in various countries by private companies. They started to give extra consideration to environmental and safety aspects.

Category: Hard Measure

Measure: Super rail cargo from Tokyo to Osaka (by Japan Freight Railway Co. and Sagawa Express Co. Ltd.)

Description: Super rail cargo, launched in March 2004, is the Japan’s first high-speed goods railway. A cutting edge driver and control system allows it to achieve speeds of up to 130 km/h as it makes the trip between Tokyo and Osaka in six hours.

Effects: Reduction in transportation time and in CO_2 emissions.

Category: Soft Measures

Measure: WEBKIT in Japan (by Japan Trucking Association and The United Association of Japan Goods Transport)
Description: The WebKIT system uses the Internet to allow truckers needing loads and shippers needing the use of vehicles to register various information in searchable format. When a likely match is found, parties are contacted by telephone and details worked out. At this point, it is possible to enter into a contract.
Effects: Reduction in waiting time and in CO_2 emissions by reducing empty vehicles.

Measure: Mimamori-kun in Japan (by Isuzu Motors Ltd.)
Description: Since 2002 Isuzu has been marketing the Mimamori-kun system. Various types of information are read from the vehicle control computers installed in large trucks, recorded, and then analyzed, including driver performance and fuel consumption. The results are provided to shipping companies to assist them in improving traffic safety and reducing fuel expenses.
Effects: Improvement of traffic safety and reduction in fuel expenses.
Measure: Eco-logitem Keyaki in Saitama New Urban Center in Omiya City, Saitama prefecture, Japan (by Saitama New Urban Center Joint Delivery Co., Ltd)
Description: This is a consolidation and delivery system for cargo destined to and from the Saitama New Urban Center area. The system is operated by Saitama New Urban Center Joint Delivery Co., Ltd., which was jointly capitalized by the truck transport companies. All delivery vehicles are fueled by CNG (Compressed Natural Gas).
Effects: Improvement of efficiency by increasing loads.

3. Types of Goods Vehicle Transport Management

Transport management measures for large goods vehicles involve minimizing distances traveled in city centers, the concentration of truck traffic on trunk roads, and the use of vehicles that reduce environmental impact. The freight traffic management measures discussed in section 1 above can be categorized as listed with examples of measures below.

Type 1: Shifting traffic

a. Improving the motorway network to avoid general roads
b. Improving ring roads/bypasses and prohibiting the through-traffic of goods vehicles in the urban areas
c. Developing and designating a trunk road network within urban areas to avoid local road
d. Promoting the intermodality of transportation and rail and maritime freight options
e. Providing traffic information

Type 2: Increasing loads

a. Improving the distribution and location of truck terminals
b. Promoting distribution centres which support the advance of joint delivery
c. Creating information system for shippers to find other shippers who are transporting cargo to the same destination.

Type 3: Shifting traffic + Increasing loads

a. Improving the road network to accommodate greater numbers of larger-sized vehicles shifts the traffic away from the general roads as well as reducing the overall traffic volume of goods vehicles.

Type4: Making Traffic Safer

a. Providing and enforcing the use of off-road loading-unloading bays for goods vehicles can mitigate the negative effects of on-street parking.
b. Improving road segments to fit goods vehicle traffic

Type5: Using Environmentally Friendly Vehicles
a. Using vehicles fuelled by CNG, vehicles with electric motors or hybrid systems.

4. Evaluation of the Outcome of Freight Transport Management Measures

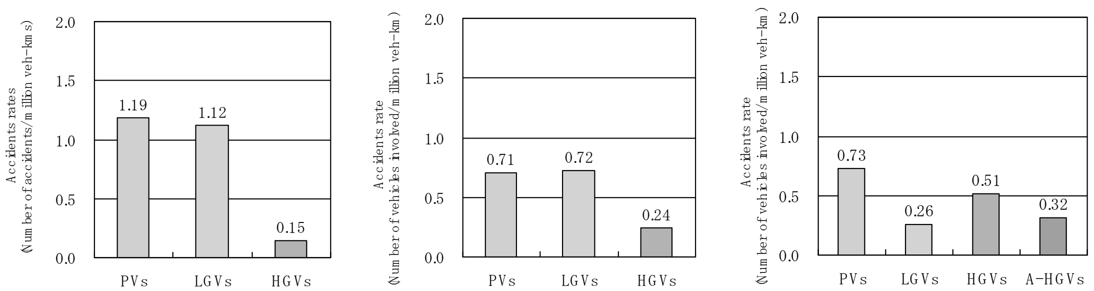
The effects of goods vehicle transport management include economic efficiency, reduced environmental impact, improved traffic safety, and rising quality of life. In this section we will take traffic safety as an example, using a simple method to evaluate the effects.

4.1 Characteristics of goods vehicle traffic accidents

We compiled and analyzed goods-vehicle traffic accident data from seven countries (PIARC, 2007): Japan, the US, Belgium, Great Britain, the Netherlands, Switzerland and Sweden. Although there are a number of exceptions, the following general principles emerged.

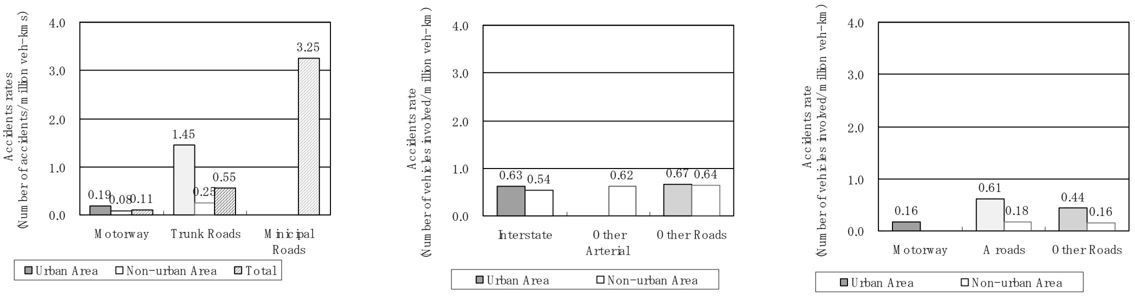
- Heavier goods vehicles are safer.
- Non-urban areas are safer than urban areas.
- Motorways are safer than general trunk roads and trunk roads are safer than local roads.
- Wider roads are safer than narrower roads.
- Roads with less on-street parking are safer.
- Railways and Coastal shipping are safer than Goods vehicles.

Some of these findings are illustrated in the graphs below. There are differences in the methods of defining and counting accidents among the countries, so no direct numerical comparisons between countries can be made.



Japan US Great Britain

Figure 5 - Accident Involvement Rates by Vehicle Type



Japan US Great Britain

Figure 6 – Goods Vehicle Accident Rates by Area and Road type

4.2 The Effect of Each Measure in Reducing Traffic Accidents

When freight traffic management measures were implemented, the incidence of traffic accidents declined as a result of changes in transport via goods vehicle and in driving. For instance, implementation of the measures below reduced the opportunities for traffic accidents to occur.

- The shift of goods vehicles to safer roads
- The shift of traffic to safer areas
- The shift from goods vehicles to safer modes
- Reducing the number of trucks on the road by increasing the load capacity of each truck
- Making roads safer (by eliminating parking on roads, etc.)

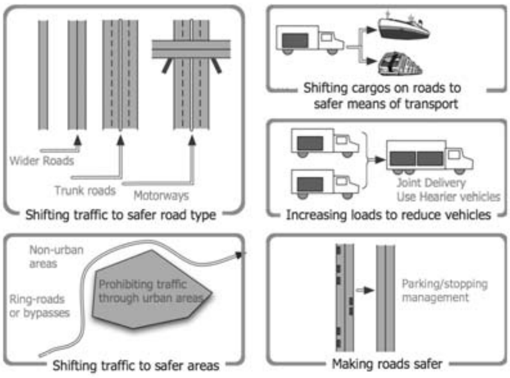


Figure 7 – Overview of Goods Vehicle Transport Management Measures

We conducted a quantitative evaluation of the goods vehicle traffic accident characteristics discussed in 4.1 above, following the implementation of each goods vehicle transport management measure, to determine the effect on safety of the implementation of the measure. By reviewing past research and inputting data from various traffic accident studies into a simulation, we can theoretically estimate possible numerical effects of the implementation of the above-mentioned individual freight traffic management measures.

The effects of each measure are different, but a reduction in the incidence of traffic accidents of from a few percent to over ten percent can be expected (Imanishi, 2007).

Shifting traffic	
a. Improving the motorway network	14% nationwide
b. Development of urban trunk road networks	8% in urban areas
Shifting traffic to safer areas	
c. Building a ring road / prohibiting goods vehicle through-traffic	17% in urban areas
Shifting cargos on roads to safer means of transport	
d. Promoting intermodality of transportation	5% nationwide
Increasing loads to reduce vehicles	
e. Developing truck terminals	2.5 % in urban areas
f. Supporting joint delivery	4 % in urban areas
Shifting traffic plus increasing loads	
g. Upgrading road networks to carry heavy goods vehicles	3% of deaths nationwide
Making roads safer	
h. Urban parking/stopping management	10 % in urban areas

5. New Freight Transport Systems

The utilization of ITS/ICT (Intelligent Transport System / Information Communication Technology) is necessary in order to efficiently implement the freight traffic management measures. Major ITS/ICT technology systems that are already in practical use are shown below (Taniguchi, 2005).

System Name: Cargo and goods vehicle search system.
Functions: Matches a shipper with a freight transport operator with extra capacities via information system on the Internet.

System Name: Cargo arrangement system for the return trip
Functions: Matches the returning goods vehicle with a shipper located near the goods vehicle's original destination.

System Name: Vehicle and delivery planning support system
Functions: Increases the loading ratio, by automatically assigning goods vehicles according to destinations and delivery times, and also by setting up the shortest delivery routes.

System Name: Delivery route optimization system
Functions: Searches for the optimum delivery route with the shortest distance and travel time by storing traffic conditions data acquired from onboard terminals, and managing vehicle travel history.

System Name: VICS/ATIS (Vehicle Information and Communication System / Advanced Traffic Information Service)
Functions: Provides traffic information to onboard vehicle navigation systems, which enables car navigation systems to search for alternative routes to bypass congested areas. ATIS provides traffic information to vehicle navigation systems, PCs and mobile phones.

System Name: On-the-Road Information Panels
Functions: Provides drivers with traffic information regarding congestion and travel times on the road information boards.

System Name: Container transporting reservation system
Functions: Enables inquiries about loading and unloading at the container yard and makes reservations for shuttle transport between the container yard and the stockyard via internet and mobile phone.

System Name: ETC (Electric Toll Collection)
Functions: Utilization of ETC-installed smart interchanges enables distribution centers to be interconnected to higher standard roads. ETC also enables flexible toll price setting and reduces waiting time at tollbooths.

System Name: Availability information and reservation system of off-street loading/ unloading spaces
Functions: Provides information through mobile phones on availability of off-street loading/unloading spaces in metro areas and enables reservations.

System Name: WIM (Weigh In Motion)
Functions: Saves time and effort in measuring vehicle weight and handling of documents by automating freight load inspection of goods vehicles.

As well as the systems mentioned above, which are already in use, future ITS/ICT technology is expected to continue to contribute to improvements in the traffic safety of goods vehicles.

System Name: Collection of delivery route data and optimization of transport
Functions: Collecting data such as delivery routes, transport volume, transport frequency, number and weight of loading-unloading freights, locations and time of parking via GPS and on-board units.

System Name: Operation management and driver education
Functions: Collecting data on the driving habit, driver's physical conditions and vehicle management history such as air pressure in tires. Giving seminars to drivers and vehicle managers based on the data mentioned above.

System Name: Automatic driverless travel in convoy
Functions: Safe, energy efficient, automatic, driverless travel in convoy, with close intervals between vehicles, will be made possible by vehicle-to-vehicle communications.

There are several studies testing automatic, driverless travel in convoy using vehicle-to-vehicle communications

Project Name: CHAUFFEUR Project in Germany (by Daimler Chrysler)
Description: In 1999, conducted the Chauffer Project, a road test of two 40-ton trucks using vehicle-to-vehicle communications to maintain electronically linked driving control.

Project Name: Development of automatic driverless travel in convoy for large-sized commercial vehicles in California, USA (by California PATH)
Description: Began developing automatic vehicle control technology in 1997, to reduce the fatigue of long-distance truck drivers in the US, support safe driving, and reduce the consumption of energy.

There are a number of new freight transport systems under study in Japan.

a. Multiple trailers

- One tractor pulling multiple trailers.
- As power sources for tractors, diesel, CNG, and hybrid diesel are under study.
- Equipped with collision avoidance and lane-departure avoidance functions through use of an Automated Highway System (AHS). DSRC conducts compiling and dissemination of time required for distances and present location information.

Figure 8 – Multiple Trailers

- Multiple trailers can transport three times the capacity of an ordinary goods truck and 12 times the capacity of a small goods truck.
- Because they cannot transit ordinary streets, chassis will need to be swapped out for ordinary tractors at truck terminals near expressway exits for transit of ordinary streets.

b. Dual-Mode Truck System

- Unmanned transport on designated tracks next to expressways, using electric motors powered through the tracks.
- They will use batteries or hybrid systems on ordinary streets, and will have drivers like any other truck.

Figure 9 – Dual-Mode Truck System

c. High-Speed Trunk Road Transport System

- When the trucks enter the lane, they are supplied with electricity through a third rail, and transit the dedicated lane in platoons (at very close intervals) without drivers.
- ITS technology is used for operating control, and automated sensors are used to control interval between vehicles. Automatic weight sensors are used in vehicle stability control systems, and merging and exit is controlled by the AHS.
- Access to the main lane is via a dedicated terminal ramp, and ETC and transport EDI are used for management of operations (Ishizuka, 2006).

Figure 10 – High-Speed Trunk Road Transport System

6. Future Prospects

Large vehicles have advantages in transport efficiency, environmental and safety characteristics. As we have seen in this paper, it is possible to build a transport system that skillfully utilizes the superior characteristics of large goods trucks to achieve high economic efficiency, low environmental impact, increased safety, and a better quality of life. In the future, further advances are expected in goods truck transport through traffic systems that use ITS/ITC.

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