



# Transport and Communications Bulletin for Asia and the Pacific

No. 80

## Sustainable Urban Freight Transport

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COMMUNICATIONS BULLETIN  
FOR ASIA AND THE PACIFIC

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## Editorial statement

The *Transport and Communications Bulletin for Asia and the Pacific* is a peer-reviewed journal published once a year by the Transport Division (TD) of the United Nations Economic and Social Commission for Asia and the Pacific (ESCAP). The main objectives of the *Bulletin* are to provide a medium for the sharing of knowledge, experience, ideas, policy options and information on the development of transport infrastructure and services in the Asia-Pacific region; to stimulate policy-oriented research; and to increase awareness of transport policy issues and responses. It is hoped that the *Bulletin* will help to widen and deepen debate on issues of interest and concern in the transport sector.

Sustainable development is a major challenge in the transport sector. Although there seems to be a convergence towards a broad definition and scope of sustainable transport, operational definitions and guidelines for its practice in the context of developing countries, have yet to emerge.

The transport sector is a major consumer of energy resources – particularly petroleum products. It is also one of the major contributors to air pollution, greenhouse gas emissions and ozone depletion, as well as a producer of waste products. Transport infrastructure and services are, however, essential elements required to support economic and social development, including achieving the Millennium Development Goals at the local, national and international levels.

In order for cities to function effectively, goods need to be moved around. However, the freight transport movements tend to be assigned a lower priority than passenger movements in developing transport policies and interventions. Many large cities are the centres of national production and distribution facilities and form the hubs of road, rail, and international maritime and air transport networks. Consequently, a large share of their freight traffic is composed of outgoing and incoming traffic.

An important development in freight transport is the growth of logistics facilities in suburban areas. While these logistics facilities may have created opportunities to introduce efficient services and new technologies, they have also led to generating of additional vehicle-kilometres and many of the logistics facilities are no longer connected to existing rail and water transport terminals. Such development trends have created new challenges to environmentally and ecologically sustainable transport development.

Despite its large environmental footprint, huge consumption of natural and financial resources and the substantial volumes of waste and pollution, freight transport has not received sufficient attention within sustainable transport development initiatives. A number of “good practices” are, however, emerging in the sector. The challenge is to advocate and implement such practices. In order to support the advocacy and implementation of initiatives, there is also a need to develop indicators that can effectively measure eco-efficiency and sustainability.

In consideration of the importance and interest in the subject, sustainable urban freight transport was chosen as the theme for the current issue of the *Bulletin*. Five papers are included in this issue.

In order to address and overcome the negative impacts of urban freight transport, it is necessary for policymakers to develop sustainability strategies that attempt to balance the economic, social and environmental impacts of urban freight transport operations. In devising these sustainability objectives and measures it is important that policymakers work in close cooperation with companies involved in the operation of urban supply chains. The first paper outlines a set of urban freight policy measures and company actions that can be

part of a sustainability strategy, and also non-freight transport policy measures that can have unintended effects on urban freight sustainability.

The second paper focuses on two issues: what governments can do to promote more eco-efficient and sustainable transport; and how the progress in this endeavour can be measured. The paper considers a number of 'attack points' on which governments can focus in order to achieve the required improvements and a range of instruments that governments can employ in order to influence outcomes on each of these points. The paper identifies a range of policies that are available to governments and suggests some specific measures that could be undertaken in implementing these policies. It also develops a framework for prioritising policy action.

The third paper provides case studies on freight transport policies and measures implemented in several countries in Asia, Europe and North America. It considers three main objectives for sustainable freight development as reducing energy consumption, decreasing the usage of less sustainable transport modes and increasing the usage of more environmentally friendly transport modes. The policies and measures in each of the categories are discussed based on their contribution to achieving the objectives, and their practicality is analyzed. Issues of concern with each policy are also presented.

With the rapid growth in road freight vehicle numbers and the corresponding increase in road freight tonnage, the road freight sector has become a major consumer of energy resources and a contributor to air pollution and greenhouse gas emissions. In order to address the issues of the road freight sector, China has undertaken various policy, legal and regulatory, and other measures including introducing pilot projects at different levels of the government. The fourth paper focuses on lessons learned from the Guangzhou Green Trucks Project, aiming to promote an alternative approach towards sustainable road freight transportation.

Urban logistics systems, involving physical distribution and supply chains in urban areas, is a promising subject that can be looked at in developing a framework on how to address the issues in urban environment in the context of transport and land use. Measures, involving transport planning and logistics in urban areas under the term of city logistics have been found promising in dealing with many traffic and transport problems. The concept of city logistics has a potential to contribute to meeting the objectives of logistics related to efficiency, economy and environment. The fifth and last paper presents how logistics and transport initiatives can be instrumental in developing a framework which can eventually contribute to alleviating the negative impacts of freight transport on urban environment.

The *Bulletin* welcomes analytical articles on topics that are currently at the forefront of transport infrastructure development in the region and on policy analysis and best practices. Articles should be based on original research and should have analytical depth. Empirically-based articles should emphasize policy implications emerging from the analysis. Book reviews are also welcome. See the inside back cover for guidelines on contributing articles.

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## ACRONYMS

ADB	Asian Development Bank
CO	Carbon monoxide
CO <sub>2</sub>	Carbon dioxide
DPF	Diesel particulate filter
DPWH	Department of Public Works and Highways (Philippines)
EST	Environmentally sustainable transport
GHG	Greenhouse gas
GNI	Gross national income
GPS	Global positioning system
ITS	Intelligent Transport System
JICA	Japan International Cooperation Agency
NG	Natural gas
NO <sub>x</sub>	Nitrogen oxides
Pb	Lead
PM	Particulate matter
RFID	Radio frequency identification
SO <sub>x</sub>	Sulfur oxides
UNCRD	United Nations Centre for Regional Development
VOCs	Volatile organic compounds

## ENHANCING THE SUSTAINABILITY OF URBAN FREIGHT TRANSPORT AND LOGISTICS

Michael Browne and Julian Allen\*

### ABSTRACT

*Urban freight transport is of crucial importance to the economic vitality of urban areas and the quality of life of those who live and work in them. However, in providing the goods and services required, freight transport imposes negative impacts in urban areas. In order to address and overcome these negative impacts it is necessary for policymakers to develop sustainability strategies for urban freight that attempt to balance the economic, social and environmental impacts of urban freight transport operations. This involves determining the objectives of such a strategy and then devising and implementing suitable policy measures in an effort to achieve these objectives. In devising these sustainability objectives and measures it is important that policymakers work in close co-operation with companies involved in the operation of urban supply chains. This helps to increase the success of policy measures and implementation strategies, and to foresee and address potential unintended consequences. Companies also have an important part to play in their own right in planning and conducting their urban operations so as to take account of economic, social and environmental impacts. Many aspects of urban freight activities offer the potential to jointly address economic, social and environmental objectives through operational efficiency. The paper outlines urban freight policy measures and company actions that can be part of a sustainability strategy, and also non-freight transport policy measures that can have unintended effects on urban freight sustainability. It also considers the barriers and difficulties that arise in attempting to put in place approaches to increasing the sustainability of urban freight transport.*

### INTRODUCTION

The aim of this paper is to consider urban freight transport activity and the measures and initiatives that can be taken in order to help it to meet the urban sustainability objectives of policymakers. The paper examines the importance of urban freight transport in maintaining the economic vitality of the city, and the negative impacts that it imposes. The concept of sustainability and the development of sustainability strategies are then discussed before considering the roles that policymakers and freight transport operators can play in helping to make these activities more sustainable.

The possible objectives of an urban freight sustainability strategy are presented, together with the specific policy measures and company initiatives that can be taken. Unintended effects of non-freight transport policy measures of urban freight operations are also considered. The barriers and difficulties that arise in attempting to put in place approaches to increasing the sustainability of urban freight transport are also discussed, together with the importance of partnership working between public and private sector organizations.

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## I. THE IMPORTANCE OF URBAN FREIGHT TRANSPORT

Urban freight transport and logistics involve the delivery and collection of goods and provision of services in towns and cities. It also includes activities such as goods storage and inventory management, waste handling, office and household removals and home delivery services.

Due to their large populations and extensive commercial establishments, urban areas require large quantities of goods and services for commercial and domestic use. The growing importance of urban freight transport is related to increases in urban populations and continued economic growth in urban areas. This results in increasing levels of demand for freight transport services.

Throughout the twentieth century the rate of urbanization continued to accelerate across the world. The global proportion of urban population increased from 13 per cent in 1900 to 29 per cent in 1950 and 49 per cent in 2005. A total of 60 per cent of the global population is expected to live in urban areas by 2030 (United Nations, 2006). This process of urbanization together with population growth has resulted in an increase in the total number of urban dwellers from 220 million in 1900 to 732 million in 1950 to 3.2 billion by 2005 (United Nations, 2006).

In 2005, 74 per cent of the population of more developed regions lived in urban areas, compared with 43 per cent in less developed regions. However, as a result of economic development, urbanization is forecast to continue and by 2030, it is estimated that urban areas will account for 56 per cent of the population in less developed regions, compared with 81 per cent in developed regions. Due to the size of population, however, less developed regions had a greater total number of urban dwellers than more developed regions in 2005 (2.3 billion people compared with 0.9 billion). It is forecast that by 2030 Asia will have the greatest number of urban dwellers, followed by Africa, and these two continents will account for almost 70 per cent of the world's urban population (United Nations, 2006).

Traffic levels and their impacts on towns and cities across the world have received growing attention in recent years. Much of it has been directed at public transport and private car traffic while relatively little consideration has been paid to road freight transport. However, urban freight transport is important for many reasons (Meyburg and Stopher, 1974; Hasell and others, 1978; Ogden, 1992). Among the most significant are:

- It is fundamental to sustaining our existing lifestyle;
- The role it plays in servicing and retaining industrial and trading activities which are major wealth generating activities;
- The contribution that an efficient freight sector makes to the competitiveness of industry in the region concerned;
- The effect of freight transport and logistics costs on the cost of commodities consumed in that region;
- The total cost of freight transport and logistics is significant and has a direct bearing on the efficiency of the economy;
- The environmental effect of urban freight movements (in terms of energy use and environmental impacts such as pollution, noise, visual intrusion etc.).

Freight transport in towns and cities responds very effectively to the requirements of modern urban economies. However, it is a major contributor to environmental impacts and has an adverse effect on the health and wellbeing of the residents of cities. Urban freight

activities involve economic, social and environmental issues simultaneously and can result in conflicts. Under current conditions the economic viability of urban areas might actually be benefiting from socially and environmentally damaging freight transport operations. Moving towards a more sustainable urban freight system requires changes and innovations in the public and private sectors.

All towns and cities require the supply of goods and services, and the removal of waste products and hence are dependent on urban freight transport. There are many similarities in the nature of these freight operations between urban areas across the world. However, some variations do exist depending on urban attributes including: the type and quality of transport infrastructure, the degree of vehicle motorization, the prevailing traffic levels, the degree of automation in vehicle loading/unloading and materials handling, the extent of freight transport regulation by government, and the organization and operation of waste collection services (Dablanc, 2010).

Several other factors have a bearing on the nature of freight transport in urban areas. These factors can vary between countries and cities and include: the organization and management of supply chains, the economic composition and structure, land use patterns, and the use of technology. Supply chain management issues that affect the extent and type of urban freight transport include: the importance and range of services offered by third and fourth party logistics companies, the degree of own account (i.e. in-house) freight transport operations, the market share of wholesalers, and the prevalence of home delivery services.

National and urban differences in economic composition and structure also influence urban freight transport activity. The importance of different types of industries affects the type and quantity of goods that need to be transported. The ownership structure within industries affects the supply chain organization and the freight transport activity. For instance, a highly concentrated industry comprising a small number of large companies with large sites (such as factories or supermarkets) tends to result in fewer supply chain links and more consolidated freight flows using larger vehicles. By comparison fragmented industries tend to have more complex supply chains and smaller freight consignments resulting in a higher level of total freight transport activity. The contrast between fragmented and concentrated industries is especially important in relation to retailing as this industry is responsible for a major proportion of urban freight transport activity. In some countries retailing is dominated by multiple retailers that control many large shops. Meanwhile in other countries retailing is made up of many small, independent businesses and can be focused on small market stalls rather than shops. The existence of a major freight interchange (such as a seaport or airport) in an urban area can also be a major generator of freight transport.

Land use patterns also influence the nature of urban freight transport. Manufacturing is an important generator of freight transport (Hesse, 2008). The degree of manufacturing in a city has an important bearing on the quantity of warehousing present. Much industrial activity that previously took place in urban areas in western European countries has now been relocated to Eastern Europe and Asia. This has led to a decline in warehousing land in the former and to an expansion in the latter, causing the related changes in freight transport activity. Another factor in the decline of urban warehousing land use in some countries was due to the increased spatial centralization of stockholding which has resulted in fewer warehouses in supply chains. By using this approach companies benefitted from the 'square root law' of stockholding and economies of scale, which has resulted in the need to hold less stock in the supply chain in total (McKinnon, 1989). This has led to an increase in the use of regional distribution centres that serve a large geographical area, and a reduction in urban warehousing. In the United Kingdom of Great Britain and Northern Ireland, for example, this process of centralisation is now at an extremely advanced stage, with many warehousing operations now located at a single site (McKinnon, 2009). However, this trend has not been universal – for instance it has been noted that there is relatively little use of regional

distribution centres in China (Wang, 2010). Rapidly rising land prices in central urban areas have also forced the relocation of warehousing to locations with relatively lower prices. This has led to the suburbanization of warehousing, with urban warehousing being relocated to the edge of the urban area or outside (Hesse, 2008; Dablan and Rakotonarivo, 2010).

Technology can play an important role in achieving greater efficiency in urban freight transport operations. This includes vehicle routing and scheduling systems that reduce the distance that vehicles travel, load planning systems that ensure greater utilization of vehicle load space, as well as supply chain management systems that help to ensure greater consolidation of freight flows and hence fewer but larger vehicle consignments. Internet penetration technology also plays an important role in the growth of online shopping and the related demand for home delivery services.

### **A. Impacts of urban freight transport**

Urban freight and passenger transport operations are responsible for a range of negative economic, social and environmental impacts. These include (United Kingdom Round Table on Sustainable Development, 1996):

- *Economic impacts:* (i) congestion, (ii) inefficiency and (iii) resource waste.
- *Environmental impacts:* (i) pollutant emissions including the primary greenhouse gas carbon dioxide, (ii) the use of non-renewable fossil-fuel, land and aggregates, (iii) waste products such as tyres, oil and other materials and (iv) the loss of wildlife habitats and associated threat to wild species.
- *Social impacts:* (i) the physical consequences of pollutant emissions on public health (death, illness, hazards etc.), (ii) the injuries and death resulting from traffic accidents, (iii) noise, (iv) visual intrusion, (v) the difficulty of making essential journeys without a car or suitable public transport, and (vi) other quality of life issues (including the loss of greenfield sites and open spaces in urban areas as a result of transport infrastructure developments).

The negative impacts of urban freight transport are relatively well understood. Efforts have also been made to calculate the external costs imposed by these urban freight impacts (Allen and others., 2010a). What is less well understood is the extent to which policymakers and others should intervene in an attempt to reduce each of these impacts and the means of intervention that is most desirable so as to produce the most sustainable outcome in economic, social and environmental terms.

In addition to the negative impacts imposed by urban freight transport operations, those performing these operations also experience problems in carrying out urban freight which reduces its efficiency. These problems are far less well understood and few attempts have been made to reduce them. These include (Allen and others., 2000):

- Traffic flow/congestion issues caused by traffic levels, traffic incidents, inadequate road infrastructure, narrow street layouts, and poor driver behaviour.
- Transport policy-related problems including neglect of freight transport issues in town and traffic planning, and other policy issues such as vehicle access restrictions based on time and/or size/weight of vehicle and bus lanes.
- Parking and loading/unloading problems including loading/unloading regulations, fines, lack of unloading space, and handling problems.
- Customer/receiver-related problems including queuing to make deliveries and collections, difficulty in finding the receiver, collection and delivery times requested by customers and receivers.

As Plowden and Buchan (1995) note: "Freight transport is essential to the modern economy. An efficient system must provide the customer with a good service at a reasonable cost." However, increasing traffic congestion in urban areas has called into question the ability to achieve higher levels of efficiency in urban freight transport. As the Freight Transport Association observed more than a decade ago: "While industry has achieved significant success in improving vehicle productivity and utilisation, urban congestion imposes major constraints on further improvements" (Freight Transport Association, 1996).

## II. DEVELOPING A SUSTAINABILITY STRATEGY

The concept of "sustainability" and "sustainable development" has become increasingly influential in policy considerations in recent years. The most widely accepted definition of sustainable development is "development that meets the needs of the present without compromising the needs of future generations to meet their own needs" (World Commission on Environment and Development, 1987). This was the definition used by the World Commission and then endorsed by the United Nations at the Earth Summit in Rio de Janeiro in 1992. This conference led to a focus on the policy action required to bring about sustainability, known as Agenda 21, which, while having no force in international law, has been adopted by many national Governments (Mazza and Rydin, 1997). As a result many urban authorities have prepared environmental strategies in the intervening period.

A key problem in implementing an achievable sustainable strategy is determining the parameters of measurement (i.e. geographical scale, environmental and social impacts etc), and, not surprisingly, it is extremely difficult to achieve a workable, acceptable set of targets, actions and measures which will result in more sustainable cities, and a more sustainable urban freight transport system within that city.

### A. Sustainability strategies for urban freight transport

The aim of a sustainability transport strategy is "to answer, as far as possible, how society intends to provide the means of opportunity to meet economic, environmental and social needs efficiently and equitably, while minimising avoidable or unnecessary adverse impacts and their associated costs, over relevant space and time scales" (United Kingdom Round Table on Sustainable Development, 1996). Since freight transport is part of the transport system it follows that the issue of sustainability must be addressed with regard to freight transport.

Urban freight movement can be improved so as to make it more sustainable in various ways. It is important to distinguish between two different groups that are capable of changing the urban freight system and their rationale for doing so:

- *Public policymakers* (especially national government and urban authorities) who make changes to road freight transport operations in an effort to reduce its negative impacts through the introduction of policy measures that force or encourage companies to alter their behaviour.
- *Freight transport companies* that implement initiatives to reduce the impact of their road freight operations because they derive some internal benefit from this change in behaviour. These benefits can be internal economic advantages from operating in a more environmentally or socially efficient manner, either through improved economic efficiency or through being able to enhance their market share as a result of their environmental stance. Instances of company-led initiatives include: increasing the vehicle load factor through the consolidation of goods, making deliveries before or after normal freight delivery hours, the implementation of IT for communications or planning purposes, improvements in

the fuel efficiency of vehicles, and improvements in collection and delivery systems. Some of these initiatives are technology-related, some are concerned with freight transport companies reorganising their operations, and some involve change in the supply chain organization.

Inefficiencies in road freight transport can occur as a result of existing road layouts or traffic levels. They can also come about due to non-freight transport policies of policymakers that have unintended consequences on freight transport operations (e.g. the introduction of bus lanes). Another cause of inefficiency in road freight transport can result from variations in freight transport policy measures in different urban areas or different parts of a single urban area. For example, different access or loading time restrictions or vehicle emissions requirements within different parts of a city can be problematic to companies serving these locations with a single vehicle. It can result in the need for additional goods vehicles and goods vehicle trips. Such inefficiencies can have both financial and environmental impacts and are therefore best avoided from both the perspective of companies and the wider society. This suggests the need for collaboration between public policymakers with responsibility for freight transport regulations in urban areas as well as consideration of the benefits of harmonizing such regulations in order to avoid causing operational inefficiency.

Although, in several instances, efficiency in operations and reduced environmental impacts go together it must also be recognized that individual freight transport operators will not necessarily by themselves be able to achieve adequate system-wide improvements in urban freight efficiency. In some instances there may be a lack of concern about freight costs by the customers of the distribution companies since these costs may be only a small proportion of total product cost. In other cases, there may be a reluctant acceptance by the freight industry of current levels of congestion, since there is no competitive advantage to any one firm as a result of a lower congestion level. This implies that a combination of company initiatives and government policies will be necessary in developing a sustainable urban freight system.

The efficient usage of road transport infrastructure in urban areas is of high priority as in most cities urban road space cannot be further increased for transport purposes. The management of urban road infrastructure usage in terms of time and space is of fundamental importance for urban policymakers resulting in the implementation of various measures for regulating the use of urban infrastructure. Some cities already provide, for instance, loading zones or bays for commercial traffic in order to improve the working conditions for freight transport operators and to avoid negative effects due to delivery operations.

Given that the demand for freight transport is a derived demand, in order to consider how freight transport can be made more sustainable it is also necessary to understand the nature of commodity and goods flows. The driving forces behind these flows are factors, such as: the geographic location of activities, the costs of transport and related activities, land prices, customer tastes and required service levels and existing policies governing freight transport and land-use. Therefore, in order to change freight transport patterns and reduce their impacts, it should be necessary to influence some of these factors that determine goods flows as well as simply focusing attention on goods vehicle movements.

Urban sustainable development strategies are likely to require national policies together with measures taken at a more local level. A national sustainability strategy could help to ensure that urban sustainability policies do not result in some urban locations becoming less economically attractive than others. It is necessary to find suitable measures for the town or city in question and these are likely to vary from one urban area to another. The types of urban freight transport policy measures required in a town or city will depend on factors, including: the economic, social and environmental objectives of the national/urban

authority, the extent of freight transport and other road traffic that exists, the size, density and layout of the urban area, and the existing transport infrastructure and street design.

### III. POSSIBLE OBJECTIVES OF AN URBAN FREIGHT TRANSPORT SUSTAINABILITY STRATEGY

An urban freight transport sustainability strategy could target a range of objectives such as congestion, greenhouse gas emissions, local air pollution, noise, and safety. In devising a sustainability strategy determining its objectives in terms of the desired outcomes is important.

The next step involves determining which aspects of urban freight need to be changed in order to bring about the desired outcome. Table 1 shows aspects of urban freight that can be changed and the negative impacts that they are related to. These aspects are further explained below.

The distance and frequency of goods transport refers to decisions made by companies about where to locate supply chain infrastructure (such as factories, warehouses, fulfilment centres, shops, etc.) and how often to transport goods between them. The times and locations at which urban freight activities take place are also based on company decision-making about supply chain management.

Freight modal share involves reducing the importance of road and increasing the use of non-road modes. This is difficult to achieve in an urban environment given the number of locations served and the extent of existing rail and water transport infrastructure.

Vehicle loading factors, the size/weight of vehicles used and empty running are all based on decisions made by companies in relation to their operational management of the freight transport system in their supply chains, taking into account operating regulations in force.

Where loading/unloading takes place dependent on the nature of the site being served (in terms of its plot size and off-street facilities) and the on-street loading facilities and regulations in place.

The rate of fuel consumption by vehicle is dependent on vehicle fleet management decisions made by companies as well as the prevailing engine and vehicle technology. The carbon intensity of the fuel source is also based on company decision-making about the fuel source used for the vehicle fleet as well as prevailing fuel technology.

Although all of these aspects of urban freight transport are ultimately based on the decision-making of companies in relation to their supply chains, these decisions are influenced by the prevailing legislation and regulations put in place by central and urban governments.

**Table 1. Aspects of urban freight that can be changed and associated negative impacts**

Aspects of urban freight transport to consider changing	Associated negative impacts
Freight modal share (i.e. proportion of all freight transported by road)	Traffic levels/congestion, total fossil fuel use, air pollutants, greenhouse gas emissions, total casualties
Distance over which goods are transported	
Frequency of goods transportation	

Aspects of urban freight transport to consider changing	Associated negative impacts
Vehicle lading factor	Traffic levels/congestion, noise disturbance, visual intrusion
Size/weight of vehicles used	
Empty running	
Times at which urban freight activities take place	
Locations at which urban freight activities are generated	
Where loading/unloading takes place	Air quality, greenhouse gas emissions, noise disturbance
Goods vehicle engine emissions and noise levels	
Rate of fuel consumption by vehicles and carbon intensity of the fuel source	Total fossil fuel use, air pollutants, greenhouse gas emissions
Goods vehicle safety	Number of casualties resulting from collisions involving goods vehicles

In order to influence the aspects of urban freight transport shown in table 1 and thereby reduce the negative impacts associated with them it is necessary for public policymakers and companies to devise suitable policy measures and initiatives.

#### IV. URBAN FREIGHT TRANSPORT POLICY MEASURES AND COMPANY INITIATIVES

Both policymakers and companies operating and using freight transport services have key roles to play in enhancing the sustainability of urban freight transport. Policymakers can implement city-wide or site-specific measures while companies can introduce initiatives in their own operations. First, the role of policymakers is considered, then that of companies. Unintended effects of non-freight transport policy measures on freight transport are also examined.

##### A. Policy measures

Policymakers can make a wide range of interventions in an attempt to improve the sustainability of road transport operations. These can be grouped into several categories of policy measure including:

- Land use and planning measures
- Transport infrastructure measures
- Managing infrastructure measures
- Pricing measures
- Attitudinal and behavioural measures
- Information provision measures
- Modal shift measures
- Other measures to reduce environmental impact of vehicle use

Policy interventions can take a number of different forms including (a) technological approaches (that aim to improve the performance of equipment and facilities, or reduce environmental impact through the application of technology), (b) economic and fiscal approaches (that aim to influence the demand for transport by making transport more expensive, or encourage a particular mode or fuel type through financial incentives), and (c)

regulatory approaches that aim to influence behaviour by restricting the way in which infrastructure or vehicles are used, or put in place qualitative and quantitative controls to help prevent poor standards and operating practices). The geographical scale at which freight policy measures are typically applied varies by country and by measure – this can be international, national, regional and urban or site specific.

Banister (2005) has argued that, “to a great extent, the (policy) options are well known and there is agreement among policymakers (at least in principle) about what needs to be done to make transport more sustainable”. This is reflected in the extent of papers and reports at the national and international level that have discussed passenger transport policy options to enhance sustainable development especially at the urban scale (for example, ECMT/OECD, 1995; 2002).

While this may be true for passenger transport, it is certainly not the case for freight transport. For instance, OECD/ECMT publications listed above make little reference to freight transport and policy interventions. Policymakers addressing freight transport and its sustainability are still at the problem definition stage (in terms of determining the objectives of their potential policy interventions) and there is currently no consensus about the policy measures required to improve the sustainability of these freight operations. The reason for this lack of maturity in freight transport policy thinking is a by-product of the neglect that freight transport has received from policymakers, which has only begun to be addressed, and even then only partially, in the last 10 years and the complexity of dealing with the industry which is made up of numerous parties working together either directly or indirectly in product supply chains (Allen and others, 2010b).

An attempt to understand the type of policy measures needed to make freight transport more environmentally sustainable in the mid- to long-term was made by the OECD Environmental Policy Committee. The OECD Environmental Policy Committee’s Task Force on Transport initiated a project on Environmentally Sustainable Transport (EST) as “current policy frameworks seemed likely not to be able to move society towards more sustainable transport systems” (Wiederkehr and others., 2004). The project team developed a vision of environmentally sustainable transport in 2030 together with corresponding EST criteria. Teams based in nine countries carried out case studies to describe how EST could be achieved. The project participants felt that, in the case of freight transport, 46 per cent of the effort necessary to meet the EST criteria will come from technology, and 54 per cent from demand-side management comprising a shift towards more sustainable transport modes through mode shift (made up of 24 per cent, 19 per cent through transport avoidance, and 11 per cent through load factor improvements) (Wiederkehr and others, 2004).

A review of freight transport policy options was carried out to determine what sustainable urban operations are available (the review included several publications that had earlier reviewed urban freight policy measures: Allen and others, 2000; 2007; Geroliminis and Daganzo, 2005; Frosini and others, 2005; Muñuzuri, 2005; Schoemaker and others, 2008; Stantchev and Whiteing, 2006). Table 2 presents these options, together with the scale at which political decisions are usually made to implement each measure.

**Table 2. Policy measures for improving the sustainability of urban freight transport**

<b>Policy measures</b>	<b>Scale of implementation</b>
<b><i>Land use and planning measures</i></b>	
Design of new developments	National/urban
Mixed use developments	National/urban
Industrial and warehouse location controls	National/urban
Loading standards for new developments	National/urban

<b>Policy measures</b>	<b>Scale of implementation</b>
<b><i>Transport infrastructure measures</i></b>	
Consolidation centres	Urban
Loading bays and areas	Urban
Lorry parks	Urban
Lorry lanes	National/regional/urban
<b><i>Managing infrastructure measures</i></b>	
Vehicle/load weight and size limits	National
Lorry routes	Regional/urban
Access time controls / automated access control systems	Urban
Access size/weight controls	Urban
Loading/unloading time controls	Urban/site specific
Variable use of road space by time of day	Urban
<b><i>Pricing measures</i></b>	
Road pricing	National/urban
Tolls	Site specific
Fuel tax	National
<b><i>Attitudinal and behavioural measures</i></b>	
Drivers hours regulations	National
Driver training	National/urban
Good practice guidance on vehicle operations	National/urban
Good practice guidance on vehicle selection	National
Good practice guidance on vehicle technology	National
Establishing freight partnerships between public and private sector	Regional/urban
<b><i>Information provision measures</i></b>	
Freight road signing and mapping	National/urban
Development of urban traffic management and control systems	Urban
Road traffic information	National/regional/urban
<b><i>Modal shift measures</i></b>	
Improvement of highway, railway and inland waterway connections	National/urban
Subsidies and grants for non-road modes	National
<b><i>Other measures to reduce environmental impact of vehicle use</i></b>	
Vehicle engine standards	International
Low emission zones	National/urban
Operator licensing	National
Vehicle maintenance and operational tests and checks	National
Promotion of alternative fuels	National
Grants/subsidies for quieter, cleaner vehicles (including cycles)	National/urban

Some of the policy measures listed in table 2 have more than one effect on freight transport operations. This can result in a reduction of the negative impacts of one aspect of freight operations, while at the same time causing an increase in the negative impacts of another operational aspect. For instance, in the case of access time controls, imposing times at which vehicles cannot enter a particular area can reduce the potential interactions between goods vehicles and pedestrians that may result in an accident. However, this can

result in companies having to send more vehicles into the area during the permitted times, each of which is relatively poorly laden, thereby increasing total vehicle kilometres. The same can be true of loading time restrictions that are intended to reduce conflicts between goods vehicles and other road users and thereby improve traffic flow, but which can result in an increase in total goods vehicle kilometres.

Weight and size restrictions on goods vehicles can reduce some of the negative impacts associated with freight activity including noise and visual intrusion but is likely to increase the number of trips made by smaller and/or lighter vehicles thereby increasing total vehicle kilometres to deliver the same quantity of goods.

## B. Company initiatives

In addition to the business developments in recent years that have led to major changes in the role of freight transport within the supply chain, companies can and in some cases have implemented initiatives to reduce the negative social and environmental impacts of their freight operations. The rise in importance of corporate social responsibility (CSR) in recent years is an important factor in encouraging companies (especially larger firms with public share listings) to introduce such initiatives.

Four levels of company and supply chain logistical decision-making that affect the level of freight transport activity can be defined (McKinnon and Woodburn, 1995). These comprise: (a) logistics structures (determined by high-level strategic decisions affecting the numbers, locations and capacity of factories, warehouses and handling facilities), (b) patterns of trading links (determined by commercial decisions on sourcing, sub-contracting and distribution), (c) scheduling of product flow, and (d) management of transport resources. Changes in decision-making at each of these four levels can improve (or worsen) the sustainability of urban freight transport. Table 3 provides examples of company-led initiatives that can be implemented to improve the sustainability of freight transport activities. The supply chain party that needs to take actions for each of these initiatives is also shown. However in many cases these decisions will often be taken as a result of discussions and negotiations between supply chain parties.

**Table 3. Company initiatives to improve the sustainability of urban freight transport**

Company initiative	Supply chain party taking action
<b><i>Land use and planning measures</i></b>	
Reducing suburban and ex-urban sprawl of warehouses and logistics facilities	Operator/shipper/receiver
Installation of locker banks for goods collection	Operator
<b><i>Managing infrastructure measures</i></b>	
Allowing use of off-street loading space	Receiver
Allowing out-of-hours deliveries	Receiver
Relaxing need for early morning deliveries	Receiver
Assisting with deliveries	Receiver
Matching vehicle fleet to operational needs	Operator
Consolidating return goods and waste flows	Receiver/operator/shipper
Achieving backloads for delivery vehicles	Receiver/operator/shipper
Using fewer suppliers	Receiver
Reducing frequency of delivery	Receiver
Greater use of shared distribution	Receiver/operator/shipper

<b>Company initiative</b>	<b>Supply chain party taking action</b>
<b><i>Pricing measures</i></b>	
Explicit delivery pricing by suppliers (to deter small order quantities)	Shipper
<b><i>Attitudinal and behavioural measures</i></b>	
Driver training	Operator
Incentive schemes to reward sensitive driving patterns	Operator
<b><i>Information provision measures</i></b>	
Use of Computerized Vehicle Routeing and Scheduling	Operator
Use of vehicle telematics and communications technology	Receiver/operator/shipper
<b><i>Modal shift measures</i></b>	
Opting to use non-road modes	Receiver/operator/shipper
<b><i>Other measures to reduce environmental impact of vehicle use</i></b>	
Use of quieter, cleaner vehicles	Receiver/operator/shipper
Development of quieter, cleaner vehicles	Vehicle manufacturers

### **C. Policy interventions that have unintended consequences for the sustainability of freight transport operations**

In addition to the policy measures available to policymakers that can be used to improve the sustainability of freight transport, policymakers also implement a wide range of other urban transport policy measures that are not specifically aimed at freight transport. These non-freight policy measures can however have unintended consequences for the sustainability of urban freight transport operations. In some cases the unintended consequences are positive but in most cases they are negative, resulting in more less sustainable urban freight operations.

Table 4 illustrates this with a selection of non-freight transport policy measures that can impact on the sustainability of urban road freight operations. Most of these policy measures affect either the distance over which goods vehicles operate (i.e. the goods vehicle driver has to drive further or less distance) or on journey speed. This impact on vehicle speed or distance tends to increase total fuel consumption and can result in impacts on the average load carried by goods vehicles as it can lead to companies having to operate more or less vehicle journeys (if the trip time has changed) to deliver the same quantity of goods.

**Table 4. Non-freight policy measures that have an impact on the sustainability of urban road freight transport**

<b>Policy measures</b>	<b>Potential impact on freight sustainability</b>
<b><i>Land use and planning measures</i></b>	
Increase in pedestrianized areas	Negative
Car-free urban development	Positive
Development at public transport nodes	Positive
Increase in urban density	Negative
<b><i>Transport infrastructure measures</i></b>	
Bus lanes	Negative
Cycle lanes	Negative
<b><i>Managing infrastructure measures</i></b>	
Enforcement of car parking	Positive
Bus and cycle priority schemes	Negative
Disabled parking regulations	Negative
Park and ride schemes	Positive
<b><i>Pricing measures</i></b>	
Increase in parking charges	Positive
Reduction in public transport prices	Positive
<b><i>Attitudinal and behavioural measures</i></b>	
Car pooling/sharing	Positive
Flexible working hours policies	Positive
Company travel plans	Positive
Telecommuting	Positive
<b><i>Information provision measures</i></b>	
Public transport promotion and education	Positive
Car reduction promotion and education	Positive
<b><i>Modal shift measures</i></b>	
New rail lines/stations	Positive
New light rail services	Positive
Increase in bus services	Positive

In order to avoid unintended consequences of other transport policy measures on urban freight operations, and vice versa, policymakers need to develop a more integrated approach to policy development and implementation. This should attempt to achieve horizontal integration (i.e. integration between all relevant policies, strategies and plans), and vertical integration (i.e. integration between relevant levels of government and also with the private sector) (Allen and Wild, 2008).

## **V. BARRIERS TO THE IMPLEMENTATION OF FREIGHT TRANSPORT POLICY MEASURES**

As already mentioned, in deciding on suitable policy measures, policymakers should determine (a) their sustainability objectives, then (b) the necessary strategy, and then (c) determine the policy measure that they believe will lead to the achievement of these objectives.

Once policymakers have decided to apply one or more transport policy measures that they believe will result in the sustainability objectives that they wish to achieve, they then need to implement that measure. This implementation process results in policy output, which is the instrument created to bring about the desired outcome (such as regulation, pricing mechanism, infrastructure development etc.). The policy output will result in policy effects; these effects determine the success of the policy (i.e. the extent to which it achieves the desired objectives). Even when a measure is successfully implemented (and therefore leads to policy outputs) it may not result in the intended policy effects or may generate additional unintended effects. In this case the measure would need to be modified or other measures implemented to achieve these effects. For example, policymakers may aim to reduce the noise disturbance caused by heavy lorries at night by introducing time restrictions on goods vehicles above a certain weight on certain urban roads. The policy effect may be achieved (i.e. less noise caused by goods vehicle operations at night), but an unintended effect may be a greater use of lighter vehicles on these roads during the restricted times.

Several barriers exist that can prevent the successful implementation of a policy measure. These barriers can either reduce the potential impact of measures once implemented or, at worst, can make implementation impossible. In addition, poor implementation can increase the chance of unintended effects, can result in a waste of public resources and can lead to a reduction in public support for the measure. There are five types of barrier that can result in poor implementation of policy measures (DANTE Consortium, 1998):

- Policy and institutional barriers. These are related to problems arising from uncoordinated action between different levels of government (e.g. urban, regional and national), or different policy-related organizations (e.g. transport planners, urban planners, councillors, the police etc.) and to measures which are in conflict with other policy objectives
- Legal barriers. Legal issues and existing laws can prevent the measure from being implemented in the way it was intended and can even prevent its implementation entirely.
- Resource barriers. Each measure has resource requirements (including financial, labour, and physical resources).
- Social and cultural barriers. Acceptability of measures among those that will be affected is often an important factor in successful implementation. Hostility to the measure will often result in re-definition or dilution, or the dropping of the intended measure.
- Side effects. If the implementation of a measure is going to have serious, negative unintended side effects this may affect other activities.

Sometimes the effect of these barriers on the implementation of a policy measure is limited; however, in other cases the barriers can severely affect implementation or prevent implementation entirely.

An empirical investigation of 62 (non-freight) policy measures aimed at making passenger transport more sustainable was carried out to assess the scale of barriers to their implementation (DANTE Consortium, 1998). Results showed that only one of the 62 measures was implemented without any form of barrier; the other 61 measures were subject to one or more barriers. Resource barriers were found to be most common in the measures investigated followed by policy/institutional and social/cultural barriers. So far, no similar analysis of barriers to the implementation of freight policy measure has taken place to the authors' knowledge.

As Banister (2005, pp. 77) has noted, “the success of a policy (is) highly dependent on its implementation. If a potentially high success measure is badly implemented, it is unlikely that the measure will have its desired effect. Unforeseen effects may occur which are counterproductive and have impacts on unrelated areas of policy. Policymakers therefore need to pay attention to the feasibility of a policy alternative at both the strategic and operational levels. But even if the measure is successfully implemented and there is a favourable response from the public, the measure may be too limited to have a measurable impact”.

## **VI. IMPORTANCE OF PUBLIC-PRIVATE PARTNERSHIPS IN URBAN FREIGHT TRANSPORT**

Efficient and reliable road freight transport operations are required to support urban economies, from the perspective of the policy maker and of the transport operator and user. It is desirable that the public and private sectors work closely together in order to ensure that urban freight sustainability strategies target the necessary issues and that policy measures and company initiatives are appropriately devised and implemented and result in the intended effects.

As Ogden (1992) has noted, the urban freight system is far more complex and heterogeneous than urban passenger transport (including policymakers, retailers, wholesalers, freight operators, warehousing companies, residents, shoppers and workers). These groups can exhibit varying perceptions of the "urban freight problem". In addition, Dabanc (2007) has noted that, in the field of urban freight transport, policymakers expect companies to adapt in order to meet emerging customers' needs and at the same time putting in place operations that reduce environment impact, while companies tend to wait for policymakers to implement (and in some cases financially support) new initiatives before becoming involved themselves. The combination of the complexity and heterogeneity of urban freight together with both sides waiting for the other to take the first step suggests that partnership working between public and private sector organizations is essential in the identification and successful implementation of urban freight sustainability strategies.

Freight Quality Partnerships (FQPs) are a United Kingdom approach to freight transport partnerships between the public and private sectors that were launched by the Freight Transport Association (FTA) in 1996. The FTA initiative brought together industry, local government and representatives of local and environmental interest groups to pursue the following agenda (FTA, 1997):

- To identify problems perceived by each interest group relating to the movement and delivery of goods in their city;
- To identify measures within the group's competence to resolve or alleviate such problems;
- To identify best practice measures and principles for action by local government and industry to promote environmentally sensitive, economic and efficient delivery of goods in towns and cities.

The Government of the United Kingdom has been promoting FQPs since 1999 (DETR, 1999; DfT 2003a and 2003b). FQPs can facilitate improved dialogue about urban freight transport issues between local authorities, freight transport companies, retailers, manufacturers and other businesses, local residents and other interested parties. This can lead on to more efficient, less harmful operations. In its guidance document, the government states that, "Freight Quality Partnerships provide local authorities with a means to formalize the consultation and development work undertaken in their sustainable distribution strategy. Authorities have an integral role to play in helping industry, through developing partnerships

to progress and develop best practice in sustainable distribution systems, and to find solutions to the issues of greatest concern" (DETR, 2000).

FQPs are a mean for local policymakers, businesses, freight operators, environmental groups, the local community and other interested stakeholders to work together to address specific freight transport problems. The FQPs provide a forum to achieve good practice in environmentally sensitive, economic, safe and efficient freight transport. The partners can exchange information, experiences and initiate projects regarding urban freight transport.

Approximately 100 FQPs have been developed in the United Kingdom over the last 10 years (Allen and others, 2010b). Their purpose ranges from regional planning, to city- or town-specific partnerships, to micro-level partnerships (may be concerned with a few streets), to issue-specific partnerships. FQPs can be formed to address any type of geographical area however the majority cover urban areas.

As shown in tables 2 and 3 many policy measures and company initiatives cover similar topics. These topics are ideally suited to the input and actions of the public and private sectors in order to maximize their effectiveness, and therefore benefit from public-private partnership in terms of defining policy measures and overseeing their implementation.

## CONCLUSION

Freight transport is an important component of urban environments but a lack of effective freight delivery systems can have an adverse impact on the vitality of urban areas in economic and environmental terms.

The urban freight transport operations that take place do not conform to any one system or pattern and if policymakers are to implement measures aimed at meeting sustainability objectives they must take these variations into account in order to avoid unintended consequences. In addition, policy measures need to be tailored to the specific situation of the city in question which will include its current traffic levels and modal split, existing transport infrastructure and street design, its size, density, economic composition and geographical layout.

In designing urban freight policy measures intended to enhance sustainability, an attempt must be made to ensure that the measures will have their desired effects and to consider their potential unintended consequences. Joint working between public policymakers and organizations involved in urban freight transport is an important means by which this can be achieved. Examples of public-private partnership in urban freight transport from the United Kingdom, the Netherlands and Japan indicate the benefits of close co-operation. All supply chain partners (including freight operators, shippers and receivers) also have an important part to play in making urban freight more sustainable. Policymakers can help by offering guidance and support to achieve this involvement.

Policymakers also need to consider the unintended effects on freight transport of all other urban transport policy measures. This paper has outlined a wide range of such measures that can have both positive and negative effects on the sustainability of urban freight operations. This indicates the importance of policymakers taking a holistic approach to the design and implementation of measures aimed at enhancing transport sustainability, in which freight is considered in conjunction with passenger transport.

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## URBAN FREIGHT TRANSPORT ECO-EFFICIENCY AND SUSTAINABILITY: POLICIES AND INDICATORS

Steve Meyrick<sup>\*</sup>

### ABSTRACT

*This paper focuses on two issues: what Governments can do to promote more eco-efficient and sustainable transport; and how the progress in this endeavour can be measured.*

*There are a number of 'attack points' on which Governments can focus in order to achieve the required improvements and a range of instruments that they can employ in order to influence the outcomes on each of these points. The paper identifies a range of policies that are available to Governments and suggests some specific measures that could be undertaken in implementing these policies. It also develops a framework for prioritizing policy actions to ensure that the best possible return is obtained on the political capital that should be used in achieving positive change.*

### INTRODUCTION

This paper documents work undertaken as part of a project called “Eco-efficient and Sustainable Urban Infrastructure Development in Asia and Latin America”, sponsored by the United Nations Development Account. The overall objective of the project is to promote the application of eco-efficiency in sustainable infrastructure development. The paper is the result of an effort to assist the ESCAP secretariat in developing a set of indicators for eco-efficient and sustainable urban freight transport.

Although the clear focus of this work is on urban freight movement, from a policy perspective it is not always helpful to separate urban from non-urban freight. The majority of inter-urban freight movements, for example, involve some travel through urban areas. Policies, designed to encourage the use of rail for inter-urban movement, will have an effect on both urban and non-urban freight; and measures, created to capture the success of such policies, will not generally separate the effect on urban freight from that of on non-urban freight. Moreover, some data that are generally available at the national or regional level are not necessarily available at the urban level (for instance, the number of freight truck registrations).

The paper, therefore, is not strictly confined to measures that could be implemented at the city level; nor is it confined to measures that are affected solely by urban freight movements. Rather, it takes a broad view of the relevant domain, and deals with measures of sustainability and eco-efficiency that are likely to be affected by developments in urban freight transport; and with policies that are likely to have an effect on the urban freight transport task or the way this task is undertaken.

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## I. ECO-EFFICIENCY INDICATORS AND SUSTAINABILITY INDICATORS

Eco-efficiency is closely related to sustainability and sustainable development, but is conceptually distinct from both of these concepts.

**Sustainability** is about the relationship between the environmental burden imposed by human activity and the constraint imposed by the capacity of the environment to support that burden. **Sustainable development** is about the ability to more completely meet human needs without breaching that constraint. **Eco-efficiency** is about the ways and means by which the environmental burden, imposed in meeting these needs, can be minimized. Perhaps the simplest and most elegant definition is that offered by Nam (2008):

Eco-efficiency is simply defined as “creating more economic value with less environmental impact”.

**Eco-efficiency indicators** focus on the process of the transformation of environmental inputs into the means of fulfilling human needs. Eco-efficiency measures are essentially ratios, relating output to input (see, for instance BASF, 2009; City of Oslo, 2005; ESCAP, 2008b; Ness, 2009; OECD, 1997). A separate but related set of indicators - sustainability indicators - measure the aggregate environmental burden, that results from the attempt to satisfy these needs at the current level, using existing transformative processes. In contrast to eco-efficiency indicators, sustainability measures are absolute measures.

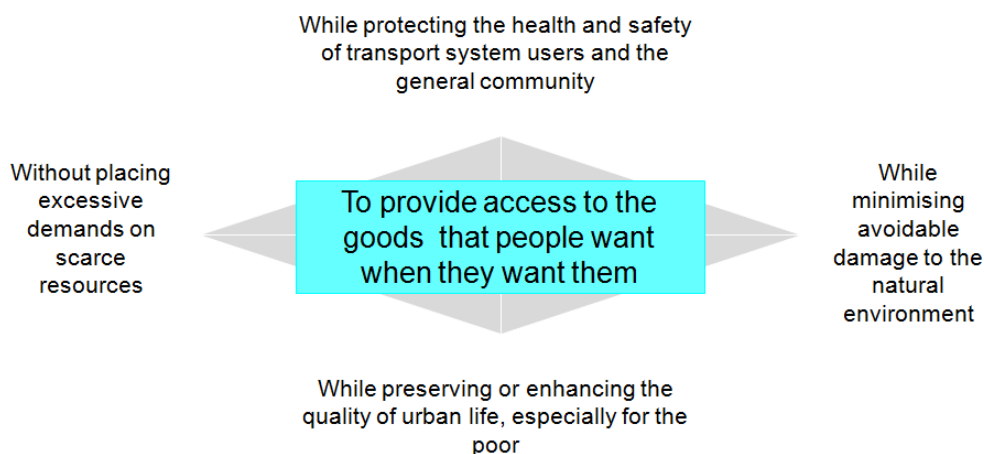
An improvement in eco-efficiency is likely to lead to an improvement in sustainability, but it will not necessarily do so. The possibility that an increase in eco-efficiency will not lead to an improvement in sustainability or environmental quality provides a strong argument for monitoring performance both in terms of sustainability and in terms of eco-efficiency.

## II. FRAMEWORK FOR SUSTAINABLE URBAN FREIGHT POLICY

### A. The urban freight policy challenge

The challenge for urban freight transport is to meet an economic need subject to a number of social and environmental constraints. The principal dimensions of this challenge are represented schematically in figure 1 below.

**Figure 1. The urban freight policy challenge**



The demand for urban freight transport is a derived demand. It arises because the locations of production and consumption are different; because the inputs to production are sourced from a number of different locations, none of which may coincide with the location of production; and, increasingly, because the process of production itself takes place in stages, with each stage taking place at a different location.

For most goods and services, a reduction in the level of consumption (unless brought about by a change in tastes) implies a sacrifice of the economic welfare associated with that consumption<sup>1</sup>. But no-one particularly “consumes” urban freight transport; it is, at best, a necessary evil. This opens up a space for potential “win-win” solutions: if the same goods can be delivered to the same consumers, in ways, which reduce the level of freight transport, and do not increase the costs of production, then both the environmental and economic gains become unambiguous.

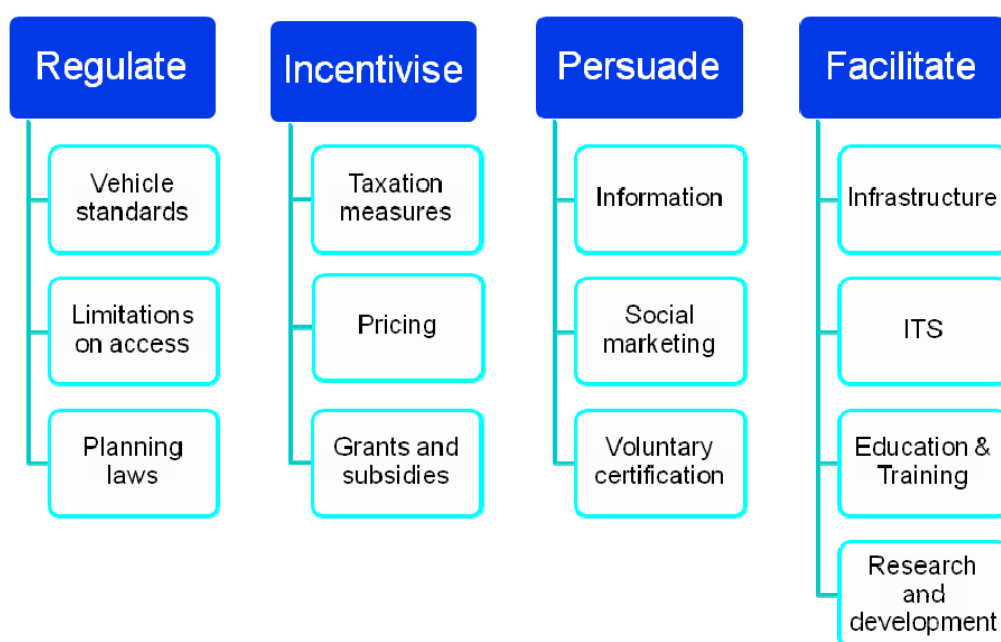
## B. Policy instruments and attack points

### *Policy instruments*

There are a number of ways in which the range of policy instruments, available to Governments, can be classified (see, for example, Lidasan, 2010; Min, 2010; Pomlaktong and others, 2010; Wisetjindawat, 2010a).

The classification adopted in this paper groups possible actions under the four headings shown in figure 2 below.

**Figure 2. Policy Instruments**



### *Attack points*

The concept of 'attack points' is used in Twice the Task (SKM/Meyrick and Associates, 2006) as a way of structuring possible responses to the challenge of

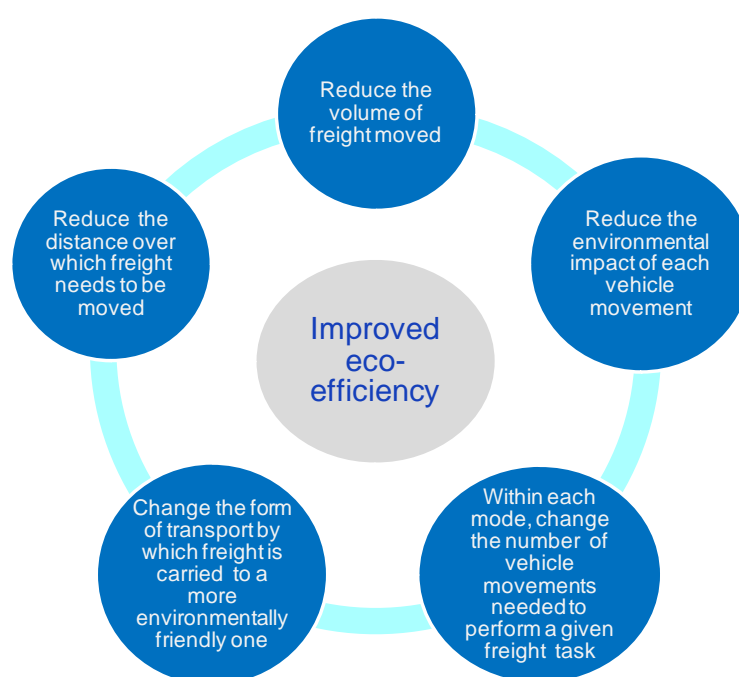
<sup>1</sup> It may well be of course, that the benefit of reducing consumption outweighs the cost. Nevertheless, there is a cost that must be weighed against the benefit.

accommodating a rapidly increasing freight task in a socially and environmentally acceptable way.

A slightly modified version of that framework is summarized in figure 3 below. Five attack points are identified.

**Attack point 1: Reduce the volume of freight moved.** This is the most fundamental approach to reducing the environmental impact of the urban freight task. It may or may not involve a reduction in overall economic activity, and tends to be the focus of those, who would classify themselves (or are classified by others) as 'deep green'. This is partly because a reduction in the freight task is likely to be closely linked to a decrease in production and consumption of physical goods, which will, in turn, reduce the impact of economic activity on the environment.

**Figure 3. Attack points in reducing the environmental impact of urban freight transport**



**Attack point 2: Reduce the distance over which freight needs to be moved.** Freight volume does not directly impact on the environment: the impact comes from the movement of the vehicles that carry the freight. The quantity of this movement is usually measured as the product of two factors: the volume of freight that needs to be moved; and the average distance over which it needs to be moved.

**Attack point 3: Change the mode by which freight is carried.** There are marked differences in the environmental impact of different modes of transport. At one end of the scale there is air transport, which is not only a very energy-intensive form of transport, but generally releases greenhouse gases at high altitude, where such effect is magnified. At the other end, there are low energy modes such as shipping and pipelines.

**Attack point 4: Within each mode, change the number of movements required to perform the freight tasks.** Within most transport modes, the environmental impact per ton of freight carried reduces as the scale of the vehicle used increases. This is particularly true for trucking, the predominant mode in urban freight transport. Using fewer larger vehicles would therefore improve environmental performance. But even without changing

the fleet composition, gains could be made by ensuring that the average load factor is increased.

**Attack point 5: Reduce the environmental impact of each vehicle movement.** For any given pattern of vehicle movements, environmental performance can be improved by the operational characteristics of the vehicles operated.

Attack points 4 and 5 tend to be the focus for those who approach the problem of improving environmental performance from the perspective of economics. This is partly because these two attack points do not require a radical transformation of, or significant intervention in the production and consumption choices of businesses; and partly, because it seems likely that at least some initiatives pursued on these attack points could lead to gains in economic efficiency as well as in environmental performance.

### III. POLICY OPTIONS

#### A. Reducing the volume of freight

##### *Decoupling economic growth from material consumption<sup>2</sup>*

There has been a considerable interest in the question of whether there is an inherent tendency for the ratio of material consumption to economic activity to decrease once a certain level of income is achieved. So far, not all of the issues associated with this debate have been resolved (see the review article by Stern, 2003). However, the balance of evidence seems to suggest that without positive specific policy action, any inherent tendency in the economy to dematerialize, as income increases, will not be sufficient to contribute significantly to the achievement of sustainability objectives.

Recognition of this reality explains the initiatives that have recently been adopted by several ESCAP countries (ESCAP, 2008a). Supportive measures that Governments can take to encourage decoupling include:

- Attitudinal change programmes, including changing the way in which progress is measured, away from the predominance of indicators that show the volume of market transactions, such as GDP or GNI, towards the broader based measures such as the genuine progress indicator (Redefining Progress, undated);
- Industry policies that promote and support services, rather than material goods, as the future engines of economic growth. Governments have at their disposal a range of tools that can be used to this effect, including investment incentives;
- Differential consumption taxes designed to shift consumption from material goods to dematerialized services.

##### *Reduce 'consequential' freight movements*

Not all freight movements are directly related to the satisfaction of customer demand. Two elements in particular stand out:

- the movement of the packaging of consumer goods

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<sup>2</sup> Some would argue that there is a 'deeper' level of policy that should be considered here: the total rejection of the notion of economic growth as a desirable social objective. The position that has been adopted in this paper is such, that while a defensible argument could be advanced for this approach in developed countries, in countries where absolute poverty remains widespread this would be inappropriate.

- 'reverse logistics' movements — the freight movements required to dispose of waste generated during the entire life cycle of consumer goods.

There is a growing consciousness of the importance of these freight movements:

"In the past decade, waste management and recycling have become important political key words in many countries. EU policy stresses prevention of waste production and possibilities of recycling of waste". (OECD, 2003)

These movements could eliminate or require a lower level of freight transport activity to support any particular level of consumption. Supportive measures that Governments could implement include:

- Mandating responsibility for reverse logistics. This approach has already been widely adopted in developed countries as far as hazardous waste is concerned;
- Regulation of packaging practice, either by making manufacturers responsible for the disposable of all packaging or by directly intervening through the regulation of packaging practice.

Bottega (2005) provides an analytical study of the use of these measures concluding that the optimal policy consists of a combination of mandated packaging standards and a tax on packaging.

### ***Increase life of products***

This policy would face considerable practical difficulties, as it is very difficult to reconcile with commercial interests of producers, which are usually served by encouraging relatively high rates of product turnover and hence increasing sales potential.

Possible supportive measures include:

- Attitudinal change campaigns at the level of both corporations and individual consumer;
- Regulation and enforcement of minimum standards relating to product life-spans, supported by labelling requirements and an alignment of warranty periods with the specified minimum product life;
- Taxation measures, including higher taxes on raw materials and waste and reduced taxes on labour. This would help to discourage built-in obsolescence and reduce the price of repair work compared to the cost of replacement.

These and other measures are discussed in greater detail in the submission by the Centre for Sustainable Consumption (2007) to the United Kingdom of Great Britain and Northern Ireland House of Lords Science and Technology Committee Enquiry into Waste Reduction.

## **B. Reducing the distance that freight travels**

### ***Collocate production and distribution activities***

The typical supply chain consists of a number of distinct movements: input materials to component factory; components to final assembly; movement of the final product to a distribution centre; movement from distribution centre to wholesaler; from wholesaler to

retailer; and from retailer to final destination. If some of these movements can be eliminated or reduced in length by the collocation of activities that take place at different stages of the supply chain then the total distance travelled by freight can be reduced.

Supportive measures that could be adopted by Governments include:

- Integration of transport, logistics and production activities within a single industrial park at free trade zones, freight villages, and logistics centres;
- Urban planning and zoning changes to allow activities at different points along the supply chain to grow up in close proximity to one another. Urban planning and zoning play an important part in ensuring that the opportunities for this to occur are preserved;
- Release of public land. Public authorities often control significant areas of land, particularly on the urban periphery. In some instances, as is the case with the Moorebank site in Sydney, Australia (Australian Rail Track Corporation, 2010), this may be the only land in the urban sector that has the potential for development as an integrated logistics hub;
- Applying differential rates of land tax to influence the location decisions of enterprises, and encourage the collocation of production and distribution facilities.

### ***Economic localization***

Over the past several decades, international trade has grown much more rapidly than the global economy, and more and more products are shipped long distance between the point of production and the point of consumption. This notion has led a number of stakeholders to advocate localization of production as a means of increasing sustainability.

The strategy, however, is highly contentious. It depends on a presumption that reducing transport distance will, at least on average, lead to a reduction in environmental impact. This may not be the case, as the eco-efficiency of production and of the different modes of transport, involved in product delivery, need also to be taken into account. Localization policies may also be used as a veiled attempt to protect inefficient local industry, and may clash with national obligations under World Trade Organization free trade agreements.

However, if economic localization is judged to be an appropriate way of pursuing sustainability goals, there are a number of supportive measures that Governments can consider:

- As a major consumer in its own right, it can include preferential purchasing clauses in its contracts that favour locally produced product;
- It can sponsor or endorse awareness campaigns that seek to increase economic localization by making consumers more aware of the distance which products travel from the point of production to retail outlet; and, explicitly or implicitly encourage consumers to regard goods that travel further as less environmentally friendly than those that are locally produced. Product labelling plays an important part in such strategies (Leopold Centre, 2003);
- A less direct approach is to sponsor 'Buy local' campaigns. These campaigns differ mainly in the directness of the approach. 'Buy local' campaigns do not explicitly focus on the environmental consequences of the consumption decision, but use whatever arguments they can to influence consumer to purchase locally produced product.

### ***Containing urban sprawl***

Asian cities use substantially less per capita energy than North American and European cities. This is largely a result of differences in average income, but the higher urban density of Asian cities also plays an important role (Dodman, 2009). However, the average density of Asian cities is falling rapidly (Dodman, 2009; Roberts undated). The relationship between urban density and the energy-efficiency of transportation is well established. While the primary determinant of this relationship is urban passenger transport, the energy-efficiency of urban freight transport is also likely to decline with reducing urban density.

Governments can support the containment of urban sprawl through:

- Land use planning policies that provide the necessary conditions for increasing urban densities. Marcotullio (2001) has argued strongly that these policies would be critical to the maintenance of compact urban forms in Asia as they have been in Europe;
- Encouraging public transport development. Although public transport is rarely used for urban freight transport, urban public transport initiatives foster the eco-efficiency of urban freight transport indirectly, by supporting and encouraging higher urban density.

### **C. Changing modes**

There are very significant differences between the energy consumption and emissions performance of different transport modes. The extent of these differences depends on the specific characteristic of the freight task and the transport vehicle used; but top-down analysis, based on total energy consumption and emissions, can provide a robust indication of the relative magnitude. A wide range of studies has confirmed the following general ranking, based on increasing energy efficiency and decreasing emissions: sea, rail, road and air.

#### ***Greater use of rail***

Although rail is not a viable option for most purely intra-urban freight movements, modal shift can still have an important impact on the eco-efficiency of urban freight transport for two specific movements:

- The movement of freight from urban or peri-urban locations to the city port;
- The movement of inter-urban freight. (Most freight between urban centres spends part of its journey travelling within each of the connected urban centres).

Greater use of rail for these freight tasks could be encouraged by:

- Improving rail infrastructure. Several ESCAP countries — including India (ADB, 2008) and Australia (ARTC, 2010) are currently planning or constructing dedicated freight rail links that will pass through urban areas;
- Intermodal terminal development. The development of efficient intermodal terminals is widely seen as essential to the competitiveness of rail with road for container and general cargo freight. The majority of ESCAP countries are actively engaged in the development of intermodal terminals at key transport nodes, and this has been supported by the Busan Declaration and the Bangkok Declaration on Transport Development in Asia (ESCAP, 2009);

- Increase competition in rail operations. Promoting competition in above-rail services has been advocated by many as a strategy for improving operating efficiency, although the real benefits of this approach continue to be debated (Pittman and others, 2007; Drew, 2006);
- Road pricing. A shift to rail would also be encouraged, if the prices paid by road freight vehicles reflect the full cost of road use, including the congestion costs and externalities, as well as the cost of road provision and road wear. However, several studies have suggested that the scale of the impact of road pricing on freight mode choice may be small (Productivity Commission, 2006).

### ***Increasing use of water transport***

For cargoes that transit urban areas to access port facilities, the use of water transport may provide an alternative to road transport. Barges account for a substantial and growing proportion of cargoes delivered to some European ports. Many of the important ports of Asia are located on or near major rivers (for example, Shanghai, Shenzhen, and Ho Chi Minh), and in some cases the delivery of containers by barge already plays a major role (United States Department of Transport, 2008).

In other instances, there is a potential to substitute coastal shipping movements for long road movements that transit major cities: for example, for cargoes produced in Southern Thailand and travelling to Khlong Toey or Laem Chabang ports.

Greater use of sea and river transport could be encouraged by:

- Reducing cargo handling costs. Generally, water transport is very competitive if terminal costs are excluded, but terminal costs tend to be higher than for other modes;
- Improving non-price characteristics of water transport. Reliability of services, and risk of damage to (or loss of) cargo are important considerations for shippers, and water transport often performs poorly in this respects. Improved security at inland points of loading or discharge, provision of customs clearance facilities at these ports, and the improvement of navigational aids on inland waterways can all play a part in improving the non-price characteristics of water transport;
- Providing dedicated port facilities for barges and coastal shipping. Greater use of water transport can also be encouraged by proper facilities are available for use by barges and coastal shipping.

## **D. Reducing the number of trips**

### ***Increase load carrying capacity of individual vehicles***

Economies of scale in operation are present in almost all transport modes. The environmental impact per unit of cargo carried also tends to decrease as the scale of the operating unit increases. One Australian study has estimated that the substitutions of B-Doubles<sup>3</sup> for standard articulated vehicles on inter-State trips could lead to a reduction of approximately 33 per cent in the number of urban vehicle movements generated by this freight task (Hassall, 2005).

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<sup>3</sup> B-Doubles mean a combination consisting of a prime mover towing 2 semi-trailers.

Supporting measures that can help to increase the payload per trip include:

- Improved road and rail infrastructure. In the case of road transport, this may require strengthening of bridges and pavements; or widening or other improvements to the road alignment. In the case of rail, it may also require bridge strengthening, the provision of additional passing loops, and the extension of terminal facilities;
- Special limits on designated freight routes. Controls on the mass and dimensions of freight vehicles need not apply equally to every element in the network. Permitting the use of vehicles that exceeds general limits on particular parts of the network, where the negative impact is small and the economic benefit is large, can significantly reduce the number of trips required to perform the freight task;
- Performance-based standards. Traditional dimensional limits are set conservatively, so that regulators can be reasonably confident that, for example, all vehicles that are below the length limit will meet regulatory requirements. Performance-based standards provide greater scope for innovative design that allows vehicles to be larger and carry greater loads while still meeting regulatory requirements designed to protect infrastructure assets and promote safety.

### ***Improve load to capacity ratios***

Much of the time, urban freight vehicles run empty. And even when they are carrying loads, the loads that are carried are often much less than the capacity of the vehicle. There are a number of things that can be done to improve load factors (load to capacity ratios), and achieving these improvements will allow the same freight task to be performed with fewer vehicle trips.

Private sector trip planning will be the main mechanism for improving load to capacity ratios. But there are a number of things that Governments can do to encourage and support private sector operators in effecting improvements.

- Developing of urban freight centres. The potential for the development and promotion of urban freight centres to facilitate the consolidation of freight has been explored in detail by Wisetjindawat (2010b) and Min (2010). Consolidation of freight can reduce the number of freight vehicle movements by both permitting the use of larger vehicles and by increasing load factors;
- Access privileges. Another strategy for encouraging freight consolidation is to provide privileged access for freight vehicles operating at high load factors. This approach is most obviously applicable in the case of port-related container traffic transiting urban areas;
- Freight matching. Access to real-time information on freight availability can also provide opportunities to improve truck utilization;
- Encouraging industry consolidation. The trucking industry in most countries is highly fragmented. Coordination and timely exchange of information are particularly difficult in very fragmented industries, and encouraging industry consolidation has been advanced as a possible solution to these problems. However, the advantages of pursuing this direction must be considered in the light of the economic advantages of promoting competition in the road freight industry as well as the social advantages of providing opportunities for SME development.

***Change logistics systems that generate excessive vehicle movements***

Modern supply chain practices made supply chains more transport-intensive, and in so doing have increased the environmental burden of freight transport (Nathan, 2007).

Supply chain decisions are overwhelmingly made by private sector actors in response to market signals, including the cost of alternative distribution strategies. However, measures that change the balance of incentives with which they are faced can re-shape these decisions. These measures could include:

- Road pricing. In many jurisdictions the prices paid for use of the road system often do not reflect the full cost of road use (Pomlaktong and others, 2010). Adjusting road prices will increase the cost of transportation relative to the cost of inventories, and may induce a reconsideration of the intercity transport of logistics practices.
- Increasing fuel taxes. Sustainability considerations may include lower transport intensity of logistics operations beyond the point that would be ideal if only economic considerations were of concern. In this case, higher fuel taxes will increase incentives to reconsider logistics practices.

**E. Reducing the impact of each trip*****Switch to more environmentally friendly energy sources***

The range of alternative fuel options for urban freight transport extends for incremental improvements such as the addition of ethanol to fossil fuel and the use of bio-diesel through to the use of fully electric vehicles (GTZ 2005). Battery-powered trucks with capacities of up to 12 ton are a proven commercial proposition.

Governments can support the switch to the use of more environment friendly fuels in urban freight transport by:

- Subsidies/tax concessions for electric or hybrid vehicles. Production costs of electric vehicle still exceed those of internal combustion engines. While this cost disadvantage will be overcome by large scale electric vehicle production, in the short to medium term some fiscal support, preferably in the form of research and development, may be necessary. (Freedonia, 2009);
- Infrastructure support. One of the obstacles to the widespread use of alternative fuels is the lack of an adequate energy supply infrastructure (Wisetjindawat, 2010b). Both regulatory and incentive policies can be used to support the development of adequate infrastructure;
- Differential levels of fuel taxation. Many countries, including Australia, Japan and the Republic of Korea, use differential rates of fuel tax to encourage the use of fuels that are considered to be less environmentally damaging;
- Access privileges. Localized problems, caused by emissions from motor vehicles - including freight vehicles, can be particularly intense in specific urban areas, for example, in and near the central business district. Restricting access to these areas to any but low- or zero-emission vehicles, either completely or during particular periods, can help to promote the adoption of environmentally friendly technologies;
- Public sector purchasing policies. A number of Governments have adopted or are considering purchasing policies that require that a certain percentage of the

government fleet consist of hybrid or other low emission vehicles (see, for example, Commissioner for Environmental Sustainability, 2006).

### ***Improved vehicle design and maintenance***

Choices that are made in vehicle design and maintenance can have a material effect on the environmental performance of urban freight transport, both through increasing fuel efficiency and through ensuring that each litre of fuel burned produces the lowest possible quantity of pollutants. A recent report undertaken by the United States of America Transportation Research Board identifies potential fuel consumption savings from various initiatives, ranging from 11 to 35 per cent (Transportation Research Board, 2010).

Possible government actions to encourage improved vehicle design and maintenance include:

- Improved Design rules/registration requirements. While some ESCAP countries, such as, Japan, already have in place very strict design requirements for new heavy vehicle, the Clean Air Initiative has shown that most countries' standards lag well behind what might be regarded as 'best practice' (ADB/CAI-Asia, 2006);
- Differential road pricing. Ideally, road user charges should vary with the environmental performance of freight vehicles. The principles of price setting, according to European Directive 1999/62/EG, make differentiation on the grounds of environmental performance a mandatory feature of road pricing schemes in Europe (Rottengatter and Doll, 2002);
- Stricter enforcement of emissions standards. The adoption of strict environmental standards for motor vehicles will only be effective if it is backed up by effective enforcement of such standards;
- Education on good vehicle maintenance practice and minor design changes. Many of the vehicle maintenance practices and minor design changes that would result in improved environmental performance also reduce fuel consumption. Fabian (2010) reported a pilot project in Guangzhou that focuses on the minor design improvements to an existing truck fleet which has resulted in a reduction of fuel consumption of 12 per cent and a payback period of 1.8 years for the required investment.

### ***Improved driving practices***

According to the Victorian Transport Association, a "driver's level of skill can effect fuel use by up to and in excess of 35 per cent" (VTA, 2009). Although savings of this magnitude are likely to be rare, it is clear that driver behaviour can have a significant effect on the environmental impact of freight vehicles operations. The United States Environmental Protection Agency (USEPA) cites a Canadian study which estimates that many fleets could achieve a 10 percent fuel economy improvement through driver training and monitoring. (USEPA, undated).

Moreover, driver behaviour is one aspect of the freight transport system that can be changed quickly and at little cost. Most of the techniques required to improve fuel efficiency are simple:

- Sponsorship of/support for driver training programmes;
- Supporting the introduction of real time performance monitoring technologies. Continued application of the lessons learned in driver training courses will be

encouraged by the presence of in-cab real-time performance monitoring equipment that provides continuous feedback on fuel consumption performance.

### ***Create better operating conditions***

The environmental performance of freight transport can also be improved by improving the conditions in which freight vehicles operate. Operating on poorly designed or poorly maintained infrastructure, or in congested conditions, increases fuel consumption per ton-kilometre carried, and consequently the GHG emissions and pollution associated with carrying the freight task increases. These factors lower vehicle productivity, which in turn requires greater number of vehicles to perform the task, increasing the demand on material resources consumed in the manufacture of these vehicles. Additionally, they may also increase other environmental impacts.

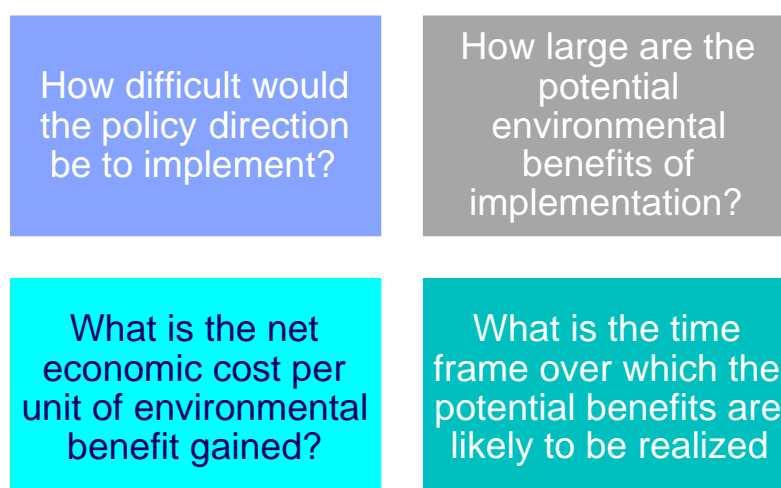
There is a choice of interventions that Governments could make to create better operating conditions for urban freight transport:

- Infrastructure investment. For both road and rail transport, fuel consumption and noxious emissions can be reduced if smooth operating conditions are maintained throughout the journey. This may require the elimination of steep grades, at-grade crossing and tight horizontal curves; the provision of smoother road surfaces and more stable rail tracks will also help;
- Introduction of intelligent transport systems. Improving the quality of the information available to truck drivers can also make a contribution. In particular, detailed real-time information on traffic conditions can lead to better decisions on which route to take, and may also, to a lesser extent, influence decisions on when to travel;
- Time of day pricing. Charging different road, or terminal access, prices at different times can reduce congestion and improve operating conditions.

## **F. Assessing policy priorities**

There is a wide range of policies available that would increase the sustainability and improve the eco-efficiency of urban freight transport. Deciding what policies to implement, and in what order, is a complex and difficult question; the answer to that is likely to vary from country to country and from time to time.

Figure 4 suggests a framework that could be adopted for assessing priorities amongst policies to improve the sustainability and eco-efficiency of urban freight transport.

**Figure 4. Proposed criteria for a preliminary assessment of policy priorities**

#### IV. METRICS FOR SUSTAINABILITY AND ECO-INDICATORS

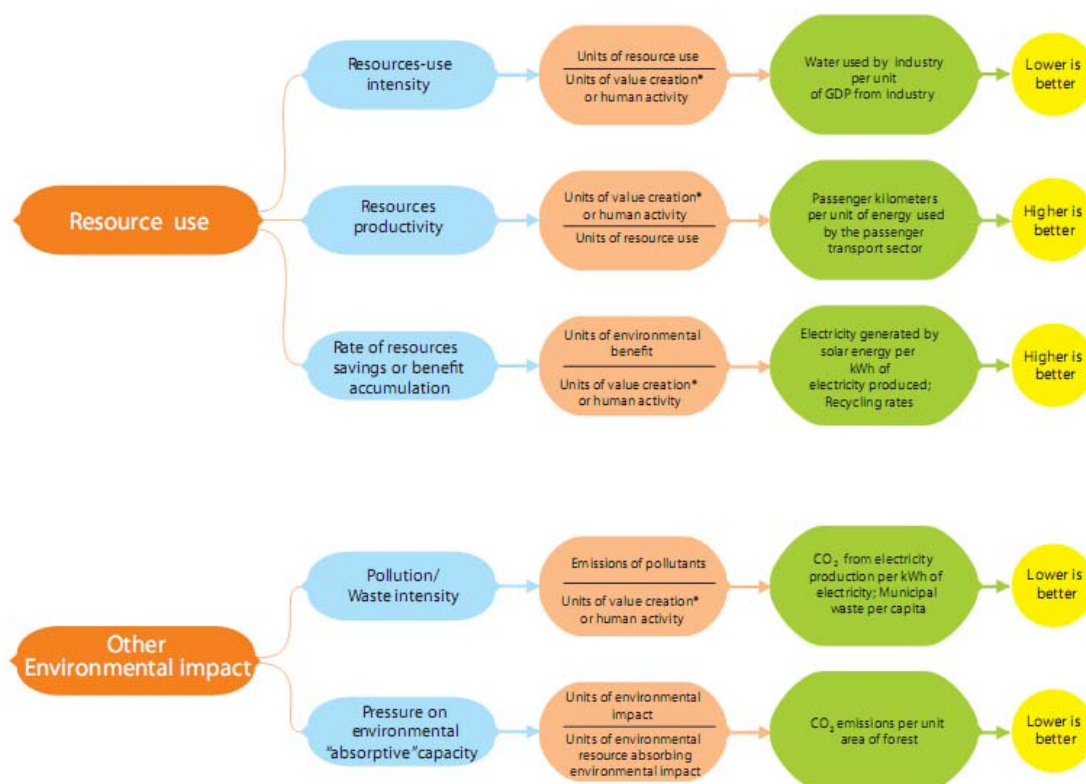
##### A. ESCAP Eco-efficiency indicators

###### ***General approach***

The ESCAP “State of the Environment in Asia and the Pacific 2005: Economic Growth and Sustainability” report directly addresses the challenge of scaling up a concept designed for use at the level of the firm to a concept that can be applied at the city, regional or national level:

“However, the types of eco-efficiency measure used at the firm level cannot reflect the wide range of human activities that comprise any economy and that impact on natural resource use, produce waste or pollution or change landscapes. Scaling up eco-efficiency concepts and applying them at the national level, therefore, requires the examination of a wide range of economic driving forces, reflecting production and consumption activity, as well as the basic human activities that contribute to economic growth and increased human welfare.” (ESCAP, 2006, pp.143-144).

The report, therefore, adopts a “back to basics” approach that centres on a clear flow of ideas from the identification of domains of environmental impacts, such as resource use, other environment impact) through to the specification of a relevant eco-efficiency indicator. This process is summarized in figure 4 below.

**Figure 5. A coherent framework for potential eco-efficiency measures**

Source: ESCAP, 2006

The report also makes some general comments on the design and use of eco-efficiency indicators that are very pertinent to the current discussion. The report suggests:

"To serve as useful indicators of environmental sustainability, eco-efficiency measures should:

1. Not be interpreted as measuring total levels of pressure on the environment...
2. Be appropriate for the context. In particular, they should be used with caution in situations of resource scarcity...
3. Be used to monitor changes over time...
4. Facilitate comparisons between economic sectors. Economy-wide eco-efficiency measures ...are strongly influenced by economic structures and can be far less policy-relevant...
5. Not be constructed in a way that can send mixed signals.
6. Be chosen carefully to ensure their relevance to the societies and countries concerned..." (ESCAP, 2006).

### **Transport indicators**

The framework shown in figure 5 is attractive. It is coherent and pitched at the appropriate level to serve as a general guide to policy formulation. However, the report stops short of full articulation of a suitable set of indicators by industry.

In a later paper, Nam (2008) goes some way towards supplying this deficiency by proposing key indicators for major industry sectors (see table 1).

**Table 1. Eco-efficiency indicators by industry sector**

	<b>Resource use intensity</b>	<b>Environmental Impact Intensity</b>
<b>Transport</b>	Energy intensity of passenger kilometre	Carbon intensity per passenger kilometre
<b>Energy (production)</b>	Share of renewable energy	Carbon intensity of electricity
<b>Manufacturing</b>	- Water intensity of GDP - Energy intensity of GDP	- Carbon intensity of GDP - Air and water pollution per GDP
<b>Commercial building</b>	Energy use per unit area	Share of energy consumption
<b>Household/Residential</b>	- Water consumption per dollar of household expenditure - Energy consumption per dollar of household expenditure	Non-recyclable domestic waste production per dollar of household expenditure

Source: Nam, 2008

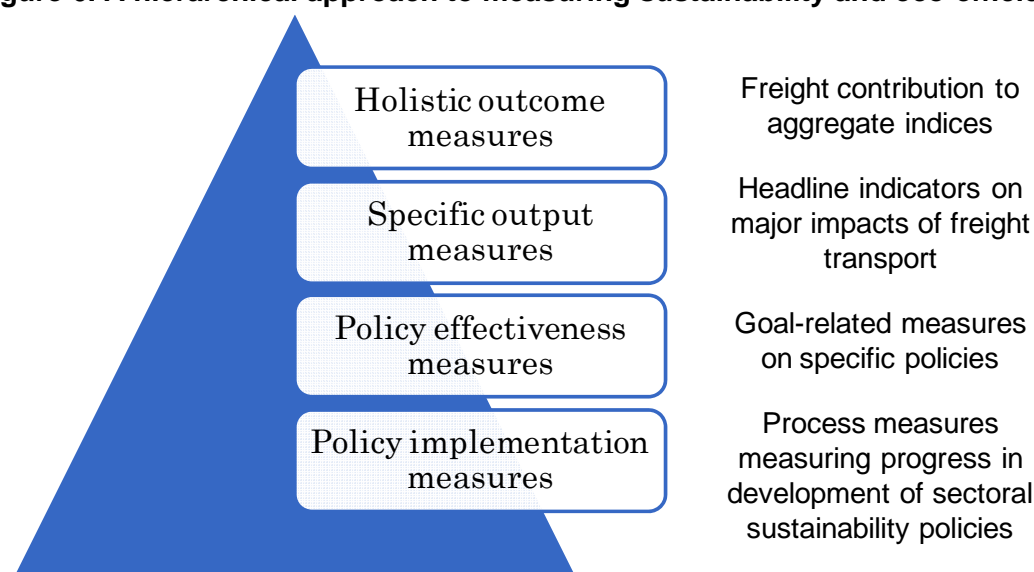
However, the focus of the indicators suggested by Nam is on passenger rather than freight transport.

## **B. A framework for urban freight transport**

In this section, therefore, an attempt has been made to construct a framework, designed to meet the specific needs of the urban freight sector. The framework is generally consistent with that of the ESCAP “State of the Environment in Asia and the Pacific 2005” report but also incorporates from a range of other reports (in particular, Global Reporting Initiative, 2006; OECD, 2003; OECD, 2006). However, the framework is not specifically modelled on any one of these.

### **A hierarchical approach**

The proposed framework, summarized in figure 6, uses a hierarchical approach to defining sustainability and eco-efficiency indicators.

**Figure 6. A hierarchical approach to measuring sustainability and eco-efficiency**

At the top level of the hierarchy are outcome measures, designed to measure the contribution that freight transport makes to consolidated indicators of the impact of a society's activities on the natural environment. These are intended both to track the impact of freight transport on reaching the ultimate objective of achieving more with less, and to allow the assessment of progress in the freight transport relative to progress in other industry sectors. At this level, sustainability and eco-efficiency measure are separately defined.

The second level indicators are the core indicators which focus the specific impacts of the freight industry. At this level, outcomes on the specific dimensions of environmental impact are separated out, and individual measures developed to track the progress that is being made along each dimension. Once again, at this level, sustainability and eco-efficiency measure are separately defined.

The third level focuses on the measurement of the success of policies designed to improve environmental performance, rather than on directly measuring the improvements themselves. Inclusion of this level of measurement allows policy makers to monitor where a specific policy instrument is working in the way in which it is intended. At this level, the distinction between measuring sustainability and measuring eco-efficiency disappears.

At the fourth level are process measures. These measures, which now play a very large part in the Global Reporting Initiative (GRI) Framework<sup>4</sup>, monitor the development and implementation of green policy measures. Including these measures allows the level three measures to be more accurately interpreted. For example, it allows the policy maker to gauge whether the failure of a policy to meet its intended goals is due to defects in the policy itself, or to defects in the way in which it is implemented. More directly, it can also provide a measure of the level of practical commitment to the pursuit of sustainability and eco-efficiency improvements.

### ***Outcome measures (Level 1)***

#### **(a) Core dimension of environment impact**

The proposed outcome measures would focus on the two core dimensions of environmental performance identified in the cited earlier ESCAP report. In that work, these dimensions are identified as: 'resource use' and 'other environment impact'. The second descriptor is not specific enough to provide, by itself, much guidance on the content of this dimension, but an examination of figure 5 suggests that it is concerned with what is known as 'environmental stress': the deleterious impact on the environment of human activity.

The fundamental distinction between these two dimensions of environmental impact is that our concern with resource depletion is ultimately an economic one, whereas our concern with environmental stress transcends economics. Resource depletion matters, because excessive consumption of resources today means that these resources are not available for the future consumption, and this may mean lower living standards for future generations. If a cheaper renewable substitute for crude oil in all its uses miraculously became available tomorrow, we would no longer be concerned about the rate at which we are using up our oil reserves. However, we should still be concerned of the rate at which we are consuming crude oil not because it may one day be all gone, but because in the process of consuming, it emits GHGs and other pollutants that put stress on the environment.

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<sup>4</sup> The Global Reporting Initiative (GRI) Framework provides the sustainability reporting guidelines that are the worldwide standard for corporate reporting on social and environmental performance. The Framework was developed through an international multi-stakeholder process, and adopted by major corporations. The Framework's comprehensive guidelines include principles for ensuring report content and quality, and define 49 core performance indicators along with 30 additional indicators and sector supplements.

As the example above shows, the two dimensions of environmental impact may be intertwined. Nevertheless, they are conceptually distinct, and from a policy perspective it is best to maintain this distinction.

### **(b) Practical considerations**

From a practical perspective, devising outcome measures is by far the most difficult task. This is mainly because they will necessarily rely on the use of composite indicators of environmental impact, and developing credible composite indicators is extremely difficult. But it is also because, even after the way in which the composite index will be constructed is agreed, gathering all of the data required to calculate it is likely to be a major task.

Some measurement frameworks make use of measures of total material resource consumption. However, all must face the challenge of how to combine different types of resources, for example, should one kilogram of uranium be regarded as the same as one kilogram of iron ore; and of where the boundaries of relevant measurement lie.

Similar concerns arise in the definition of the environmental stress caused by freight transport. One established candidate is the use of 'ecological footprint'. However, the construction of this indicator remains contentious, and in any event it incorporates both environmental stress and resource depletion elements.

In the absence of adequate composite measures, and given the difficulty of assembling the relevant data, it may be desirable to defer the articulation and implementation of these measures, and focus on the other three levels of the hierarchy. An alternative would be to construct a relatively simple proxy that could act as an interim substitute for both of these measures. This could be done by constructing an index based on the weighted average ton-kilometres of travel by freight vehicles where:

$C_i$  is the average freight capacity, in tons, of vehicles of type 'i' (basing the index on available freight-capacity rather than actual freight carried allows the index to capture the effect of improvements in vehicle utilization)

$K_i$  is the total kilometres of travel by vehicles of type 'i'.

$W_i$  is the weight assigned to vehicles of type 'i'.

The number of vehicle classes used in constructing the index could be varied depending on the quality of available data. Ideally, it would include at least two or three categories of truck as well as (where relevant) at least one train and barge. The sophistication with which the weights to be assigned to each vehicle type are derived will also vary depending on the quality of available data. Generic (internationally derived) values for relative fuel consumption for vehicles of different types could serve as default values, with gradual refinement as a greater understanding of the total environmental impact of various vehicle types in a particular environment becomes better understood. Weights could also be adjusted over time as improvements in vehicle technology or emission standards reduce the impact per vehicle-kilometre travelled.

### **(c) Proposed outcome measures**

The proposed outcome measures, both ideal and interim proxy, are set out in table 2 below.

**Table 2. Proposed outcome measures**

IDEAL: Ecological stress caused by freight transport activities	Ecological stress caused by freight moved per unit of GDP
IDEAL: Total material requirement from freight transport activities	IDEAL: Total material requirement per ton-km per unit of GDP
PROXY: Weighted ton-km of travel by freight vehicles	PROXY: Weighted ton-km of freight moved per unit of GDP

***Headline indicators of major impacts (Level 2)***

Freight transport, and particular urban freight transport, affects the environment in a number of ways. It is tempting to strive for comprehensiveness and include a wide range of indicators to reflect all of these impacts. However, using fewer, more clearly targeted indicators will help to ensure consistency and clarity of interpretation.

There appears to be an implicit consensus in the relevant literature that the three critical issues for freight transport are:

- Resource depletion: the consumption of fossil fuels
- Environmental stress: GHG emissions
- Environmental stress: Air pollution

The proposed headline indicators set out in table 3 below therefore focus exclusively on these three key issues.

**Table 3. Headline indicators for the impact of freight transport**

Petroleum fuel consumption by freight transport	Fuel consumed per ton-km of freight carried
Aggregate GHG emissions for freight transport	GHG emissions per ton-km of freight carried
Composite measure of emissions <sup>5</sup>	Composite emissions per ton-km of freight carried

***Policy effectiveness measures (Level 3)***

The level 1 and level 2 measures discussed focus directly on the outcomes that green policies on freight transport are seeking to achieve: increasing the efficiency of fossil fuel use in freight transport and reducing the environment stress resulting from freight transport operation.

But in order to achieve these outcomes, governments seek to change behaviour in various ways, and it is important to track these behavioural changes themselves as well as the environmental outcomes that they are intended to achieve. The information gathered in this process can be used to change or refine policy directions.

<sup>5</sup> One possible approach to developing a composite measure emission is to use the weights assigned to each type of emission in the computation of the air quality index.

In section II (B), the concept of 'attack points' was introduced, and these attack points were used as a way of categorising the various policies that a Government may wish to pursue.

Level 3 measures are designed to measure progress on these attack points. Suitable measures for each attack point are set out in table 4 below. It may be noted that these measures are not eco-efficiency indicators, but simply provide guidance on whether policies to improve eco-efficiency are working.

**Table 4. Policy effectiveness measures for each attack point**

Reduce the volume of freight moved	Freight tons/unit of GDP
Reduce the distance over which freight is moved	Freight ton-kilometres/freight tons
Change mode of transport	Modal shares of freight transport (ton-km)
Reduce number of vehicle movements	Ton-km per vehicle (veh)-km for each mode
Reduce impact of each vehicle movement	Fossil fuel consumption per veh-km by mode Pollution emissions be veh-km by mode

#### ***Measures of policy implementation (Level 4)***

The measures proposed for levels 1 to 3 are strictly quantitative. By contrast, level 4 measures are concerned with the development and implementation of policies to achieve improvements in the environmental performance of freight transport. They are essentially process measures, and not amenable to quantification.

In this sense, process measures are closely akin to many of the measures that are now included in the GRI reporting framework. Many of these measures require respondents to document what they are doing to promote improved performance against a particular goal, as well as measure progress against the goal. In cases where measuring progress against the goal is very difficult, process measures are to be used instead of progress measures.

Section II discusses a large number of policy options from which a Government may choose in an endeavour to improve the environmental performance of freight transport. The scope of the level 4 indicators will vary depending on which policy a Government chooses to pursue.

A fully developed set of level four indicators would include:

- Clear articulation of the policy directions that a Government intends to pursue in order to improve environmental performance, for example, to encourage a switch to more environmentally friendly energy sources;
- Details of the supporting measures that will be used to implement this policy, for example, in the case of encouraging the use of greener energy sources; encouraging research and development on new fuel sources; differential taxation of various energy sources; privileged access to certain infrastructure for vehicles meeting certain environmental performance standards; subsidies for electric or hybrid vehicles; and public sector purchasing policies to encourage the purchase of environmentally friendly motor vehicles;
- An implementation programme for each of these supporting measures, including commitment dates for legislative, regulatory and contractual changes; and, where relevant, proposed budgetary allocations;

- A checklist, allowing ready comparison of performance against the documented implementation programme.

#### IV. Summary

To measure the progress in achieving the desired policy outcomes, the paper recommends maintaining a tight focus on the most important dimensions of performance. It recommends the development of a hierarchy of performance measures for tracking at the top level of the hierarchy. These are outcome measures, designed to measure the contribution that freight transport makes on the natural environment. The second level indicators are the core indicators which focus on the specific impacts of freight industry. The third level focuses on the measurement of the success of policies designed to improve environmental performance and the fourth level consists of process measures.

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## REVIEW OF GOOD PRACTICES IN URBAN FREIGHT TRANSPORTATION

Wisinee Wisetjindawat\*

### ABSTRACT

*This paper provides information on freight transport policies implemented in several countries in Asia, Europe and North America. It defines objectives for sustainable freight development as follows: a) Reducing energy consumption per ton-kilometer; b) Decreasing ton-kilometers of less sustainable transportation modes such as road transport, and c) Increasing usage of more environmentally friendly transport modes such as rail and water transports. Implemented policies and measures in each of the categories are discussed based on their contribution to achieving the stated objectives, and their practicality is analyzed. Issues of concern with each policy are also presented.*

*Freight centres and consolidated deliveries provide the most promising way to achieve sustainable development as they can reduce the use of road transport, which generates the most negative environmental impact. Multi-modal facilities of freight centres together with the development of rail and water transport networks are highly recommended since they respond to the objective of increasing the share of more environmentally friendly modes, as well as increasing the opportunities for consolidated delivery that can reduce trip numbers. Coordinated implementation of the measures is also recommended in order to improve the chances of success. Successful implementation of measures will also require cooperation from the private sector operators.*

**Keywords:** urban freight transport, freight transport, sustainable transport

### INTRODUCTION

Freight transportation is critical to economic growth in any country. Efficient freight transport and logistics systems can strengthen the business competitiveness of a country. The cost of logistics is generally computed as a percentage of gross domestic product (GDP) of a country. According to a report from Bangkok Bank (2007), in developed countries, such as the United Kingdom of Great Britain and Northern Ireland or Japan, the logistics cost is around 10 per cent of GDP, while for countries in Asia and the Pacific region, the median cost is higher, at about 11.6 per cent of GDP. However, the cost varies from one country to another and for most developing countries, it is much higher. For example, in Thailand the estimated logistics cost is about 19 per cent of GDP. This means that Thailand is in a less competitive position in the global market.

Environmental as well as economic concerns of high logistics cost should be examined. During the last 10 years, environmental questions have become more pressing around the world. In 1987, the Brundtland Commission declared that sustainable development was the key for future development. The word “sustainable” and its implications in terms of resource use, for example, have become part of the development agenda since then. Sustainable development in the freight sector is important for both economic and environmental considerations. The objectives for more sustainable freight transport development can include: a) reducing energy consumption per ton-kilometre; b) decreasing ton-kilometre of less sustainable transportation modes (such as road transport); and c)

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increasing the use of environmentally friendly transport modes, such as rail and water transport. The issue is how these objectives can be achieved in practice.

To move towards a sustainable freight transport system, one needs to understand the whole logistics system. Each purchase by an end customer is the result of several previous activities. Raw materials, while being transformed into a finished product, are moved around several times. For example, raw materials from their origins are moved to manufacturing units, where they are changed into a packaged product, before being transferred to warehouses. From warehouses, the finished product is moved to wholesalers and then on to retail shops, waiting for the customer to purchase it. In reality, the system is usually more complicated.

Understanding the actors involved, their roles, and the scope of their activities will be important when deciding on suitable freight policies. Taniguchi and others(1999) classifies the actors in city logistics, who are referred to as “freight actors”, into four groups: shippers, receivers, carriers, and administrators. Shippers and receivers are the actor of supply and demand for products. Carriers have a major role in today’s transport system. They respond to the demand for transportation of products between shippers and receivers. Finally, administrators play a role in controlling the functioning of the whole system through encouragement or enforcement of measures related to freight transport.

Transportation inevitably has a major share in freight movement costs. Transportation costs are estimated to represent as much as 40 per cent of the total logistics costs. Private sector actors, of course, try to reduce costs as much as possible, and may be less concerned with environmental or safety issues. The city planner, however, can be expected to be directly concerned with safety and environmental questions, as well as economic growth. In fact, it is not easy for the city administrator to enforce strong measures to control the activities of the private sector. Inappropriate policies could harm the wider economic system. It is hard for a city planner to deal with diverse actors with different perspectives and to find a compromise between their interests and those of the wider population.

In developed countries, policies and measures to address the environmental impact of freight transportation have been considered since the 1990s. Among the implemented measures, some have succeeded and many have failed. This paper presents a general review of sustainable freight transport policies and identifies the key determinants of their success or failure; gives a summary of policies and measures that have been implemented in some countries; offers a categorization of implemented policies and measures together with their advantages and disadvantages; and finally presents a set of conclusions and recommendations.

### ***Objectives for Sustainable Freight Transportation***

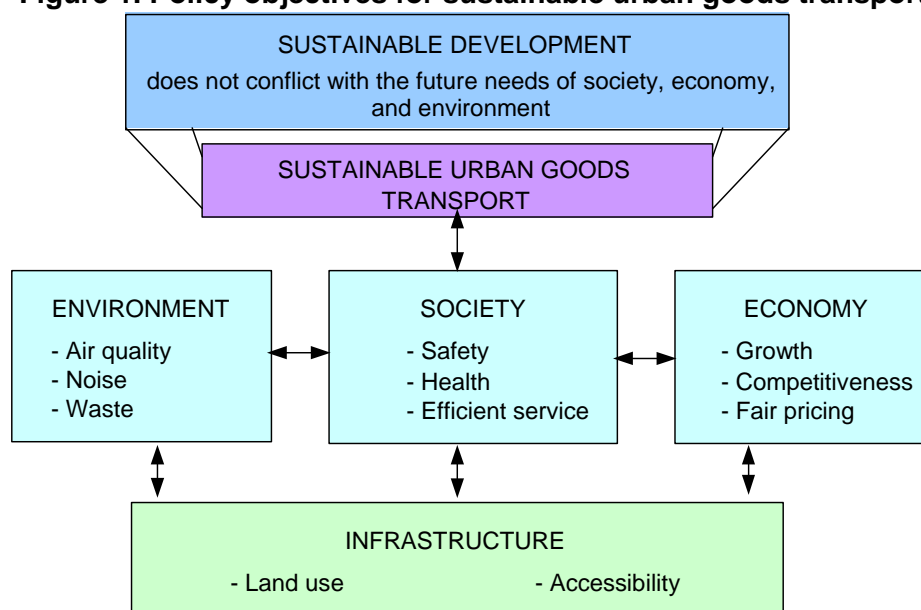
The paper sets the objectives for sustainable freight transportation based on the European Federation for Transport and Environment (2000) on ways to achieving greater freight transport sustainability. The objectives are as follows:

- (a) Reducing energy consumption per ton-kilometre;
- (b) Decreasing total ton-kilometres of less sustainable transportation modes such as road transport; and
- (c) Increasing the use of environmentally friendly transport modes such as rail, water, and inland water transports.

However, environmental issues are the primary concern of these objectives. Sustainable development requires a more comprehensive approach considering other aspects of development, namely society and economy.

Taking into consideration a wider approach, Visser (2006) presents the policy objectives for urban goods transport as shown in figure 1. Sustainable development, precisely “sustainable urban goods transport”, requires that it is compatible with the future needs of the society, the economy, and the environment. Focusing solely on single aspect could hurt the other two. Transport development should serve all the three aspects of sustainable development, and improving the competitiveness of the economy should not compromise the environmental and social issues.

**Figure 1. Policy objectives for sustainable urban goods transport**



Source: Adopted from Visser (2006).

## I. FREIGHT TRANSPORTATION POLICIES

Based on Visser's categorization of freight policies (2006), the report on European freight policy by EXTR@Web (Exploitation of Transport Research via the Web, 2006), and a sourcebook of good practice in freight transport by the European Commission (2000), the policies on freight transportation can be categorized into five groups:

- (a) Licensing and regulations;
- (b) Freight centres and consolidated delivery;
- (c) Vehicles and fuel technology: optimized vehicles, low-emission vehicles, alternative fuels, and broader use of environmentally friendly modes;
- (d) Information technology (IT) and driver training; and
- (e) Freight transportation systems for the new century.

The first two categories of policy development should be government led. Policy measures in categories (c) and (d) usually require considerable input from and cooperation of the private sector. Category (d) policy measure benefits the private sector most directly through improved human and technological resources. Policies in category (e) deal with the

future development of freight transportation systems and may require a completely different approach than that of today.

### A. Licensing and regulations

This approach is the one most widely used. Examples of licensing and regulation can include, weight restrictions, eco-zoning, and truck bans during certain hours. Government regulations can be effective, for example, in introducing weight restriction systems to prevent large vehicles from entering restricted zones, which are normally residential areas and city centres. Eco-zoning systems is a new trend to allow only low-emission vehicles to enter the restricted zone. The restrictions can differ according to: time period, emissions level, weight limit, and size of vehicle.

A selection of measures in the licensing and regulations category is presented in this paper. These include:

*Low emission zones* have been implemented in: the Kingdom of Sweden; the Kingdom of the Netherlands, Amsterdam; and the United Kingdom, London. Emission criteria are set out by the local government to allow only vehicles that meet the desired emission level to enter to the restricted zones (Seattle Urban Mobility Plan, 2008).

*Combined use lanes.* Variable Message Signs (VMS), for example, in the Kingdom of Spain, Barcelona, alter the usage of lanes at different times of the day, such as through-traffic only during peak periods, temporary truck loading stops during the day, and on-street parking during the weekend (Seattle Urban Mobility Plan, 2008).

*Freight-exclusive lanes* are implemented in the United States of America but are limited to truck traffic to/from port facilities or at international border crossings. For example, at the Port of New Orleans, the roadway to the Port is split one half for general traffic and the other for commercial vehicles (2 lanes each). In Laredo, Texas, the 8-lane commercial-traffic only highway was built to serve the increasing trade at the border between Mexico and the United States, Texas (Seattle Urban Mobility Plan, 2008).

*Incentives for off-peak delivery* are, as the name implies, measures intended to shift deliveries to the off-peak period. An example of such actions is the introduction of a fee for commercial vehicles entering a restricted zone during peak periods. This was implemented at the Ports of Los Angeles and Long Beach in 2005. A Traffic Mitigation Fee is required for truck movements during peak hours. Seattle Urban Mobility Plan (2008) reports that 30-35 per cent of typical day containers have changed to off-peak hours since the implementation of the measure.

*Restricted delivery hours* are one of the most popular policies, being implemented in several cities. For example, in Boston, vehicles with commercial license plates are prohibited from using certain streets in downtown, except during a certain time period. Only certain companies such as the United States Postal Service and newspaper delivery firms are allowed to enter after 2 p.m., while other companies who want to enter the restricted zone have to apply for a one day special permit (Seattle Urban Mobility Plan, 2008).

*Truck ban* policies, are similar to the restricted delivery hours. The difference is that the focus of truck bans is generally on larger commercial vehicles. Here, truck ban refers to restrictions for a specific kind of truck, prohibited from the designated areas during a certain period of time. A truck ban policy has been implemented in Manila, the Republic of the Philippines. Punzalan (2000) studies the socio-economic impacts of truck ban policy on truck operators, drivers, and truck operation in Metropolitan Manila. The study reveals that truck operators prefer using their usual routes, and rather than using alternative routes shift the driving time to night-time or in-between the truck ban times instead. Night-time driving, evidently, results in undesirable impacts on truck operators and drivers as it disrupts driver's sleeping patterns and hence may increase the risk of accidents.

*Parking restrictions in different forms* are adopted widely. Parking spaces for commercial vehicles is one of the most crucial problems, especially in the central areas. Insufficient loading space for truck operations leads to problems such as double parking. Regulations need to be enforced consistently and effectively for these vehicles. Some examples in Japan include providing a specific space for commercial vehicles in each parking area in the city centre, or specifying a space for commercial-vehicle-only parking in low traffic volume areas. This arrangement helps to improve efficiency and safety. In addition, the installation of parking meter can improve turnover rates.

*Road pricing* is applied widely in many countries. Mostly, the charges are applied to both passenger and freight vehicles. Road pricing schemes aim to reduce the number of vehicles entering into the city. The objectives are to manage demand and to generate revenue for the operation and maintenance of the infrastructure, and to recover external costs directly from the users of the infrastructure. However, in applying this method, fair pricing is required. With respect to commercial vehicles, Allen and Eichhorn (2007) reported that urban goods transport pricing could not effectively manage demand, as most goods would have to be transported to their destinations anyway and it is difficult to reduce the vehicle operation.

Results from the implementation of licensing and regulations can be expected in the short-run. For example, large truck ban policies are expected to result in an improvement in environmental conditions in the restricted zone. In addition, from a safety perspective, a ban can be effective as large trucks maneuvering in dense city centres cause numerous safety problems. However, in the long-run, implementing restrictions without considering their economic and social impacts may cause other problems.

## **B. Freight centres and consolidated delivery**

Browne and others (2005) explains the meaning of freight centre, or urban freight consolidation centre (UCC), as they call it in Europe, as principally a logistics facility located in close proximity to an urban area to serve consolidated deliveries within that area. The UCC has also several other names; such as urban transshipment centres, consolidation centres, urban distribution centres, and city logistics.

Freight centres and consolidated delivery systems seem to be the best way to achieve sustainable freight development. The concept of consolidation is the same as for passenger transportation (buses, trains, etc.), where shipments sharing the same origin and destination are consolidated into a single vehicle to reduce the number of vehicles used. Consolidated delivery is generally performed for the delivery of shipments of a single company. Consolidated deliveries for multiple companies may be possible. However, in practice this is not easy to implement as it impacts on the competition among them and companies may be reluctant to share their delivery technology.

Freight centres are designed to promote consolidated deliveries. Large long-haul trucks stop at the freight centre and transfer their shipments to smaller trucks, a process known as transshipment, before these smaller trucks enter the city centre. In addition, with freight centres, it is possible that the shipments from different companies can be consolidated before deliveries are sent to downtown. With this type of arrangement, one can obviously expect a reduction in the number of trucks operating in dense city centres, hence less congestion and safer environment.

The advantages of urban freight consolidation centres are as follows:

- *Environmental aspect:*
  - Less emissions and noise because of a smaller number of trucks operating in the city centre;

- Improved opportunities for usage of other non-road modes that are better from an environmental perspective such as rail and inland water transport.
- *Social aspect:*
  - Health and safety improvements due to fewer trucks (especially large trucks) maneuvering in the city centre;
  - Less congestion in the city centre due to fewer trucks;
  - More efficient services to customers due to faster deliveries.
- *Economic aspect:*
  - Participating companies gain benefits from reductions in vehicle trips and vehicle-kilometers;
  - Improvement of load factor that reduces the unit cost of transportation of goods;
  - Opportunities to gain revenue from the return trip by carrying some products back instead of running an empty truck.

Despite the attractiveness of these advantages, among the many UCC that have been piloted in several countries, a few of them have succeeded but a large number of freight centre projects have failed. City logistics, or City logistik is the German equivalent to the UCC. In 1999, the Federal Republic of Germany launched “City Logistik” schemes in about 80 German cities for the consolidation of shipments outside the city centre (Seattle Urban Mobility Plan, 2008) and for joint deliveries of goods from different companies to urban areas (Visser and others, 1999). However, the majority of these projects were suspended. Nobel, 2007 reported that among these pilot projects, consolidation centres were still operating in only 5 cities: Aachen, Bremen, Essen, Frankfurt and Regensburg.

The Best Urban Freight Solutions (BESTUFS) Project under the auspices of the European Commission, which aims at identifying problems and providing solutions related to city logistics in European cities, states that the key to success of UCC projects is that publicly organized UCCs should be led and operated by one or several major commercial players. In addition, there should be sustained support from the public sector for research work and studies related to the UCCs, otherwise such operations are unlikely to succeed.

Points of concern when adopting UCC schemes are as follows:

- High set up costs.
- A need for several UCCs in large urban areas since a single UCC usually cannot handle the full range of goods and is likely to be less attractive for freight operators.
- Careful selection of participants to avoid the risk of creating monopolistic situations.
- Consolidated delivery lessening direct interactions between suppliers and their customers.
- Difficulties in attracting large companies because of their having a similar system of consolidated shipments.

A *Freight village* is a freight centre with transshipment terminals grouped in a specific area with designated transport services provided. The examples are Guterverkehrszentren (GVZ) in Germany and Interporti in the Republic of Italy. “GVZ” and “City Logistik” in Germany differ with respect to their targeted geographic zones. GVZ is designed to serve inter-regional freight movement between conurbations, while City Logistik is for the joint deliveries of goods within urban areas. GVZs are often a form of a multimodal freight centre in which road, rail, and/or water transports can be connected. Multimodal freight centres are

one of the most interesting approaches by which the objective of sustainable freight systems can be achieved through increased usage of environmentally friendly modes. With multimodal facilities transportation choices become wider and it increases the probability of operators choosing rail and water transport that can be more economical when transporting over long distances.

In Japan, there are facilities to gather small and medium size wholesalers (SMEs) of food products in a selected area, which is known as a wholesale market. In these markets the wholesalers are provided with dedicated logistics facilities coordinated with local transport operators. The wholesale market is classified in the business group development category. The operation of the wholesale market has been successful in increasing competitiveness among the companies. At present, there are numerous wholesale markets of this kind operating in most cities in Japan. This kind of freight centre is very promising. Since the facility gathers the same type of firms in a single space, there are increased opportunities for coordinated deliveries.

For the operation of UCCs and other similar arrangements, public private partnership (PPP) is the recommended organizational structure for freight facilities. It is important to note that the key to success for most schemes is the enthusiasm of the private sector operators participating in the project. The development of an understanding of the benefits of sustainable transport among private sector operators is very important, since the benefits in reduced costs are not always obvious, and can cause the private sector to lose interest in the long run.

### **C. Optimized vehicles, low-emission vehicles, alternative fuels, and greater use of environmentally friendly modes**

The shift to environmentally friendly modes is a key step in creating sustainable transportation systems. Road transport is the most popular delivery mode because of its flexibility, punctuality, security, and competitive cost. However, traditional freight vehicles worsen air quality and cause numerous other environmental and social problems. A sourcebook of good practices in freight transport, published by the European Commission (2000) points out that a switch from road transport to other environmentally friendly modes will deliver immediate improvements. The more environmentally friendly modes include rail, inland waterways, and coastal shipping. Many studies reveal that large amounts of energy can be saved when goods are transported by train or waterways. For example, a German food company has saved as much as 40 per cent in energy consumption by switching off to rail for long distance transportation (European Commission, 2000). Generally, rail is a very competitive option on price and delivery time for long distance deliveries. The sourcebook also suggests that combined transportation, such as between road and rail, provides very cost-effective and reliable alternative to the road only option and can avoid congestion. Multimodal facilities are, therefore, necessary to promote the combined transport option. In addition, multimodal facilities could operate as freight centres creating opportunities for consolidated deliveries by firms.

Another example of modal shifts for deliveries in cities is the City Freight project adopted in Europe. The project recommends a strategy of combining freight traffic with passenger traffic within cities. This can include using cargo trams, electric and hybrid vehicles, bicycle couriers, and messengers on foot.

Since road transport is unavoidable for deliveries in urban areas, much research has been devoted to lowering emission rates and to the development of alternative fuels, such as compressed natural gas (CNG) or low sulfur diesel. However, there is a need for the public sector to ensure sufficient infrastructure for the supply of alternative fuels. An inadequate

supply infrastructure is a major obstacle to the widespread adoption of these alternative vehicles. In addition, alternative fuels may entail additional costs for transport operators.

A company in Denbighshire in the United Kingdom (Welsh Assembly Government, 2008) proposes the utilization of dual-purpose vehicles to improve freight efficiency and reduce emissions from freight vehicles. Each vehicle would be equipped for both highway and maintenance operations, instead of using a vehicle solely for each purpose. The multiple-usage of vehicles can reduce the total number of vehicles required for both operations and can also prevent many vehicles from being idle for long periods of time.

Another factor to consider is the size of vehicles for urban distribution. The current trend is for greater numbers of lower weight deliveries which create more trip requirements. Egger and Ruesch (2003) recommended optimized vehicles with higher cubic capacities and lower deck heights, equipped for handling, for example, fragile or temperature sensitive goods.

#### **D. IT and driver training**

The development of technologies for improved efficiency and driver training tends to be the most attractive option for the private sector. Encouragement to use these technologies is apparently the easiest way to achieve win-win solutions for both the public and private sectors. The companies benefit from their improved service, such as reduced energy wastage when efficient delivery routes are used. At the same time, city dwellers can expect a better quality of life resulting from the environmental and social benefits of the measure.

Several projects related to applications of technology have been launched in Europe. The European Commission (2006) recommends supporting the development of web-based technologies and E-commerce and to standardizing the traffic information data. Web-based technologies can be used, for example, for finding the shortest routes for delivery service, online vehicle routing, track-tracing systems, and vehicle fleet management.

Another technology that can be shared with passenger transportation is intelligent transportation systems such as electronic toll collection (ETC) and the global positioning system (GPS). ETC systems automatically debit toll fees from road users with no stoppage required. At present, ETC systems have already been implemented in many countries, such as Japan, the United States and European countries. The system can significantly reduce congestion and allows for variable charges depending on the time of day and type of vehicle. Commercial vehicles, operating within an ETC set up, can profit from reductions in travel time delays when using the expressway networks. Travel time information systems on highways are also very useful for users to receive timely information on congestion and traffic incidents, so that they can avoid delays. In Japan, the system called vehicle information and communication system (VICS) provides such traffic information through electronic boards set up along the highways and expressways throughout the country. Global positioning systems (GPS) have become common in vehicles in Japan. Vehicles equipped with GPS systems are positioned on the network map in real-time and are easily guided to the most efficient routes. Information on the travel times on links is automatically updated from the traffic information centre.

One of the most interesting freight systems for urban areas is that of the eDRUL project which has been implemented in Siena, Italy and Lisbon, the Portuguese Republic (EXTR@Web consortium, 2006). The "Park and Buy" service adopted in Siena has been very successful. There are about 20 shops enthusiastically participating in the project. The system facilitates customers, who previously had to walk into the pedestrian city centre to buy heavy items, by offering a booking and delivery service that allows consumers to

purchase items and have them delivered to a collection point in a car park. The system resolves the customer's parking problems and increases the sales.

Unattended delivery systems resolve delivery problems when recipients of goods are neither at home or in their office. A considerable amount of energy is lost when a truck attempts to deliver goods and finds that the recipient is not there to receive them. The truck then has to return to the depot and must try to deliver the goods later. This may double the amount of energy used. An example of an unattended delivery system is the online book store developed by Yahoo in Japan. The system allows the customers to choose and get the books delivered at home or to pick up the books themselves at a convenience store of their choice. Another method implemented by some online businesses in Japan is that the customer is allowed to choose the location to have the products dropped there when he/she is absent.

The economic gains from the more ecological ways of driving are not negligible. A driver training scheme can save significant amount of energy as well as improve safety. A report on "eco-driving" schemes in Japan reveals that savings of 12 per cent in fuel consumption can be made after a company adopts such a programme (Japan Institute of Logistics System, 2008). Similar findings are reported in several other countries (European Commission, 2000): For example, truck manufacturer, Mercedes-Benz pointed out that between five and ten per cent fuel consumption reduction was achieved after they organized courses and training programmes for the company's drivers. In addition, up to 18 per cent fuel consumption reductions are reported to be reached by the driver training schemes of a British company. The increase in fuel-efficiency is achieved by encouraging drivers to use gears properly, to switch off the engine when the vehicle is stationary, and to avoid fast accelerations.

### **E. Freight transportation systems for the new century**

In the Netherlands, there is a move to develop a new form of urban freight systems which is called Underground Freight Transportation (UTF) (Pielage, 2001). Planning began in 1995 and the project is still in the development stage. The concept is to move freight vehicles underground in order to reduce their impact, especially in the city centre. The implementation of this system is feasible with the currently available technology. For example, the Mail Rail system in London, which began in 1927, was an automated underground transport system that had operated for more than 75 years. The UTF system is similarly designed to transport goods using underground pipelines. Transport through the pipelines is planned to be fully automated. When this new system comes into operation, the government expects enormous benefits from improvements in the environment and people's quality of life.

In Japan, a similar study has been undertaken on the feasibility of an underground freight system for Tokyo. The study (Taniguchi and others, 2001) estimates that NO<sub>x</sub> and CO<sub>2</sub> would be reduced by 10 per cent and 18 per cent, respectively. A reduction of 18 per cent in energy consumption and an increase of 24 per cent in average travel speed are also predicted.

## **II. Comparisons among the freight practices and recommendations**

Table 1 provides a summary of the policies on freight transport practices, their advantages and short remarks on each of them.

Table 1. Comparisons of freight policies

Category	Policies and measures	Regions/cities	Advantages	Remarks
A	Licensing and regulations			
	Low emission zones	Cities in Sweden, Amsterdam, and London	<ul style="list-style-type: none"><li>Immediate results can be expected from the improvements in safety and in environmental conditions.</li></ul>	<ul style="list-style-type: none"><li>Social side-effects from changing delivery times in response to the policies, such as increases of accident rates due to drivers' lack of sleep and truck overloading.</li><li>Opposition from the private sector due to increased costs for additional vehicles.</li><li>Advised to be adopted together with other schemes for better results, such as the provision of freight centres, so that the private sector has more choice and a less negative reaction.</li></ul>
	Combined use lanes	Barcelona, Spain		
	Freight exclusive lanes	New Orleans, Laredo, United States		
	Off-peak delivery	Long Beach, Los Angles, United States		
	Restricted delivery zones	Boston, United States		
	Truck ban	Manila, Philippines		
	Parking regulation	Many countries in Europe, North America and Japan		
	Road pricing	Many countries in Europe and Japan		
B	Freight centres and consolidated delivery			
	Multimodal freight centres	Germany, Italy	<ul style="list-style-type: none"><li>Increased likelihood of using other more environmentally friendly modes: rail and water transports.</li><li>Increased opportunities for consolidated delivery that will reduce commercial vehicle trips entering the city centre.</li></ul>	<ul style="list-style-type: none"><li>A very effective spur to sustainable development, but difficult in practice.</li><li>High investment costs.</li><li>Large area is required.</li><li>Strong cooperation from private sector is required for success.</li></ul>
B (cont'd)	Urban freight centres	Germany, Japan	<ul style="list-style-type: none"><li>Increased opportunities for consolidated delivery.</li></ul>	<ul style="list-style-type: none"><li>Education on the advantages of consolidated delivery is</li></ul>

Category	Policies and measures	Regions/cities	Advantages	Remarks
				necessary.
	Business group development such as wholesale markets in Japan.	Japan	<ul style="list-style-type: none"> <li>Economic growth from a firm's improved competitiveness.</li> <li>Increased opportunities for consolidated delivery.</li> <li>Successfully adopted in most cities in Japan.</li> </ul>	<ul style="list-style-type: none"> <li>High investment costs.</li> <li>Large area is required.</li> <li>Need to provide competitive transportation services to prevent companies preferring their own vehicles.</li> </ul>
C	<i>Low-emission vehicles, environmentally friendly modes, and alternative fuels</i>			
	Increasing use of low-emission modes such as rail and water transports.	Europe	<ul style="list-style-type: none"> <li>Large environmental and safety improvements from reduction in road transport.</li> </ul>	<ul style="list-style-type: none"> <li>To increase the usage of other modes, the public sector has to provide sufficient facilities to support flexible multimodal transport</li> </ul>
	Encouraging the development of low emission vehicles, multi-purpose vehicles, and alternative fuels.	Europe, Japan	<ul style="list-style-type: none"> <li>Technology ready: important developments on low-emission vehicles (e.g. hybrid vehicles) have already been achieved.</li> </ul>	<ul style="list-style-type: none"> <li>Suggesting implementation together with "Licensing and Regulation" policy.</li> <li>For alternative fuels, a need to provide adequate supply facilities to ensure widespread adoption.</li> </ul>
D	<i>IT and driver training</i>			
	Intelligent transportation systems (ITS), such as ETC, GPS, and traffic information system.	Europe, Japan, United States	<ul style="list-style-type: none"> <li>Can be shared with passenger transport operators.</li> <li>Mature technology that is widely adopted in developed countries.</li> </ul>	<ul style="list-style-type: none"> <li>High set up costs.</li> <li>This does not increase the use of more environmentally friendly transport modes</li> </ul>

Category	Policies and measures	Regions/cities	Advantages	Remarks
D (cont'd)	Service improvement through technologies such as web-based delivery routing system, park and buy, and unattended delivery systems.	Europe, Japan	<ul style="list-style-type: none"> <li>• Inexpensive cost of implementation.</li> <li>• Likely to be well-received by the private sector.</li> </ul>	<ul style="list-style-type: none"> <li>• Encouragement from the public sector is often required, e.g. providing low cost technologies that are affordable for most private sectors.</li> </ul>
	Driver training	Europe, Japan	<ul style="list-style-type: none"> <li>• Not expensive.</li> <li>• Positive private sector response.</li> <li>• Environmental and social benefits from reduced energy usage and lower accident rates.</li> </ul>	<ul style="list-style-type: none"> <li>• Encouragement from the public sector is important, e.g. organizing training courses for the private sector.</li> </ul>
E	<i>New freight transport system</i>			
	Underground freight transport	the Netherlands, Japan	<ul style="list-style-type: none"> <li>• Alters the urban structure. Freight vehicles are separated from other traffic, resulting in reduced negative impacts from freight vehicles.</li> </ul>	<ul style="list-style-type: none"> <li>• Enormous investment costs.</li> <li>• Still in the development stage.</li> </ul>

The policies discussed above are recommended for coordinated implementation since many of them are mutually supportive of each other. Policy coordination greatly strengthens the chance for successful implementation, notably through reduced negative reactions from the private sector. From the viewpoint of the public sector, Category A: *Licensing and Regulation* is particularly attractive, and immediate results can be expected. However, undue regulation can elicit negative responses from the private sector. In addition, some policies, like the truck ban as implemented in Manila, evidently causes other negative impacts as transport operators are obligated to shift deliveries to night-time. Accident rates may increase due to drivers' disrupted sleep patterns and overloaded trucks, when operators try to maximize efficiency during restricted periods (Castro and Kuse, 2005).

In principle, consolidated delivery is the best way to achieve sustainable freight development by reducing freight trips and, hence, energy consumed. However, it is not easy to implement such a system practice. In addition to relatively high set up costs for freight centres, understanding and cooperation from the private sector are necessary. Multimodal freight facilities are also recommended to increase the use of other more environmentally friendly modes. A problem for most developing countries is that infrastructure is insufficiently developed for transport modes other than roads. Developing railways, inland waterways, and coastal transport systems concurrently with provision of facilities to support flexible multimodal systems is the most promising option. Transportation costs can also be reduced for long-distance deliveries since rail and water transports are often cheaper. The option of business group development, such as wholesale markets in Japan, is also a promising approach to sustainable freight transport development. Gathering wholesalers together in a dedicated facility strengthens the competitiveness of businesses. Moreover, shipments can be grouped together, resulting in reduced transport costs and emissions. If the facility is well planned and provides high quality transport services, the probability is that consolidated delivery of goods will increase.

Category C includes measures supporting the adoption of low-emission vehicles and alternative fuels. Several technologies have been developed for both passenger and commercial vehicles: low emission vehicles, such as hybrid vehicles and electric vehicles; and alternative fuels, such as CNG and low sulfur diesel. However, the main problem is that there are insufficient supply infrastructure facilities for these special vehicles. Hybrid vehicles have no problem because they consume gasoline, but, for electric or gas vehicles, supply facilities remain limited. This situation has caused many to drop the idea of using such new vehicles. Governments that promote low emission vehicles and alternative fuels need to invest more in supply facilities, as well as research on the new technologies.

Among the categories presented above, Category D (IT and driver training) is likely to achieve the most positive response from the private sector. Affordable technologies and driver training courses provided by the government can be very attractive. Companies gain benefits from using these technologies through improvements in their efficiency and reductions in costs, resulting in increased competitiveness. Citizens also gain benefits from these measures which make city traffic safer. Compared with the high set up costs for intelligent transportation systems (ITS), investment costs for online technologies and training courses are low. Investments on ITS systems benefit passenger and freight vehicles. Commercial vehicles enjoy benefits from reduced travel delays and from easier delivery scheduling. However, ITS systems are, clearly, not the way to reduce the share of road transport, which is an important goal of sustainable development.

The 'new freight system', that is, an underground freight transportation system, is an innovation as it completely separates freight transport away from passenger traffic. Negative impacts of freight transport operations, such as exhaust gas and accidents, can be significantly reduced, along with improvements in delivery times and in reliability. However, the choice of this type of system seems to be available only to wealthy countries.

The implementation of a combination of the policy measures is highly recommended. For example, regulation, such as low emission zones, combined with the provision of freight transshipment facilities is a good option. This combination provides choices for freight operators and opportunities for consolidated delivery. In addition to licensing and regulations, support from Governments in the adoption of new technologies, such as new engines and new fuels and service improvements, such as web-based technology and GPS navigation systems, is critical to their successful implementation as they are often expensive. Finally, it is essential that the private operators understand the benefits from sustainable development policies.

## CONCLUSION AND RECOMMENDATIONS

It is reasonable to assume that with further economic development the demand for freight transportation will continue to increase. However, policies that can reduce the total demand should be encouraged. These may include buying locally produced goods and carbon taxes. It is important to note that more efficient transport systems will not only reduce pollution for a given quantity of ton-kilometres transported, but they will also encourage a larger quantity of ton-kilometres to be transported. Hence, policies that lead to more efficient transport systems and that reduce demand for transport should be implemented in unison.

Policies discussed in this paper have different impacts on freight operators, the wider economy, and the environment. Governments must choose where their priorities lie. In order to achieve the best results, coordinated implementation of the policies is recommended. Many of the measures are mutually reinforcing and a balanced overall package of measures can increase cooperation from the private sector.

The key idea for sustainable freight transport is to use road transport only when it is necessary. Immediate changes can be expected through the development of freight centres concurrently with increasing the use of the more environmentally friendly modes. For the long distance deliveries, it is strongly recommended using the less polluting modes. However, appropriate infrastructure facilities are necessary to support flexible intermodal delivery systems. The development of multimodal freight facilities, such as GVZ in Germany and Interporto in Italy, is necessary to connect between rail and/or waterway to road transport to enter the urban areas. It is also important to increase the capacity of railways, waterways, and coastal shipping.

In urban areas, road transport seems to be the choice of transport operators due to its flexibility. The policies of urban freight centres and consolidated deliveries provide a way to reduce the number of truck trips entering into cities. However, it is not an easy task. Many urban freight centres and consolidation schemes have failed for various reasons. In many cases, the implementation of urban freight centres leads to increasing costs to the freight operators. Even for the City Logistik scheme in Kassel, Germany, which claims not to generate any extra costs to the participants, it has been reported that some companies have already left the scheme because of such extra costs. This experience demonstrates the need to give adequate attention to cost efficiency for operators in the implementation of consolidation schemes.

Licensing and regulation should be carried out concurrently with the implementation of urban freight centres and consolidation schemes. Implementation of pricing and regulation schemes with the introduction of freight centres and consolidation programmes can increase the opportunities for cooperation among freight operators. However, it does not always guarantee the best result. Implementation of strong regulatory measures without well planned freight centres may lead to undesirable effects.

Technology for improved efficiency, as well as consolidation schemes, can lead to a reduced number of freight vehicle trips in cities. Proper route planning and vehicle fleet management help to reduce unnecessary delivery trips. In addition, this approach is easier to promote among freight operators since the benefits of reduced costs can be clearly seen.

Supporting the development of low-emission vehicles and alternative fuels for freight vehicles obviously reduces the pollution in cities. Although the scheme itself cannot reduce the number of truck trips entering into the city, implementation of such measures together with pricing and regulation can achieve significant improvements in air quality.

The proposed underground freight transport system in some countries is very promising despite the huge investment required. The promotion of modal shift to increase the usage of rail and waterway may not work for several reasons, such as when, most trips are short distance deliveries and other modes are not attractive for freight operators.

Encouraging cooperation among private sector actors is suggested as well. The success of many European businesses comes from their cooperation: Consolidated delivery and sharing of technologies can reduce operation costs and at the same time decrease the environmental impact. In developing countries, similar cooperation should be encouraged. Incentives for shifting deliveries from shipper's own trucks to using services provided by freight forwarders are also recommended in order to increase the chance of consolidated deliveries. The public sector should also be ready to intervene to support the business of professional carriers in order to increase competitiveness in this field. Encouragement of the use of low-emission vehicles, service improvements, and organizing driver training appear to be the easiest measures to implement and are likely to be very well received by private sector operators. In addition, particular attention should also be given to aiding small and medium enterprises (SMEs) to acquire new technology, as their operations are often less efficient due to lower economies of scale. Considering the large number of SMEs operating in the transport sector in developing countries, significant improvements can be expected if sufficient attention is paid to their particular needs.

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# REDUCING EMISSIONS FROM ROAD FREIGHT: EXPERIENCE IN CHINA

Yan Peng\*

## ABSTRACT

*China has been trying to find effective ways to energy conservation and emission reduction for the past ten years, particularly during the 11<sup>th</sup> Five-Year Plan period (2005-2010). However, the freight sector, particularly the road freight, remains a major concern. The fragmented structure of this sector along with its mobile nature makes the management of the sector very challenging. With the rapid growth of road freight vehicles and the corresponding increase in road freight tonnage, this sector has become a major contributor to air pollutants and greenhouse gas emissions. The road freight sector now accounts for 35 per cent of the world's transport energy use, and heavy-duty diesel vehicles are the major fuel consumer in Asia. They, in turn, account for a proportionate share of air pollution and carbon dioxide (CO<sub>2</sub>) emissions.*

*To address the issues facing the road sector, China has undertaken various policy, legal, regulatory, and other measures including introducing pilot projects at different levels of the Government. The paper focuses on lessons learned from the Guangzhou Green Trucks Project, aiming to promote an alternative approach towards sustainable road freight transportation.*

## I. WHY FOCUSING ON ROAD FREIGHT?

### A. Road freight as economic sector

The efficient movement of goods and services is important in achieving sustainable development. All modes of freight – road, water, air, and rail – have impacts on the economy, environment and society and, thus, need to be managed. Before the advent of the internal combustion engine, most of the world's freight relied on shipping and heavy rail. However, with the advancement of the road transport technology and the rapid expansion of the road network, the road sector has become the dominant mode of freight transport in most countries of the world.

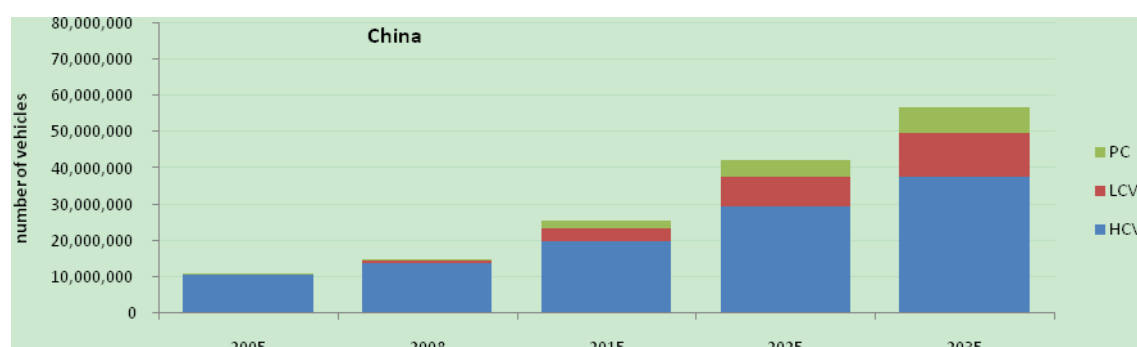
The increase in economic activity in China is expected to be accompanied by an increase in the number of vehicles on the road, volume of goods transported by road vehicles, and the share of the road freight in the freight sector.

The total number of diesel motor vehicles is expected to grow from around 10 million in 2005 to almost 60 million in 2035 (figure 1). Diesel trucks, buses and vans, including light and heavy commercial vehicles will continue to constitute the dominant share of the road vehicle population.

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**Figure 1. Expected growth in diesel motor vehicles in China 2005 – 2035**

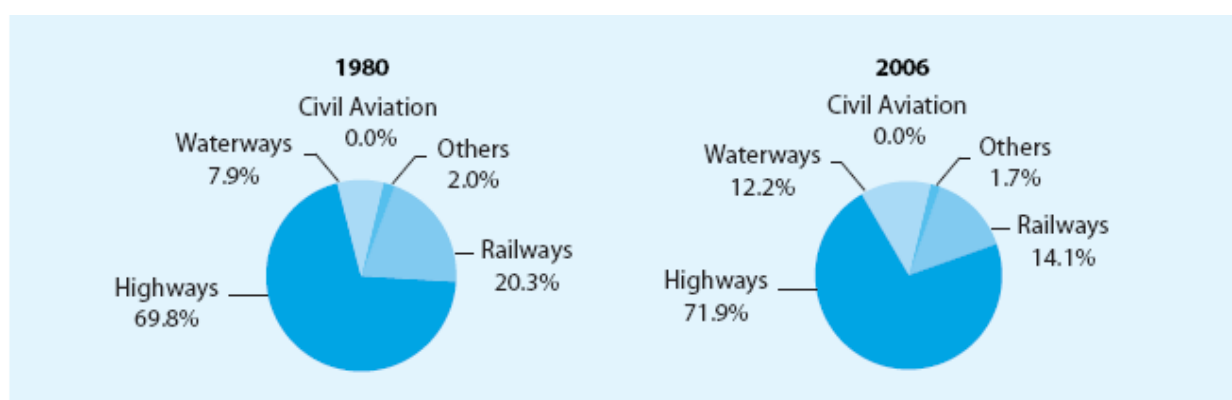


Source: Fabian and others (2011)

Notes: PC = personal cars; LCV = light commercial vehicles; HCV = heavy commercial vehicles

Similar to China, trucks also dominate the freight sector in many Asian countries even though the infrastructure for other freight modes is developed.

**Figure 2. Freight transport mode per cent share in 1980 and 2006 in China**

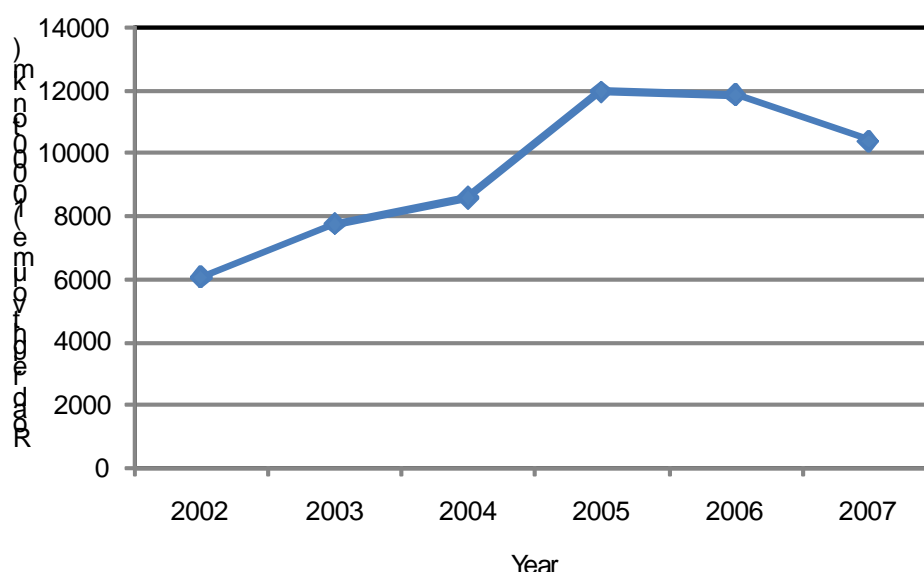


Source: ADB (2008).

Figure 2 shows that in 2006, the vast majority of freight in China, nearly 72 per cent, was transported by road; and the percentage has remained relatively stable since 1980. The share of railway has decreased from 20 per cent to 14 per cent over the same period. According to the Guangdong provincial transport plans, 220 billion yuan was budgeted for the construction of an expressway network in the province (Zhan, 2009). By 2012, the region will have 3,000 km of expressways. With further expansion of the road network, the road freight will continue to hold on to its dominant position in the freight sector.

Figure 3 shows that road freight volumes have increased from approximately 60 million ton-km in 2002 to over 100 million ton-km in 2007, representing a 67 per cent increase.

**Figure 3. Road freight transport volume in Guangzhou**



Source: Guangzhou Bureau of Statistics (2008) *Guangzhou Statistical Yearbook*.

Notes: Freight volume is expressed in ton-km which is the number of tons carried multiplied by the distance travelled.

Table 1 shows the distribution of commodities carried by road transport in Guangzhou from 2002 to 2007. Total freight tonnage by trucks registered in Guangzhou grew from 1.47 million tons in 2002 to 2.16 million tons in 2007, representing a 47 per cent increase. As truck numbers in Guangzhou increased by only 12 per cent, this may suggest that either trucks registered outside Guangzhou have largely contributed to the increase in truck numbers or it may also indicate higher volumes of freight transported. Currently available data does not show a further breakdown of “other” category of economic use, although this is the largest category.

The table also shows that at least one-third of the freight by weight, transported by trucks, represents non-perishable goods. Further analysis will determine the characteristics of the remaining two-thirds of the goods. When the freight is in a perishable category, it should be able to reach its destination fast, which limits the ability for redesigning routes and freight logistics.

**Table 1. Freight transport by trucks in Guangzhou (in 10,000 tons)**

Commodity/Year	2002	2003	2004	2005	2006	2007
Petroleum, natural gas and their products	3.33	6.84	6.93	6.80	4.00	5.90
Iron and steel	1.93	2.39	3.11	14.37	17.00	19.20
Mineral construction materials	0.14	0.30	0.55	0.30	0.28	0.28
Cement	0.58	1.40	1.42	3.98	7.00	7.23
Timber	0.08	0.33	0.39	0.52	0.32	0.28
Machinery	19.90	27.70	20.23	34.76	42.00	35.20
Chemical materials and products	1.11	1.43	2.27	6.99	1.00	1.58
Non-ferrous metals	--	0.75	0.28	0.35	0.21	0.17
Light industrial and medical	10.07	32.97	34.30	3.78	2.00	0.11

Commodity/Year	2002	2003	2004	2005	2006	2007
products						
Daily necessities	--	32.97	25.49	1.63	1.50	7.25
Others	109.55	161.93	228.57	154.20	144.05	139.25
TOTAL	146.69	269.01	323.54	227.68	219.36	216.45

Data on overloading of freight trucks, which is a major issue in China, and percentages of empty hauls on the road are not available, but may be obtained as part of a survey on truck drivers and companies.

## **B. Road freight transport as an increasing fuel user and a key emission source**

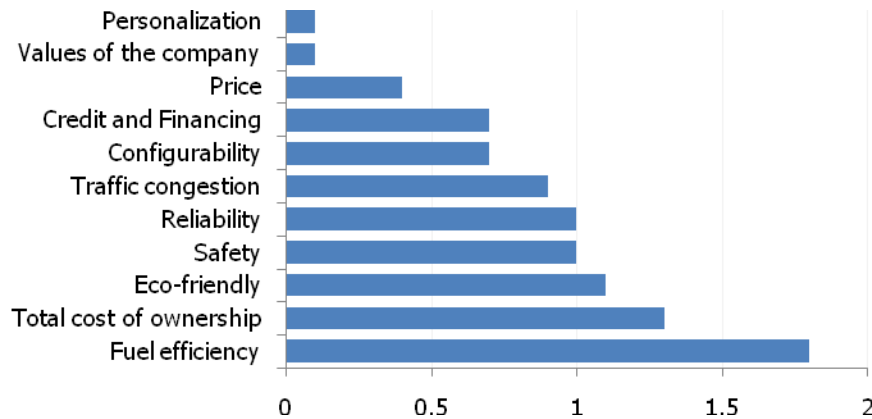
### ***Fuel consumption***

A more energy efficient road freight sector would favour not only the environment, but also road freight companies. Fuel costs represent a major component of the operating costs of trucking companies. For example, in Guangzhou, China, interviews with operators reveal that fuel costs represent 40-50 per cent of their operational costs (CAI-Asia Center, 2010a).

The risks brought about by imported fuel dependency can be seen in China. The 10 million trucks on Chinese roads, which represent more than a quarter of all vehicles in China, are the major consumer of oil. The total energy consumption by both passenger and freight transport in China accounted for 5.34 per cent of the total world production in 2005 and will account for 9.9 per cent in 2035 according to the estimates by the World Business Council on Sustainable Development (WBCSD) and the International Energy Agency (IEA) (2004). With international crude prices fluctuating from as low as US\$ 40 to as high as US\$ 140 a barrel in 2008, economists still expect that in the long term fuel prices will continue to increase (BAQ, 2008). The policy of subsidies on diesel for socio-economic reasons has resulted in a surge in diesel truck sales in China (in 2008 the sales were nearly twice as high as those in the United States of America) and, subsequently, diesel supplies could not keep up with the demand for diesel at service stations, causing rationing and shortages (Shen and Bai, 2008).

Fuel efficiency is becoming more and more important with the anticipated decrease in the global oil production in the future. As shown on figure 4, fuel efficiency was identified as the most important criteria in buying trucks in 2020 in a survey done by IBM with executives from organizations within the entire global truck value chain (Risbi and others, 2008).

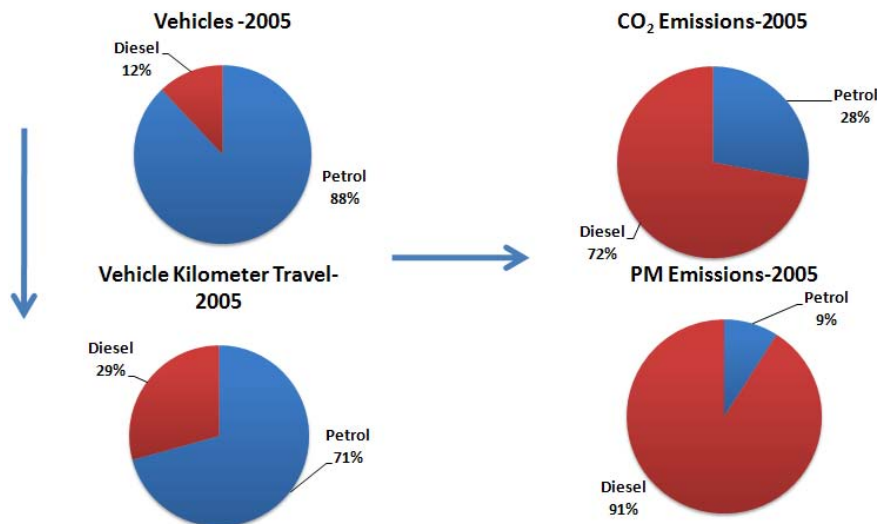
**Figure 4. Change in vehicle buying criteria importance from 2008 to 2020**



Source: IBM Institute for Business Value (2009)

## Emissions

**Figure 5. Trucks relatively high emissions impact in China**



Source: Fabian (2010)

## Air pollutants

A major problem caused by road freight is air pollution, which in many developing countries in Asia, including China, is usually considered a worse problem than greenhouse gas (GHG) emissions. The consumption of fossil fuels results in emission of air pollutants such as particulate matter (PM), nitrogen oxides (NOx), carbon monoxide (CO), volatile organic compounds (VOCs), lead particles (Pb) and sulphur oxides (SOx).

The health impacts of diesel trucks have been identified through a number of studies and are summarized in box 1. The health effects from these pollutants vary in severity and symptoms. According to the World Health Organization, 800,000 people die prematurely each year because of air pollution, with more than half a million coming from Asia (Cohen, 2003). Air pollution has replaced cigarette smoking as the first cause of lung cancer in Guangzhou. In the recent decade the number of lung cancer cases has doubled.<sup>1</sup> In Hong

<sup>1</sup> [http://www.lifeofguangzhou.com/node\\_10/node\\_37/node\\_85/2008/09/28/122258050352278.shtml](http://www.lifeofguangzhou.com/node_10/node_37/node_85/2008/09/28/122258050352278.shtml)

Kong, China, approximately 1,600 people died each year as a result of air pollution, mostly from heart attacks, stroke, pneumonia, and other lung diseases.<sup>2</sup>

Vehicle emissions also result in the formation of secondary pollutants, which are not directly emitted at the tailpipe but are developed through the reactions of different components in the air. One such example is ground level ozone or photochemical smog, which is formed from NO<sub>x</sub> and VOCs. Ground level ozone can result in acute health impacts on the elderly and people with weak lungs. NO<sub>x</sub>, SO<sub>x</sub> and VOCs emissions can lead to formation of PM<sub>2.5</sub> which are fine particles with diameters of 2.5 micrometres or smaller. They pose greater risks to human health as compared to larger particles because they can be lodged deeper into the lungs and can even penetrate the blood stream.

### **Box 1. Health impacts of diesel emissions**

The results of studies, measuring exposure to diesel emissions coming from older and newer engines, indicate impacts on the respiratory, reproductive, and cardiovascular systems. Extrapolation of these findings to people exposed to much lower concentrations of diesel emission components than those used in experimental studies or in epidemiologic studies of occupationally exposed workers can be challenging.

Despite these challenges, many agencies have determined that diesel emissions are of sufficient concern to merit action to reduce emissions. New diesel engines with control systems meeting 2007 emission standards for heavy-duty highway vehicles are now on the market. A detailed report on emissions characteristics coming from four of such engines will be presented in the Advanced Collaborative Emissions Study (ACES), which is a joint effort of the Coordinating Research Council and the Health Effects Institute (HEI); chronic and acute health endpoints will be assessed for one of the engines. Although durable older engines with higher emissions level will continue to be used, these new engines, and those designed to meet the more stringent 2010 standards, will gradually become more common, with substantial replacement expected by 2030.

*Source: HEI Air Toxics Review Panel (2007).*

### **Greenhouse gases and black carbon pollution**

Road freight is also contributing to the growing problem of climate change. GHG emissions are rapidly rising in Asia, particularly in major cities. The Kyoto Protocol covers six main greenhouse gases.<sup>3</sup> Air pollution and greenhouse gas emissions have similar causes, mostly energy-related, and there is an increased evidence that their effects are interacting.<sup>4</sup> The strongest evidence points to black carbon, the carbonaceous component of soot (particulate matter) that is produced mostly by burning of biomass, diesel and coal. In addition to its contribution to air pollution, black carbon is a dominant absorber of solar energy. Recent scientific studies suggest that black carbon is the second largest contributor to global warming following CO<sub>2</sub> (Ramanathan and others, 2007). The transport sector has been identified in a recent study of the United States Agency for International Development (2010) as the third largest source of energy-related black carbon emissions in Asia. On-road diesel consumption accounts for the majority in black carbon emissions within the transport sector in Asia where many countries have moved towards being more dependent on diesel.

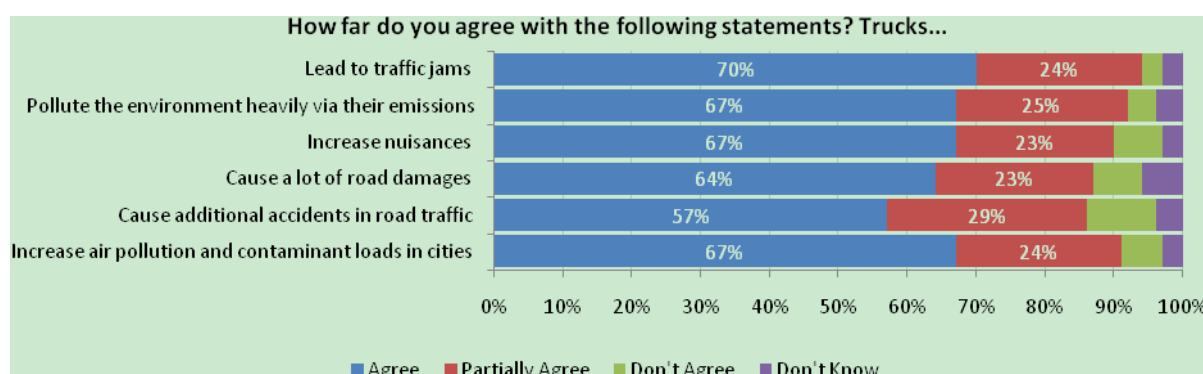
<sup>2</sup> [http://www.redorbit.com/news/science/533045/pollution\\_costs\\_hong\\_kong\\_1600\\_lives\\_2bn\\_dollars\\_annually/index.html](http://www.redorbit.com/news/science/533045/pollution_costs_hong_kong_1600_lives_2bn_dollars_annually/index.html)

<sup>3</sup> Carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>), nitrous oxide (N<sub>2</sub>O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF<sub>6</sub>)

<sup>4</sup> Nitrogen oxides (NO<sub>x</sub>), sulphur oxides (SO<sub>x</sub>), carbon monoxide (CO), particulate matter (PM), volatile organic compounds (VOCs)

The IEA estimates that the transport sector accounted for 23 per cent of the world's carbon dioxide (CO<sub>2</sub>) emissions and 13 per cent of global GHGs<sup>5</sup>. Although the share of the CO<sub>2</sub> emissions attributable to transport sector of developing countries is currently low, it is expected to increase by 45.6 per cent between 2005 and 2030. Unlike traditional air pollutants that can be monitored at the "tail-pipe," CO<sub>2</sub> emissions cannot be controlled that way and must be regulated by reducing fuel consumption.

**Figure 6. Perception on the impacts of trucks on different issues**



Source: Price Waterhouse Coopers (2008).

## II. WAYS TO ADDRESSING THE PROBLEM

### A. Existing measures

In China, key plans and laws are first developed at the national level and then employed at the provincial and local levels through provincial and local plans and policies. The most relevant ones are:

- Transport. 11<sup>th</sup> Five-year Plan for the Transport Sector (2006-2010) and various regulations on road transportation, including road freight transport;
- Energy. Energy Conservation Law. Fuel efficiency standards for commercial freight vehicles;
- Environment. Environmental Protection Law. Air Pollution Prevention and Control Law; Emission standards and policies relevant to diesel vehicles;
- Implementation Guidelines of the Law on Road Traffic Safety Law, effective 1 May 2004.

Table 2 below presents the key policies and laws relevant to road freight sector.

**Table 2. Plans, policies and laws/regulations relevant to the Guangzhou Green Trucks Pilot Project**

Policy/legislation	Level	Description	Relevance to the project
<b>TRANSPORT</b>			
The 11th Five Year Plan for the transport sector	National	<ul style="list-style-type: none"> <li>Aims to establish a highway transportation network. Trucks are projected to reach 7 million in</li> </ul>	

<sup>5</sup> 2006 estimates

Policy/legislation	Level	Description	Relevance to the project
		2010 with the shares of heavy-duty trucks, special vehicles, and vans trucks reaching 30 per cent, 30 per cent and 20 per cent respectively. ( <a href="http://www.moc.gov.cn/2006/06tongjisj/06jiaotonggh/shiyiwuguihuaajd/guihuaajd/200611/t20061107_115042.html">www.moc.gov.cn/2006/06tongjisj/06jiaotonggh/shiyiwuguihuaajd/guihuaajd/200611/t20061107_115042.html</a> )	
China Regulation on road transport	National	<ul style="list-style-type: none"> <li>Defines principles and management methodologies on road transport in China</li> </ul>	Core regulation for Guangzhou freight transport
Management Regulation on Road Transportation of Guangzhou province (2002 amendment)	Provincial	<ul style="list-style-type: none"> <li>Defines road transport management in Guangzhou including freight transport, passenger transport, transfer, loading and unloading, service and maintenance of motor bikes</li> </ul>	Local and direct management regulation on the freight transport for Guangzhou trucks
Regulations of road administrative control	National	<ul style="list-style-type: none"> <li>Defines the principle of road administrative control and the duties of road administrative control organizations</li> </ul>	Main law for road management
State Council Circular: Decision on the Revision to Protocol of Road Management, 1 January 2009	National	<ul style="list-style-type: none"> <li>Road construction can be financed nationally and locally through designated investment companies, co-financing with international organizations, public funding, loans, and Vehicle Procurement Tax.</li> <li>Charges can be introduced at main ports, bridges, Tunnels and toll gates on major roads with the purpose of repaying loans. Approval is required from the provincial government.</li> <li>Charge rates should be approved by financial and pricing agencies.</li> <li>Roads are classified as national, provincial or local roads. Provincial Department of Communications (DOC) is responsible for the construction, maintenance and management of the first two types of roads, while the local Bureau of Communications (BOC) takes care of the local roads.</li> </ul>	Mandates of BOC/DOC on road transport; Linking the mandates on road construction and toll gate fees with incentives to reduce truck emission

Policy/legislation	Level	Description	Relevance to the project
Decision on the Revision of Management Regulation on Road Freight Transportation and Stations by Minister of Communications, July 2008	National	<ul style="list-style-type: none"> <li>Defines that DOC/BOC takes responsibilities for truck fleets and stations business permit and management</li> <li>Regulates approval procedures</li> <li>Defines the responsibilities of the business enterprises on transport or stations</li> <li>Specifies the technical standards applied to trucks</li> </ul>	Very important document as it identifies the full range of stakeholders: BOC/DOC, Business owners of truck stations, owners of truck fleet, management fees, set of of transportation rules, driving behavior, overloading, poor maintenance are also specified.
<b>ENERGY</b>			
Implementation Methods on Energy Conservation Law in Land and Water Transportation Sector, issued by the Ministry of Communications	National	<ul style="list-style-type: none"> <li>Defines the energy saving responsibilities of the Ministry of Communications (transport), the Provincial Department of Communications (transport), and the Municipal Bureau of Communications (transport). Define administrative management framework for energy saving in transport sector. Define responsibility to publish recommended technology for transport vehicles, etc.</li> </ul>	Energy conservation is the key mandate of the Bureau of Communications. Shall have incentives to explore energy saving technologies and strategies
Fuel Efficiency Standards for Commercial Freight Vehicles issued by MOC in June 2008	National	<ul style="list-style-type: none"> <li>Stipulates standards for fuel efficiency</li> </ul>	The standard impacts cost of truck freight transport, especially trucks using diesel fuel.
Trial Management Provisions on Qualifications of Freight Transportation Enterprises by Ministry of Communications, 2001	National	Classification of freight transportation enterprises, differentiated by the levels of approval and scope of work. MOC, DOC and BOC are the main approval and administration agencies. Annual review requirements for transportation enterprises	Fleet classification affecting the stability of economic output of the truck industry. Fleet selection for pilot projects.
<b>ENVIRONMENT</b>			
Law of China on environmental	National	<ul style="list-style-type: none"> <li>Main/general law on environmental protection in</li> </ul>	One of the guild laws for vehicles

Policy/legislation	Level	Description	Relevance to the project
protection		China. Defines environmental protection and improvement and stimulates management methodology for environmental protection and monitoring, as well as legal responsibilities	management
Law of China on air pollution prevention and control	National	<ul style="list-style-type: none"> <li>Defines air quality standards and air pollution levels, including for the vehicle management</li> </ul>	One of the guild laws for vehicles management
Limits and measurements for exhaust fumes from compression ignition and gas fuelled positive ignition engines of vehicles(III, IV, V) (GB 17691-2005)	National	<ul style="list-style-type: none"> <li>Light-duty gasoline vehicles and M-types light diesel vehicles need to accord with Grade III Emission standard as of 1 July 2008.</li> <li>New gasoline vehicles with compression ignition engines should add OBD system as of 1 July 2008.</li> <li>M-type light diesel vehicles need to accord with Grade III Standard in main cities.</li> <li>Vehicle producers have to conform to environmental protection standards.</li> </ul>	The regulation specifies the country's emission standard requirements for trucks
Management methods of vehicles emission monitoring	National	<ul style="list-style-type: none"> <li>Early policy and measures for vehicle emission control and management, show manage measures for the new cars, in-use cars and engines.</li> </ul>	Early policy for vehicles in China, updated by the Air Pollution Prevention and Control Law
Technology and policy on pollution prevention and control for diesel vehicles	National	<ul style="list-style-type: none"> <li>Technology and policy to reduce pollution and control emissions in diesel vehicles, car-use diesel productions and diesel fuel</li> </ul>	Technology and policy specific to diesel vehicles
Technology and policy on pollution prevention and control for vehicles	National	<ul style="list-style-type: none"> <li>Technology and policy for vehicles, including diesel vehicles, motorbikes and car-use engine production to reduce pollution and control emissions</li> </ul>	Technology and policy for vehicles including diesel and gasoline vehicles
Method for an estimation of air pollution coming from vehicular transport in urban areas	National	<ul style="list-style-type: none"> <li>Stipulates the method for vehicular emission estimation as an industrial standard in urban areas</li> </ul>	Relevant in measuring the pollution level coming from trucks and its health implications

An in-depth study, financed by the Asian Development Bank (ADB) and implemented by the Ministry of Transport (MOT) of China, discussed many aspects of 'green transport' (Green or sustainable transport is a transport system that leaves a smaller physical footprint, uses less energy and produces less CO<sub>2</sub> and other harmful pollutants). The study provided a detailed analysis of the freight sector and offered some conclusions (ADB, 2008).

**Table 3. Policies relevant to freight sector mentioned in the ADB study**

Chinese legislation and regulations in relevance to GHG emissions	Effectiveness level	Year of release*	Year of implementation
<b>China laws related to climate change</b>			
Environmental Impact Assessment Law of China	Law	28-Oct-02	1-Sep-03
Environmental Protection Law of China	Law		
Energy Conservation Law of China	Law	28-Oct-07	1-Apr-08
<b>China transport legislation related to emissions and energy consumption</b>			
Road Transport Regulation of China	Regulation	30-Apr-04	1-Jul-04
Management of Toll Roads Regulation	Regulation	13-Sep-04	1-Nov-04
Provisions for the Administration on Training Motor Vehicle Drivers	Act	12-Jan-06	1-Apr-06
Policy on Automobile Manufacturing Industry	Policy	1994	1-Jun-94
Suggestion on Application of Smooth Traffic Project to China Urban Road and Transport Management (MoPS & MoCon)	N/A	N/A	N/A
Regulation Publication on Energy-Saving Products for auto and vessel fleets	Regulation	20-Mar-92	1-Jun-92
Popularization and Application of Energy-Saving Products (Technologies) for car and vessel fleets	Act	14-Aug-95	15-Oct-95
Transport Industry Directive on the Implementation of Energy Conservation Law	Act	16-Jun-00	16-Jun-00
<b>China transport policy measures related to emissions and energy consumption</b>			
"fee-to-tax" (fuel tax in China)	-	-	-
Congestion toll	-	-	-
Parking fee	-	-	-

*Note:* In China, "laws" are issued by The National People's Congress of China; "regulations" are issued by the Central People's Government of China; different "Acts" are issued by different ministries and departments of China.

The above acts are mainly issued by the Ministry of Transport (MOT) and other transport related authorities, while some are co-issued by MOT and State Environmental Protection Administration of China, National Bureau of Statistics of China, etc.

\* "year of release" refers to the last revision.

Source: ADB (2008)

## **B. Barriers and policy gaps**

The section provides an overview of issues, including policies and institutional arrangements, freight sector challenges and the availability of technologies and financing mechanisms that should be addressed to make the road freight industry more sustainable.

### ***Policies and institutional arrangements***

Most countries have adopted policies on trade facilitation and infrastructure development (e.g., improvement of ports and airports) to improve freight and cargo movement between countries and/or regions. However, policies dealing with the environmental performance of trucks and the trucking industry are often lacking or limited.

Many countries set heavy-duty vehicle emission standards but often have trouble enforcing them. Policies for light-duty vehicles usually are introduced first and the standards for heavy-duty vehicles often follow years later. This applies to vehicle emission standards, fuel economy standards and most other environmental-related policies. In China, the government introduced light-duty vehicle fuel economy standards in 2005, while the government fuel economy standards for heavy-duty vehicles were introduced only in 2010.

Furthermore, freight is seldom included in the design and planning of urban transport systems and policy development. As a result, ad hoc solutions are created to mitigate problems, associated with urban freight transport, as they arise. Some of the main issues are lack of dedicated trucking routes, limited parking facilities for loading/unloading of goods inside cities, and fragmented logistics centres.<sup>6</sup>

The number of government agencies that truck operators and drivers in China need to deal with adds more complexity to the sector.

### ***Freight sector challenges***

The road freight sector is highly fragmented with a majority owner-driver trucks. A survey carried out at logistics centres in Guangzhou, China, found that of the surveyed drivers, 48 per cent worked for truck companies and 52 per cent owned the truck they were driving. In Guangzhou, almost 80 per cent of the surveyed drivers, working for truck companies, were registered outside of Guangdong Province, which made it more difficult for governments to control or reach out to them. Multiple logistics centres, existing around many Asian cities, limit the coordination of trucking operations. Furthermore, shippers seem to have a less direct relationship with carriers than shippers in the United States, because they have contracts with the factories that they purchase goods from. These factories arrange for the transport of goods to ports or storage areas through logistics firms that hire small companies and individual drivers to carry the load. Environmentally and socially responsible companies will find it harder to reduce fuel consumption and emissions coming from the road transport in their supply chain.

The highly fragmented nature of trucking industry without strong government regulations makes it difficult to promote the use of newer vehicles and the adoption of better technologies (e.g., aerodynamic skirts, which can reduce fuel consumption).

The fragmented nature of the trucking industry is one of the main reasons for the high percentage of trucks on empty hauls. A Chinese study found that around 50 per cent of

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<sup>6</sup> <http://transport-solutions.blogspot.com/2010/08/urban-freight-victim-of-policy-neglect.html>

truck trips were empty hauls (Guo and others, undated). These empty trips result to an annual estimated losses of US\$ 8 billion.

For comparison, in the Philippines 89 per cent of delivery vehicles were found empty in their return trip.<sup>7</sup>

Another common problem in the Asian developing Asia countries is overloading of trucks. A study done in Anhui province of China found that vehicle overloading was widespread and a serious problem on the arterial highways of the province (Ying, 2008). The traffic load greatly exceeded the standard bearing capacity of the road pavement causing premature damage. The study also found that the mean gross vehicle weight of the load trucks went over the limits, which indicated that many of the trucks were overloaded.

### ***Technologies and financing***

The adoption of cleaner technologies is a key to addressing different impacts on the road freight sector, particularly in Asia, where many developing countries have poorly maintained and/or old truck fleets.

Table 4 presents the average reduction potential of different technologies. Long-range trucks have the greatest potential for fuel saving and GHG emissions reduction through technology applications.

**Table 4. Fuel consumption reduction potential of different heavy-duty vehicle technologies<sup>8</sup>**

Technology	Fuel reduction potential (per cent)
Aerodynamics	3 to 15
Auxiliary loads	1 to 2.5
Rolling resistance	4.5 to 9
Mass (weight) reduction	2 to 5
Idle reduction	5 to 9
Intelligent vehicle <sup>9</sup>	8 to 15

Table 5 presents the estimated potential for reduction of fuel consumption from tyre and aerodynamics technologies for the 1.23 million trucks registered in Guangdong Province of China in 2007.

**Table 5. Fuel and emissions reduction potential from tyre and aerodynamics technologies for trucks registered in Guangdong Province<sup>10</sup>**

Parameter	Total	Remarks
<b>Total number of trucks registered in Guangdong Province</b>	1,230,000	67.2 per cent heavy-duty (or 826,520), 19.8 per cent medium-duty (or 243,540) and 13.0 per cent light-duty (or 159,900) trucks, based on the ratios found in the truck industry survey.
<b>Total investment</b>	12,137,461,109	Tyre technologies, reducing rolling resistance,

<sup>7</sup> Garsuta, Rebecca (1995)

<sup>8</sup> Transportation Research Board (2010).

<sup>9</sup> Intelligent vehicles include information about the state of the vehicle, the environment around the vehicle, and Global Positioning System (technology with computers and mobile communications technologies in order to achieve fuel consumption reduction).

<sup>10</sup> CAI-Asia Center (2010b).

Parameter	Total	Remarks
<b>costs (tyres and aerodynamics) (in US dollars)</b>		included aluminum wheels (heavy duty trucks), low rolling resistance tyres and tyre pressure monitoring system. Aerodynamics equipment package, reducing air resistance and drag, and included a nosecone, cabin fairing, and trailer skirts.
<b>Total fuel savings (litres/year)</b>	3,962,456,995	Fuel savings for the tyre package are assumed at 5 per cent and for the aerodynamics package at 3-7 per cent compared to the United States' experience of 6-8 per cent and 10-13 per cent respectively.
<b>Total fuel cost savings (\$/year)</b>	3,586,066,990	At diesel price \$ of 0.9 per litre
<b>Total CO<sub>2</sub> savings (tons/year)</b>	10,233,591	CO <sub>2</sub> = 2.582 kg CO <sub>2</sub> /litre
<b>Total NOx savings (kg/year)</b>	37,009,348	NOx = 9.34 g/litre
<b>Total PM savings (kg/ year)</b>	1,584,983	PM10 = 0.40 g/litre
<b>Payback period (in years)</b>	3.38	

Challenges to the wide-spread adoption of technologies by the road freight sector in China are the following:

- The availability of technologies in Asia is much lower than in the United States or Europe. A fragmented technology suppliers' network adds to the problem.
- High speeds requirement for the aerodynamic technologies to work properly could not always be achieved. This is partly caused by traffic congestion and poor conditions of highways. Another factor, contributing to low speed, is long-haul trucks delivering in urban areas rather than transferring their loads to smaller trucks when entering urban areas. All this lead to slow urban traffic.
- Limited case studies contain several examples that could help Asia build confidence in using technologies.

Financing green technologies will represent a challenge for China for the following reasons:<sup>11</sup>

- Limited tax policies exist for the road freight sector relevant to energy and emissions management and minimal experience of policymakers in applying economic instruments to the trucking sector.
- Initial investment costs are too high for many companies, even if potential savings are large and the payback period is short. High investment costs could be explained by small number of technologies suppliers and low technologies production and sales rates. Furthermore, the tariffs for imported truck equipment exceed 110 per cent.

<sup>11</sup> CAI-Asia Center (2010c)

- The trucking industry is not considered a reliable sector for lending, especially to small companies and individual truck driver owners.
- ESCOs (energy service companies), successfully operating in the industrial sector, have no experience working with trucking fleets.
- The local financial community lacks knowledge and tools required for new technologies financial appraisal. This has, so far, prevented the introduction of innovative financial mechanisms, such as revolving funds.

A specific challenge applies to using diesel particulate filters (DPF). Many Asian countries have high sulfur diesel fuel unacceptable for the use with DPFs. Though poor maintenance practices will impact most technologies to some degree, they are especially damaging for retrofitted DPFs, because without proper maintenance they risk getting blocked. On top of that, DPFs cost of several thousand dollars does not result in fuel savings enough to help recover such cost, unlike with many other technologies. For this reason, DPFs should either be mandated or included in a technology package that, as a whole, generates net savings.

### **III. GREEN FREIGHT STRATEGY**

#### **A. Description of the Guangzhou Green Trucks Pilot Project**

The World Bank (WB) initiated a pilot project entitled “Guangzhou Green Trucks Pilot Project” in support of Guangzhou’s efforts to improve air quality in preparation for the 2010 Asian Games. The goal of the project was to develop a “proof of concept” for a truck programme in Guangdong Province, and possibly in China that aimed at:

- Enhancing the fuel economy of the truck fleet
- Reducing black carbon and other air pollution coming from trucks
- Consequently, ensuring GHG emission reduction

The project was implemented by the Clean Air Initiative for Asian Cities Center (CAI-Asia Center), in cooperation with Cascade Sierra Solutions, the United States Environment Protection Agency (EPA) and the World Bank and the support of Guangzhou Environmental Protection Bureau (GEPB), Guangzhou Transport Committee (GTC), and Guangzhou Project Management Office (PMO) for the World Bank.

The pilot project aimed at addressing three problems, related to truck fleet in Guangzhou and the wider Guangdong province: fuel costs and security; air pollution and associated health impacts; and greenhouse gas emissions and climate change.

The project covered Guangdong Province, focusing on diesel trucks accessing or passing through the city of Guangzhou and the surrounding cities, such as Shenzhen. Besides dealing with GHG emissions, the scope of project included black carbon and other air pollution from trucks because of their potential hazardous interacting effects and the contribution to climate change, and, also, because air pollution is an important local concern.

The pilot project consisted of the following components: background analysis; survey on Guangzhou truck sector; driver training course for fuel efficiency of trucks; and technology pilot.

The purpose of the technology pilot was to demonstrate that technologies used in the United States and other Western countries can also work in China, to identify factors of influence for China and to determine the potential for fuel and emissions reductions for Guangdong Province under a future programme. The pilot results are promising but a larger

pilot is needed to confirm savings potential. For this reason the results from the technology pilot should be considered as indicative only and must be verified under a larger pilot.

The technology pilot component of the project tested:

- Tyre equipment package to reduce the weight and rolling resistance of the tyres consisting of aluminum wheels (heavy-duty trucks (HDTs) only), low rolling resistance tyres and a tyre pressure monitoring system
- Aerodynamics equipment package to reduce air resistance and drag consisting of a nosecone, cabin fairing, and trailer skirts

### **Summary of results**

Three companies participated in the pilot: Star of the City Logistics (SOCL), Xinbang Logistics (XWBL), and Baiyun District Guangzhou. At SOCL, tyre and aerodynamics equipment were tested on two long-haul HDTs. Investment costs were US\$ 16,333 and the estimated annual savings amounted to 3,557 litres of diesel (6.64 per cent), 9.18 tons of CO<sub>2</sub>, 33.21 kg NO<sub>x</sub>, and 1.41 kg PM<sub>10</sub>. The project has a payback period of 5.1 years. The lower than expected fuel savings could be explained by the slower (50-60 km/h) average speed of pilot trucks, influenced by heavy loads, poor weather conditions, such as frequent fog, highway construction and traffic congestion,, while the highest benefits from aerodynamics equipment were achieved at a speed above 75 km/hr. If the equipment packages were installed on the entire long-haul fleet of SOCL, consisting of 30 HDTs, then, based on the pilot results, the initial investment of US\$ 489,996 could have resulted in 106,704 litres of fuel savings, which is the equivalent to US\$ 96,033. The payback period would have been five years. Emissions reductions would have comprised 276 tons CO<sub>2</sub>, 996 kg NO<sub>x</sub> and 42 kg PM<sub>10</sub> per year. It is important to note that SOCL is considering purchasing several equipment packages for its fleet, and is most confident about nosecones, cabin fairings, aluminum wheels and low rolling resistance tyres.

A shorter payback period could be achieved if:

- Equipment was factory-installed on trucks.
- Equipment was purchased wholesale (current costs are based on retail prices for equipment purchased for the Guangzhou pilot project).
- The longer life time of LRR tyres compared to existing tyres would be considered for the HDTs of SOCL as this would lower the LRR tyre investment costs over the time period.

### **B. Lessons learned from the Guangzhou project**

Conclusions and recommendations are presented in three groups:

- Technology pilot and potential for the trucking sector
- Need for a nation-wide programme sector to improve fuel efficiency and reduce emissions from diesel trucks
- Considerations for the design of a Green Freight China programme

A Green Freight China programme may be designed with the lessons learned from the Guangzhou pilot project.

## ***Lessons learned from the technologies tested***

A general conclusion is that technologies used in the United States may not always be suitable for China. Based on the technologies tested, the following lessons can be drawn for future consideration in future pilots and a broader programme:

- Tyre quality is a key issue in fuel efficiency gains and emissions reductions. Low rolling resistance (LRR) tyres ease the rolling resistance on the road and thus reduce fuel use. Single wide LRR tyres would have provided the largest savings but could not be tested due to legislation in China barring all changes to the truck structure. Dual LRR tyres appear to generate enough savings to be economically feasible, especially due to the longer life span compared to normal tyres. The improved stability of tested garbage trucks with the LRR tyres contributed to the larger savings. Even improving the quality of conventional tyres used on trucks could result in significant savings. Aluminum wheels could be considered as part of the tyre package especially if they are factory installed, replacing existing steel wheels. The first Chinese SmartWay tyre, Double Coin Holding, is a very important step in for developing SmartWay technologies developed and distributed in China.<sup>12</sup>
- Tyre pressure monitoring systems have a good potential to reduce fuel and emissions, but depend on proper installation of the system and instruction of the drivers on how to operate them.
- Nosecones and cabin fairings were considered successful technologies because of reasonable savings, even at lower speeds, and relatively low investment costs. For this reason SOCL decided to install these equipments on the entire long-haul fleet.
- Trailer skirts, aimed to reduce drag, were less successful because the long-haul trucks did not reach average speeds of 75 km/hr when fuel savings became significant. At lower speeds, the added weight of trailer skirts offsets the fuel savings from reduced drag. High average speeds may be more difficult to reach in China than in the United States because of speed limits, traffic congestion, weather conditions and road quality. The weight of truck loads also plays an important role, as overloading of trucks is common and renders driving at high speeds unsafe. The pilot also found that a wide range of truck load is not always measurable because customers often pay per freight volume or units transported.

A future pilot project should have a stronger focus on domestic trucks, such as DongFeng, HOWO, STEYR. These trucks manufacturers could be involved in a pilot by installing selected technologies while trucks are being assembled, thus providing financial support for the pilot project in return for the use of the pilot results to promote their trucks. Global engine manufactures that have agreements with Chinese engine manufacturers could also be asked to financially support pilot projects to test new technologies, e.g. Jianghuai Automobile Co. Ltd. (JAC) and Navistar.<sup>13</sup> Available technologies and strategies for improved fuel efficiency and reduced emissions from trucks are shown in box 2.

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<sup>12</sup> <http://fleetowner.com/green/archive/china-made-first-smartway-0322/>

[http://www.tirereview.com/Article/72045/epa\\_smatway\\_adds\\_first\\_chinese\\_tire.aspx](http://www.tirereview.com/Article/72045/epa_smatway_adds_first_chinese_tire.aspx)

<sup>13</sup> [http://fleetowner.com/trucking\\_around\\_world/archive/navistar-chinese-engine-maker-1030/](http://fleetowner.com/trucking_around_world/archive/navistar-chinese-engine-maker-1030/)

### **Box 2. Technologies and strategies for improved fuel efficiency and reduced emissions from trucks<sup>14</sup>**

- **Vehicle activity and driving pattern improvement** - Fuel consumption is strongly connected with vehicle driving pattern in real-world operation.
  - **Driver training.** Drivers can be trained to follow fuel-saving driving habits or keep their highway speed within efficient range.
  - **Reducing speed** on highways to a level where fuel consumption is most efficient
  - **Reducing overloading** can reduce fuel consumption.
  - **Improved freight logistics.** The total activity can also be reduced by better logistics management such as increasing returning load and reducing empty trip. Vehicle activity is linearly correlated with total fuel consumption.
- **Enhanced maintenance** - Truck condition can affect not only operation performance, but also fuel economy and emission. A routine inspection/maintenance (I/M) is barely enough to ensure good condition. Special training and improved fleet management can help contractors improve the condition of their trucks. Engine rebuilding is considered the strongest enhanced maintenance strategy.
- **Vehicle body improvement** - Several strategies based on vehicle body improvement can be applied to reduce diesel consumption by reducing the drag.
  - **Truck weight reduction** is a common strategy to improve the fuel economy of a truck.
  - **Improved aerodynamics** reduces drag and thus fuel consumption.
  - **Reducing rolling resistance** through tyre system modifications: single wide-based tyres, low rolling resistance tyres or automatic tyre inflation or tyre pressure monitoring systems can also reduce fuel consumption.
- **Reduced idling.** Several technological options, including auxiliary power units (APUs), automatic engine idle systems, and truck stop electrification can assist drivers in reducing truck idling,.
- **Fuel, oil and lubricant improvement**
  - **Low-sulfur diesel** can reduce emissions of in-use trucks immediately. It is also a precondition for a successful emission retrofit programme.
  - **Low viscosity lubricant** can also help improve fuel economy.
  - **Oil by-pass filtration system** improves oil life performance and indirectly contributes to fuel efficiency due to reduced engine wear.
- **Emission retrofit** - In-use diesel retrofit with emission control devices including EGR (Exhaust Gas Recirculation), DPF (Diesel Particulate Filter) and DOC (Diesel Oxidation Catalyst) systems have been widely applied in the United States and Europe. The selection for target trucks and technology verification is crucial for a successful retrofit.

**Fleet and engine modernization** - Fleet modernization can introduce much cleaner engines into the fleet to lower PM and NO<sub>x</sub> emissions. Engine replacement is also a type of fleet modernization strategy

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<sup>14</sup> CAI-Asia Center (2010a)

## ***Lessons learned from the training process***

The training process is equally important in successful application of technologies. The main lessons brought for consideration in future pilots and a broader programme are as follows:

- Driver training, including eco-driving and equipment handling training can greatly add to fuel and emissions savings. For example, drivers mistakenly switched off pressure monitoring sensors while increasing tyre pressure, because instructions on handling the equipment had not covered the subject. Technology training of the drivers of pilot trucks directly by the technology supplier or OEM supplier would be preferable.
- Clear and detailed pilot protocols for data collection are essential. Their implementation can be difficult, and if not implemented correctly, the margin of error may exceed the savings percentage thus rendering unreliable results as was the case with XWBL. At SOCL, the protocols were initially not exactly followed, and it was due to strong personal interest and commitment from top management that the right incentives were provided to pilot drivers during an expanded pilot to ensure that data collected was reliable. Ideally, data collected for equipment tests should be integrated into a company's overall monitoring system.
- Conditions for pilot and control trucks need to be kept as close as possible. Of particular importance are the same load weight/daily load factor, same driver, same training, same cab – trailer combination and same routes.
- Participating companies are keen to be considered leaders in their sector. Identification of leading companies that would profile fleets that advance emissions reduction and fuel savings in the transportation sector would benefit a future pilot or programme.

In addition, other matters that may also be considered include:

- Focus on fuel, climate change and air pollution
- Focus on different type of trucks
- Bringing costs of equipment down
- Ensure broad stakeholder participation
- Build on existing successful programmes tailored to China

As part of the further design of a longer-term programme following the pilot implementation, existing taxes, subsidies and other economic instruments relevant to the trucking industry in China should be considered. The matter should be discussed with the Ministry of Transport, which, among others, is focused on improving the freight sector through promoting freight trucks types that are more environmentally friendly and energy efficient. Economic instruments could also play an important role.

## **C. Next steps**

CAI-Asia noted that city level and regional level projects could be successful and sustainable only if an integrated policy package on freight carried across regional borders was introduced on the national level. For this reason it is proposed to establish a Green Freight China Programme, presented below in box 3 focuses on energy efficiency and reduced greenhouse gas emissions and air pollutants. The programme

- Fills policy and institutional gaps in the Guangdong project that was restricted just to Guangdong Province,

- Provides a basis for expanding experience gained in Guangdong Province and Guangzhou to the whole of China. To this extent it is important that the programme design makes use of the outcomes and results of the Green Trucks Pilot Project in Guangzhou as well as the lessons learned from the preparation phase and early implementation phase of the Guangdong Green Freight Project
- Can also be used as a model for other countries establishing such programmes, especially in developing countries

### **Box 3. Components of the Green Freight China Programme**

- Green Freight Partnership of shippers, carriers and regulators relevant to Guangdong, China (mirroring the Smartway Partnership in the United States) and Green Freight Network, comprising broader stakeholder groups also including suppliers, NGOs, universities and other members. The global membership network will be useful to access expertise and support for the programme as well as the Global Environment Facility (GEF) project.
- Technologies and Logistics, which also includes the policies that affects them
- Financing, which could include state loan programmes (revolving loan funds) or provision of limited grants for the purchase of technologies and/or new trucks
- Freight database, which would include data submitted by carriers on fuel use, technology application and other aspects of their fleet; results from technology applications and other measures taken by programme participants to reduce fuel use and emissions; data from surveys as part of the programme; and data from external sources, such as national statistics, and from studies carried out by others. It would also include a measurement model for energy use, CO<sub>2</sub> emissions and air pollutant emissions for the road freight sector.

In addition, there are a number of cross-cutting activities, including research, policy development, training, communication and marketing aimed at the freight sector, government agencies and other relevant stakeholders in China. Examples of cross-cutting activities are: research on methodologies for measuring fuel and emissions reductions from trucks; policy recommendations on how technologies can be promoted through national policies; capacity building and institutional strengthening activities; training materials, videos and tools; outreach centres to provide a face-to-face contact with drivers directly; marketing materials; a dedicated website on the Green Freight Programme.

## **CONCLUSION**

The reduction of road freight activity is heavily influenced by the nature and amount of freight demand. This is valid not only for China but also for other Asian countries. There are several ways in which road freight activity reduction can be achieved:

- Promotion of local production and consumption, as well as compact land use planning can result in the avoidance of the road freight activity.
- If facilities within the same supply chain are located geographically closer to each other, the need for transportation would be lower. Similarly, industries producing goods that are to be shipped abroad should ideally be located as close to ports as possible. This can be achieved through better land use planning and industrial zoning.
- Logistics of the freight sector can be significantly improved. The measures include better communication linkages between shippers, carriers, logistics centres and manufacturers or end-users. Information and communications

technologies play an increasingly important role. Logistics centres help facilitate the efficient distribution of goods and thus the efficient use of trucks. However, in many cities, the number of logistics centres is high and their locations are selected on an ad hoc basis, often leaving the initiative with the private sector operators. Reducing the number of logistics centres and re-assessing their location, as well as improving the coordination between them are other options. Logistics centres can be improved to reduce the multiplicity of delivery points in urban areas by redistributing loads from large trucks to smaller ones. This would greatly contribute to reducing road freight vehicle trips, vehicles (as each vehicle's utility is maximized, fewer vehicles are needed) and vehicle kilometres travelled.<sup>15</sup> In turn, this would reduce supply chain cost.

- The reduction of road freight trips can also be achieved through policies and programmes directed at increasing the loads carried by freight vehicles. Over the past decades many developed countries have increased the legal axle limits to accommodate such higher axle loads. India's legal single axle load limit is now 10.2 tons, which used to be 8.16 tons a decade earlier. Thailand's maximum axle load limit is 8.2 tons while the truck-load limit is 25 tons, which was increased from 21 tons in 2006. Accompanying government subsidies and regulations for encouraging truck owners to shift to vehicles with more axles in order to minimize road infrastructure damage must accompany this trend of increasing loads limits (Sathaye and others, 2009).

## **DISCLAIMER**

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## CITY LOGISTICS: POLICY MEASURES AIMED AT IMPROVING URBAN ENVIRONMENT THROUGH ORGANIZATION AND EFFICIENCY IN URBAN LOGISTICS SYSTEMS IN ASIA

Hussein S. Lidasan \*

### ABSTRACT

*Several recent studies have shown the impacts of the transport system on environment, particularly in urban areas. Urban logistics, including physical distribution and supply chains in urban areas, is a promising subject that can be looked at while developing a framework on addressing the issues in urban environment in the context of transport and land use. The environmental problems, brought in by freight traffic in urban areas, such as impacts on air quality and energy conservation, also have direct or indirect effects on climate change. Measures, involving transport planning and logistics in urban areas, called city logistics have promised to solve many traffic and transport problems. The concept of city logistics is not a new one. However, only recently it has caught the attention of transport planners and experts for its potential contribution to meeting the objectives of logistics from the efficiency, economic and environmental standpoints. This paper shows how logistics and transport initiatives can help in developing a framework, which may eventually contribute to alleviating the negative impacts of freight transport on urban environment.*

**Keywords:** Urban environment, city logistics, low carbon transport system, green and reverse logistics

## I. INTRODUCTION

### A. Rationale

Freight transport contribution to deteriorating the urban environment has finally been noted. The growth of trucks in urban areas not only worsened the roads and highways and created traffic congestion but also contributed to an overall deterioration of urban environment. Traffic management schemes and measures restricting truck movements in urban areas, such as truck ban and similar vehicular volume reduction schemes have been implemented. Though such schemes seem to curtail truck movements, they have negative economic consequences and can become a regulatory impediment for the development of an intermodal logistics network system in urban areas. It is, therefore, imperative to formulate a holistic framework, addressing the environmental issues related to intermodal logistics system in urban areas.

### B. Urban environment, logistics and transport systems

Logistics activities are more important in urban centres than in non-urban and agricultural areas. Urban logistics, involving physical distribution and supply chains in urban areas, is a promising area for developing a framework for addressing transport and land use issues. Environmental problems, brought in by truck traffic in urban areas, such as impacts on air quality and energy use have direct or indirect effects on climate change. Traffic management schemes alone could not alleviate such concerns. There is a need to consider other impacts on urban environment, apart from traffic congestion. The transport system, which is the backbone of a country's logistics system, plays an important role in economic

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development and growth. However, if not properly managed, it can contribute to the worsening environmental condition.

The concept of city logistics, which is not necessarily a new one, has caught the attention of transport planners and experts in the recent years. The concept can contribute to meeting the objectives of logistics from the efficiency, economic and environmental viewpoints. The concept of city logistics combines transport planning and urban planning in addressing freight transport issues in urban areas. A positive aspect of city logistics is the active participation of the private sector. This ensures that all key players and stakeholders participate in the process. City logistics is also closely related to green logistics and reverse logistics that are relevant for mitigating environmental effects of transport. Both green logistics and reverse logistics can reduce the adverse impacts of logistics and transport systems on the environment and energy conservation. Properly applied city logistics initiatives could contribute to the economic and financial gains and promote a low-carbon intermodal transport system in urban areas.

## **II. THE CONCEPT OF CITY LOGISTICS**

To understand city logistics, it is necessary to define the concept, policy objectives and key actors involved, and then determine the types of initiatives that are better suited to address the problems, associated with urban freight. Congestion levels on urban roads have been rising due to the increasing levels of traffic demand. A study by Taniguchi and others (1999), noted that the environmental problems, caused by the traffic, became serious issues in many cities, and that large trucks produced substantial amount of air pollution in urban areas by emitting NO<sub>x</sub>, suspended particle materials (SPM) and other gases. The problem of energy consumption is an important consideration because natural resources conservation and CO<sub>2</sub> emissions reduction are crucial issues. The reduction in CO<sub>2</sub> emission is the key to limiting global warming and, thereby, reducing impacts on climate. Thus, efficiency gains in urban freight logistics through upgrading freight traffic operation could improve urban air quality and reduce the negative effects on environment.

Taniguchi and others (1999) defined city logistics as the process of totally optimizing the logistics and transport activities by private companies in urban areas, while considering traffic environment, traffic congestion and energy consumption within the framework of a free market economy. The main aim of city logistics is to globally optimize logistics systems within urban areas by considering costs and benefits of schemes to the public and to the private sector.

City logistics provides a holistic approach in addressing energy efficiency and environmental degradation while alleviating traffic problems in urban areas. The concept of city logistics includes both public and private sector, as transport and logistics service providers and as concerned organizations and stakeholders. All parties can benefit – the private shippers and freight carriers can reduce their freight costs, the government can alleviate traffic congestion and environmental problems and the end users, the consumers, can benefit from reduction in cost and improvement in urban environment.

The concept illustrates not only private participation in addressing urban problems but also transport planning, urban planning, information technology, economic modeling, management all combined in coming up with the strategies and initiatives.

### **A. Policy objectives of city logistics and key actors involved**

To understand the objectives of city logistics, it is essential to know the key actors involved in urban freight activities. The key actors involved are: a) shippers; b) freight carriers (transport freight providers; c) residents; and d) administrators (Taniguchi and

others, 1999). Figure 1 illustrates the relationship of the key actors involved in urban freight transport and their respective interest. By knowing the relationships between the actors one could understand how the objectives of city logistics were established. Each of the key actors has their own interests in urban freight. They tend to behave in a different manner, and their behaviours should be considered in modeling city logistics.

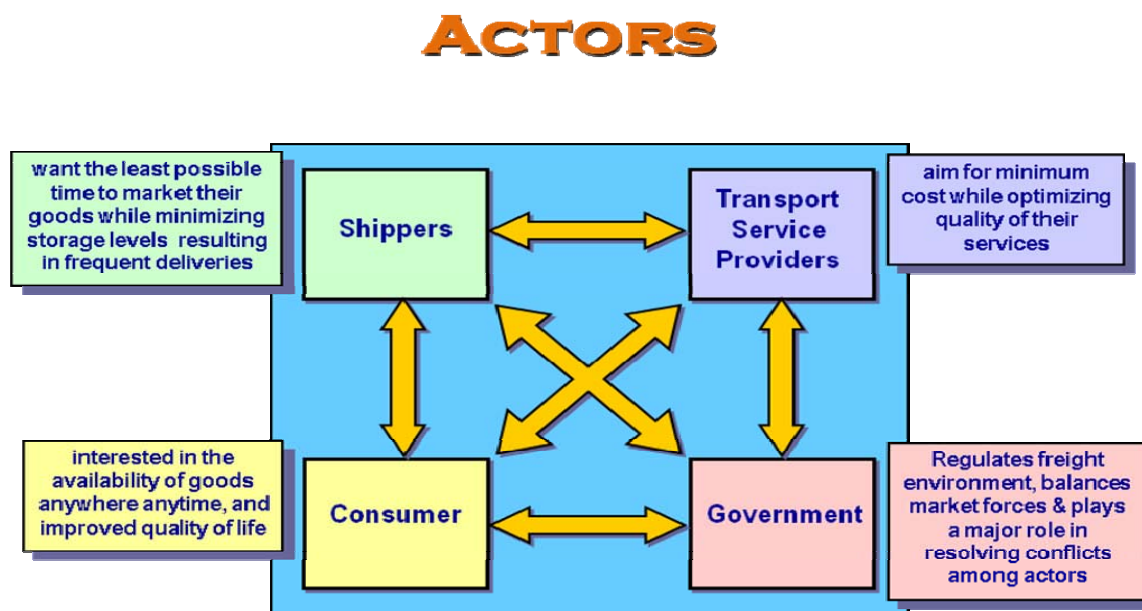
Shippers would like to have high levels of services (LOS) in order to meet their objectives, such as achieving just in time (JIT) requirement.

Transport providers, who are the freight carriers (forwarders) and customers of the shippers, would like to minimize costs of collecting and delivering commodities to customers (the consumers) in order to maximize their profits, but without jeopardizing the quality of their services. Thus, providing higher levels of services at minimal total costs to consumers are among the objectives of the freight carriers.

Likewise, the consumers (or residents) are the people being served who live, work and shop in urban areas. They have their own requirements and as much as possible would like to restrict the entry of trucks in their localities and would not like traffic congestion, noise, air pollution and traffic accidents near their residential and retail areas.

Finally, governments are responsible for enhancing economic development, increasing employment opportunities and, at the same time, alleviating traffic congestion, improving the environment and reducing traffic accidents in the urban area. Generally, the local governments formulate policies and provide infrastructure to achieve their objectives. Ideally, they should be neutral playing a critical role in resolving conflicts arising between the other stakeholders/actors involved in urban freight transport. Though the private sector leads in introducing city logistics initiatives, it is the government that coordinates and facilitates city logistics initiatives within urban logistics and transport policy framework.

**Figure 1. Key stakeholders in city logistics**



Sources: OECD, 2007 and Visser and others, 1999.

Key stakeholders interactions and their respective objectives should be taken into account when considering city logistics initiatives. To this end, the objectives of city logistics, which are considered comprehensive in nature, were defined to appropriately meet the

requirements of the respective stakeholders or actors in urban freight transport. As such, no single field of specialization can provide the strategies to meet these objectives.

Congestion, air pollution and noise, among others, are considered the most important adverse effects of freight traffic in urban areas. It is therefore in this context that logistics policies and corresponding strategies should be formulated and implemented. Table 1 provides a summary of some issues related to freight transport that are being addressed in selected cities.

**Table 1. Summary of issues related to urban freight in selected cities**

Key factors to be addressed	Monaco	Kassel	Zurich	Chester/ London	Winchester	Barcelona	Bologna
Congestion				◇		◇	◇
Environment	◇				◇		◇
Noise					◇		
Safety					◇		
Intrusion	◇				◇		
Political considerations	◇			◇			
Cost							
Lack of loading facilities						◇	
High percentage of in-house transport		◇	◇				◇
Poor utilization of vehicles		◇	◇				◇
High proportion of commercial traffic							◇
Restore balance between retail and transport practices				◇			◇

Source: Visser, and others, 1999.

City logistics initiatives, in addressing the impacts of urban freight transport, try to achieve a balance between sustainability and economic development. Table 1 presents wide and conflicting issues that are being addressed in these selected cities. A range of policy objectives, associated with city logistics, includes: a) efficiency; b) economy; c) road safety; d) environmental; e) infrastructure; and f) urban structure (Ogden, 1992).

The efficiency objectives address both the reduction of transport costs and improvement of the quality of transport services, including accessibility, reliability, travel time, flexibility and freight security. The improvement in efficiency contributes to national income and as such serves economic objectives. Gaining efficiency helps the society and has positive effects on income, business and profitability. The environmental objectives, on the other hand, are more focused and are intended to achieve (Visser and others, 1999):

- a) Reduction in local air pollution, coming from carbon monoxide, nitrogen dioxide, ozone, aerosols, benzene and lead;
- b) Reduction of traffic noise;
- c) Improvement of general safety (reducing the number of traffic accidents);
- d) Reduction of other forms of nuisance, such as risk, physical hindrances and vibration;
- e) Reduction in urban space for transport infrastructures and delivery points;

- f) Reduction of emissions, which influence climate change, such as carbon dioxide (CO<sub>2</sub>), greenhouse gases (N<sub>2</sub>O and methane (CH<sub>4</sub>) and acidification (oxides of nitrogen (NO<sub>x</sub>), sulphurdioxide (SO<sub>2</sub>) and hydrocarbons; and
- g) Slowing down the depletion of natural resources, such as materials and fossil energy.

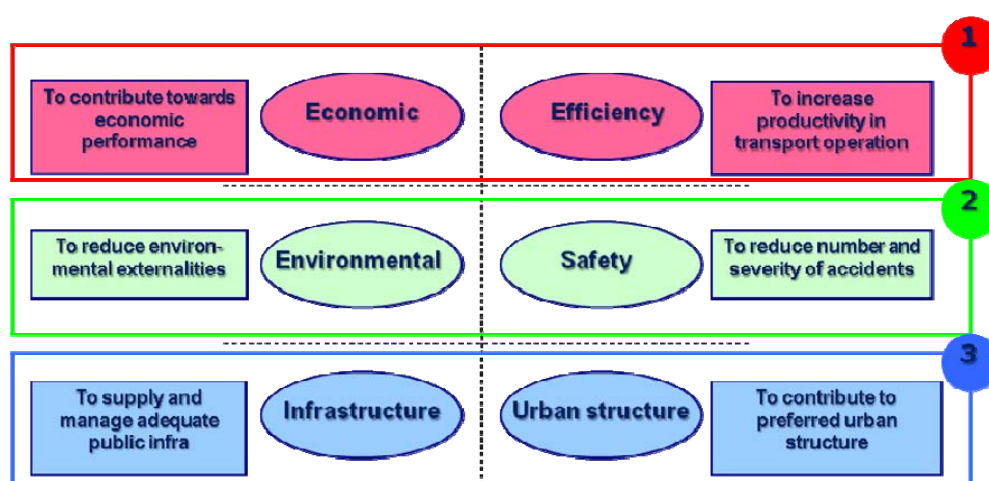
The environmental objectives clearly illustrate that city logistics provide the tools for combating environmental degradation and improving air quality in urban areas. The last group of policy objectives of city logistics is related to preserving and maintaining the urban structures, notably those with historical and cultural importance. The policies aim to maintain a balance between infrastructure development and preservation of areas of historical and cultural importance. Figure 2 illustrates the groupings of the city logistics policy objectives.

### B. Types of city logistics initiatives

The key point in defining city logistics initiatives is simple - the freight transport is considered to be urban freight transport as soon as it crosses the city borderline. One has to keep in mind that most of freight traffic originates outside city areas or comes from other urban areas. The note is essential since it can have impacts on the effectiveness of particular (localized) measures or schemes.

Figure 2. City logistics policy objectives

## Grouping of City Logistics Objectives



Sources: OECD, 2007 and Visser and others, 1999.

Table 2 below provides different strategies or policy measures that comprise the city logistics initiatives, as provided by Ogden, 1992. These groupings of initiatives, in some cases, differ from the classification in other literature on city logistics; however, they are basically the same and consistent with the policy objectives discussed in the previous section. Table 2 provides a menu of strategies, addressing environmental issues, for urban policy makers to employ. They can plan their environmental policy framework considering the strategies that are appropriate and responsive to the needs of their localities. Innovative strategies using the advantages of information and communications technology (ICT) and

improving the level of services of intermodal logistics systems and the transport systems in urban areas. These are summarized in table 3.

Highly urbanized areas and metropolises in Asia, especially in South-East Asia, have already started either employing most of the strategies or developing such strategies using ICT systems. However, other strategies, such as the non-ICT strategies can be initiated by smaller cities.

**Table 2. City logistics initiatives or measures**

<b>Initiative</b>	<b>Description</b>
• <b>Network strategies</b>	– Specific routes can be nominated for use by trucks, such as truck routes designated only for specific classes of vehicles
• <b>Parking or loading strategies</b>	– Provision of different facilities for parking, loading and unloading: curb-side use, off-street facilities and truck parking facilities
• <b>Location and zoning of land use</b>	– Considering spatial concentrations of transport generating or attracting activities near freight transport facilities
• <b>Licensing and regulations</b>	– Provision of a menu of traffic regulations or measures, such as allocation of curb space, loading time restrictions, truck routes regulations and truck access controls, transport regulations, like permits for entering certain areas, or vehicle regulations, to regulate vehicle sizes or emissions
• <b>Pricing strategies</b>	– Imposition of road pricing or charges on access or parking as means to allow market mechanisms solve traffic congestion
• <b>Terminals and modal interchange facilities</b>	– Introducing transfer points at borders of urban areas, providing transport optimization and limiting the number of truck movements in urban areas

Source: Visser, et al, 1999.

**Table 3. New strategies in city logistics**

<b>Initiative</b>	<b>Description</b>
• <b>Traffic information systems</b>	– Provision of road traffic information through vehicle information communication system (e.g., in Japan: VICS) or through electronic traffic boards along the road
• <b>ITS (Intelligent Transport Systems)</b>	– Introduction of new vehicle control systems, maximizing movement of vehicles and commodities
• <b>(ETC) Electronic Toll Collection</b>	– Installation of electronic systems at limited access roads, such as tolled expressways, to improve performance of toll collection and decrease impediment
• <b>Logistics information systems</b>	– Employed in-company or between companies to improve distribution of goods or they can be

Initiative	Description
	employed between companies for cooperative pick-up and delivery or for cooperative operation of terminals
• <b>Vehicle technology improvements</b>	– Improvement of vehicles so as to obtain better performance or to reduce energy-use affecting engine, cargo handling or construction of vehicles
• <b>Voluntary co-operation</b>	– Employing various cooperative pick-ups and delivery or cooperative operations of terminals

Source: Visser, and others, 1999.

Figure 3 illustrates how the policy measures are related to the operation of urban freight transport.

**Figure 3. Grouping of policy measures related to city logistics**

	Transport Function	Goods Handling Function	Information Function
<b>Node</b>	1 ➤ Freight terminals (Distribution centers)	3 ➤ Off-street loading and parking facilities	
<b>Link</b>	2 ➤ Road construction	➤ On-street loading and parking bays	4 ➤ Road traffic info system
<b>Mode</b>	➤ Low emission vehicles, Electric vehicles, etc.		➤ Parking guidance info
<b>Operation</b>	➤ Cooperative delivery		➤ Vehicle tracking system
<b>Control</b>	5 ➤ Truck ban, size/weight restrictions, allocation of truck routes/lanes, etc.	➤ Loading and parking time limits	➤ Vehicle routing system
		➤ Building ordinances	➤ Cargo info system
<b>Market</b>	6 ➤ Road pricing	➤ Parking charges	

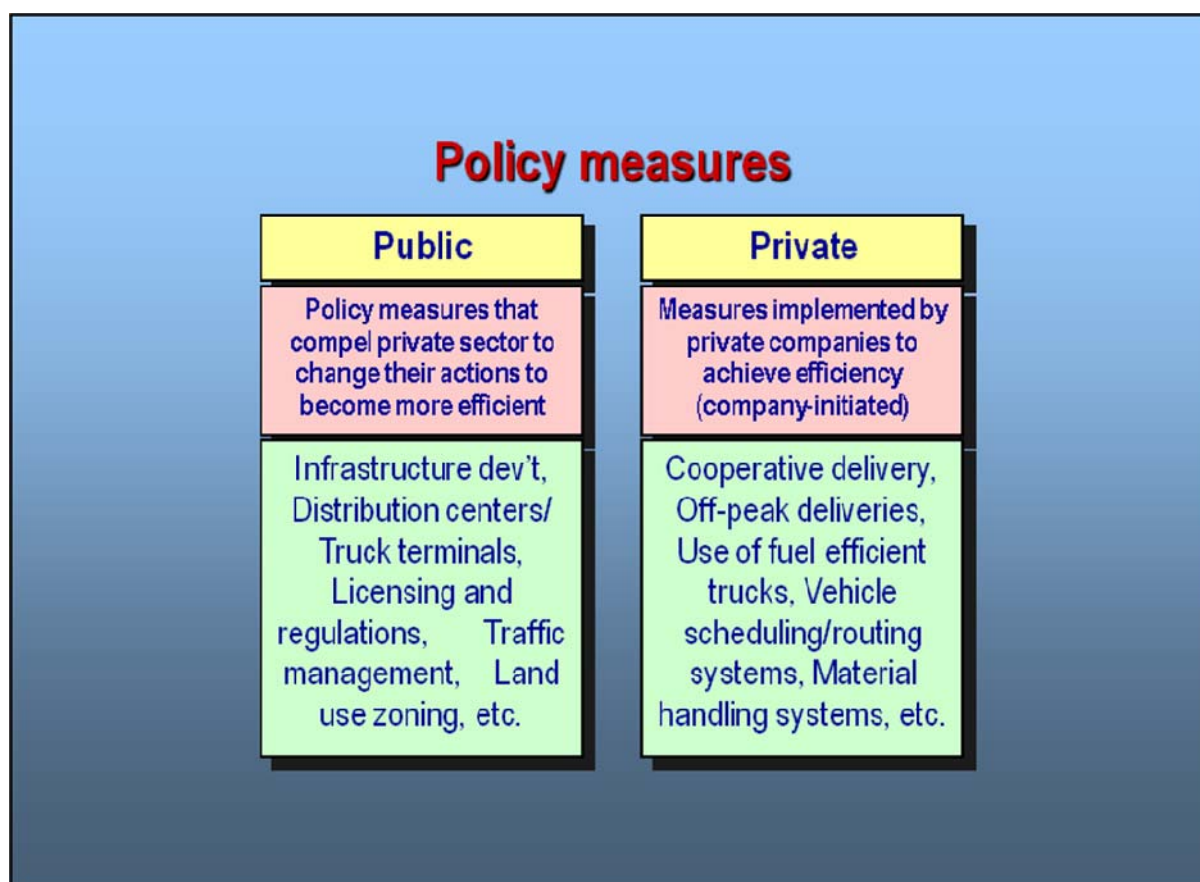
Sources: OECD, 2007 and Visser and others, 1999.

Figure 4 further suggests that the private sector and government need to coordinate their acts in coming up with policy measures so that the combined initiatives are indeed consistent with the city logistics policy objectives. Likewise, the initiatives formulated by the private sector and government have to be complementary so as to avoid conflict, as illustrated in figure 4.

Table 4 summarizes some policy measures, related to city logistics that are being formulated by governments. These measures are grouped according to types and application in addressing the requirements of the urban freight transport system. They provide the menu of infrastructure, regulatory and economic measures that the governments, particularly the local governments, can choose in addressing urban freight transport concerns. This indicates that no single group of measures can solve urban freight transport problems. The same can also be said of with city logistics initiatives that can

contribute to alleviating environmental problems from the viewpoint of urban freight transport.

**Figure 4. Policy measures by private and public sectors**



Source: OECD, 2007 and Visser and others, 1999.

Most of the policies, cited in table 4, are widely employed in developed countries of Europe and the United States. However, metropolitan areas in Asia, such as Tokyo, Singapore, Kuala Lumpur and Bangkok, have initiated their own policies similar to those mentioned in table 4. Manila and Jakarta, on the other hand, had just begun to formulate their own logistics policies. However, compared to cities in the developed countries, cities in South-East Asia, except Singapore, do not have advance ICT systems to support their logistics policies.

**Table 4. Menu of policies related to logistics and transport that governments consider in formulating city logistics initiatives**

	Infrastructure provision		Regulations		Economic measures	
	Physical/ Transport	Information	Regulations	Standardization	Pricing	Subsidies
<b>Land use</b>		Digital map, GPS	Zoning for logistics activities		Property tax	
<b>Networks</b>	Ring roads, freight networks	ETC, Road traffic info system	Truck route control, vehicle and time restriction		Road pricing	
<b>Terminals</b>	Distribution centres	Berth guidance system		Standards for intermodal terminals		Subsidies for cooperative facilities
<b>Parking</b>	On-street parking spaces	Parking guidance info system	Compulsory parking spaces, Parking time		Parking charge differentiation	Subsidies for off-street parking spaces
<b>Vehicles/ Containers</b>	Electric vehicles, low emission vehicles	Fleet management system, vehicle and cargo matching	Emission control, load factor control	Standardized containers, electronic tags	Vehicle tax, fuel tax, environmental tax	Subsidies for low emission vehicles
<b>Cargoes</b>		Cargo tracking, order entry systems				Subsidies for cooperative delivery

Source: Visser and others, 1999

### C. Comparative assessment of city logistics initiatives in selected Asian cities

A collaborative research done by Japan Institute of Highway Economics for Organisation for Economic Co-operation and Development (OECD) undertook a preference survey of experts in selected cities in Asia in 2003 to ascertain how these cities considered city logistics policy objectives and initiatives. Employing weight scaling, Table 5 shows the results of the survey on their preferences of policy objectives.

**Table 5. Preference survey experts on city logistics policy objectives  
(weight objectives)**

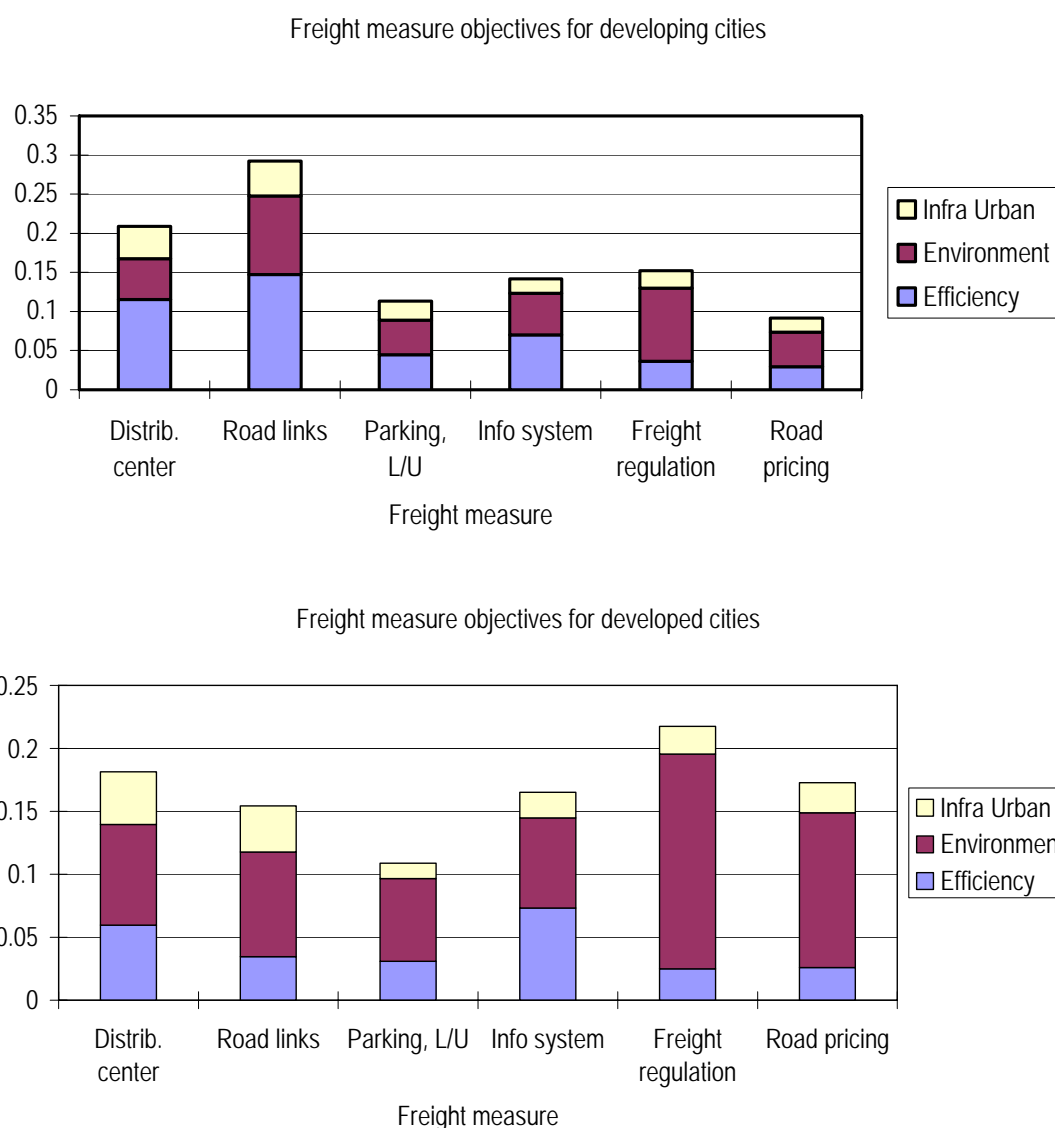
Objectives	Bangkok	Jakarta	Kuala Lumpur	Manila	Shanghai	Seoul	Osaka	Tokyo
<b>Efficiency &amp; Economy</b>	0.327 (2)	0.481 (1)	0.258 (2)	0.550 (1)	0.500 (1)	0.311 (2)	0.097 (3)	0.167 (2)
<b>Safety &amp; Environment</b>	0.413 (1)	0.405 (2)	0.637 (1)	0.240 (2)	0.250 (2)	0.493 (1)	0.570 (1)	0.667 (1)
<b>Infra &amp; Urban Structure</b>	0.260 (3)	0.114 (3)	0.105 (3)	0.210 (3)	0.250 (2)	0.196 (3)	0.333 (2)	0.167 (2)

Source: OECD, 2003

Note: values in parentheses refer to rank order of importance

The table indicates that there are differences in the priorities of cities with regard to city logistics policy objectives. The cities considered developed (Seoul, Tokyo and Osaka) set higher priority on safety and environmental objectives as compared to developing cities. Developing cities, such as Manila and Jakarta, placed more emphasis on economic and efficiency objectives. The choice is obvious, considering that these cities still aim at improving their economic support infrastructure and services. On the other hand, Bangkok and Kuala Lumpur, which are considered to be on the verge of joining developed cities of Asia, regard safety and environmental objectives as more important due to the gravity of air pollution problem and high accident rates.

Figure 5 further supports the results of the survey as summarized in table 5. Albeit this observation, an interesting note to consider is that both the developed and developing cities are now putting more importance on urban structure. To have a clearer understanding of how the cities rated their policy objectives, table 6 summarizes the freight transport infrastructure policy characteristics of the selected cities. It showed an indication for the rating of the experts of their cities.

**Figure 5. Policy objectives by type of initiative by city**

Source: OECD, 2003.

Finally, table 6 shows perceived logistics policy objectives as prioritized. The freight characteristics, primary objectives and existing freight measures of the selected cities are summarized, including the IT applications at the time of the survey. The cities that had shown no IT applications have now introduced applications, such as ETC (Electronic Toll Collection, among others). The table further indicated varied responses to a number of discussed topics. The difference may explain the standing in terms of economic development of the selected cities. The cities that have attained economic growth and development have high levels of logistics infrastructure and information systems and, as such, may have placed higher priority on environment and safety as their policy objectives, compared to the cities that are just introducing in place logistics infrastructure and facilities to support economic growth and development.

### III. METRO MANILA: A CASE STUDY ON CITY LOGISTICS FRAMEWORK FOR URBAN ENVIRONMENT

#### A. Urban environment issues and initiatives in addressing them for Metro Manila

Like any other metropolitan area in Asia, Metro Manila faces several challenges. Its logistics policies are consistent with that of the country. At the local level, they are focused on a) reducing traffic congestion, b) alleviating environmental and social impacts, and c) improving economic and technical efficiency of the transport system. At the national level, the policy objectives aim at providing efficient intermodal transport system that serves as the backbone of the country's intermodal logistics network system, supporting economic development and regional economic cooperation in the South-East Asia. Policy objectives at the regional and international levels are focused on improving efficiency of moving people and freight, reducing impacts of transport on the global environment and at the same time facilitating global competitive trading. It can, therefore, be said that policy objectives are indeed consistent with city logistics. Following this premise, Metro Manila's prioritized city logistics policy objectives are as follows:

- a) Efficiency and economy;
- b) Safety and environment;
- c) Infrastructure and urban structure.

In line with the above policy objectives, the following city logistics initiatives were introduced:

- a) TDM (Travel Demand Management) Schemes;
  - i. UVVRP (Unified Vehicular Volume Reduction Program)
  - ii. Truck ban at major thoroughfares
- b) Application of ICT (Information and Communications Technology);
  - i. ETC (Electronic Toll Collection)
  - ii. Customs facilitation at major ports
- c) Land use controls;
- d) Development of terminals;
- e) Development of economic and industrial zones at urban fringes.

**Table 6. Freight transport characteristics of selected cities in Asia**

	Shanghai	Jakarta	Manila	Bangkok	Kuala Lumpur	Seoul	Osaka	Tokyo
Primary objective	Efficiency and economy	Efficiency and economy	Efficiency and economy	Efficiency and economy	Safety and environment	Safety and environment	Safety and environment	Safety and environment
Underlying problem	Congestion	Congestion	Congestion	Congestion accidents	Accidents	Accidents	Air pollution	Air pollution accidents
Prioritized measures	Road links Terminals Info system	Road links Regulation Terminals	Road links Terminals Info system	Road links Terminals Regulation	Regulation Info system Regulation	Info system Terminals Road links	Regulation Terminals Pricing	Regulation Pricing Parking facility
Main expected effects	Capacity Jobs Accidents	Costs Reliability Accidents	Costs Reliability Capacity	Costs Decentralize Air pollution	Accidents Noise Reliability	Accidents Air pollution Reliability	Air pollution Noise Decentralization	Accidents Air pollution Decentralization
Existing measures								
Node				Public freight terminals		Public freight terminals	Public freight terminals, Truck parking facilities	Public freight terminals, Truck parking facilities
Link	Road network	Road network	Road network	Road network	Road network	Road network	Road network	Road network
Mode							Idling-stop	Idling-stop

	Shanghai	Jakarta	Manila	Bangkok	Kuala Lumpur	Seoul	Osaka	Tokyo
							trucks	trucks
Operation	Off-peak deliveries	Off-peak deliveries	Off-peak deliveries	Off-peak deliveries	Off-peak deliveries	Cooperative delivery, Off-peak deliveries	Cooperative delivery, Vehicle fleet sharing	Cooperative delivery, Vehicle fleet sharing
Regulations	Truck restriction	Truck restriction	Truck restriction	Truck restriction	Truck restriction	Truck restriction		Local truck restriction
Economic measures		Truck parking fees				Truck parking fees		Parking charges, Road pricing
IT application					ETC	EDI, ITS	EDI, ITS	EDI, ITS, Internet load auction

Source: OECD, 2003.

As mentioned, the primary objective of Metro Manila in the context of city logistics is attaining efficiency and economy. As in other Asian cities the underlying problem related to urban freight transport is congestion. To address the problem and at the same time meet efficiency and economy objectives, the priority measures should include: a) provision of road links; b) development of terminals; and c) development of information systems. The provision of road links is aimed at building the country's economic infrastructure backbone. To achieve the purpose, intermodal logistics corridors, such as the Subic/Clark-Metro Manila-Batangas corridor, are being improved through the upgrading of a high standard highway system. To this end, completion of the limited access highway network in the corridor will provide the vital link from southern Luzon to central Luzon, where major international ports and airports are located. The corridor will also enhance the access of production areas to the markets and improve mobility of people in the two regions.

The underlying expected effects are reduction of costs and improvement of reliability and capacity. The logistics corridor is not complete, particularly in Metro Manila, where trucks travel on urban roads and are subject to local traffic management schemes. The main measures include off-peak deliveries and truck movement restrictions. These measures will contribute to relieving congestion and reducing environmental impacts; however, they also incur additional costs and impediments.

With the passage of the country's law on climate change, the Philippine Government, through its concerned line agencies have drawn guidelines coming up with measures in addressing climate change. Priority for cleaner fuel or energy use has been set and all vehicles are now subject to gas emissions inspection. The establishment of the Road Safety Board shows country's concern for the improvement of road safety. Speed limits on toll roads were set and enforced.

Within the city centres, notably in metropolitan areas, such as Metro Manila, Metro Davao and Metro Cebu, various TDM schemes were implemented. The most noteworthy is the imposition of truck restrictions, known as truck ban, which will be discussed further in this paper. Another important TDM measure is vehicular volume restriction on peak hours, technically known as the UVVRP (Unified Vehicular Volume Reduction Program) and popularly called colour-coding based on the original programme name designated for color coding for private vehicles. The UVVRP has been in place in Metro Manila for more than ten years and is currently being reviewed.

The measures imposed under the infrastructure and urban structure objective that affect urban logistics are as follows: a) land use zoning and controls; b) restricting construction of logistics centres and terminals near residential areas and areas designated as historical and heritage preservations. Similarly, designation of locations for logistics

centres, terminals and related facilities in urban areas are now being incorporated in land use city plans. Likewise, decongesting urban areas through the development of new towns, creating economic and industrial zones at urban outskirts, is being urged by both the government and the private sector.

The development and application of ICT for logistics aim at meeting the general objectives of city logistics policies. They not only reduce the impediment in the intermodal logistics network system but also enhance efficiency of logistics system and contribute to improving urban environment. The reduction of transaction time at customs facilities in ports is another merit of ICT.

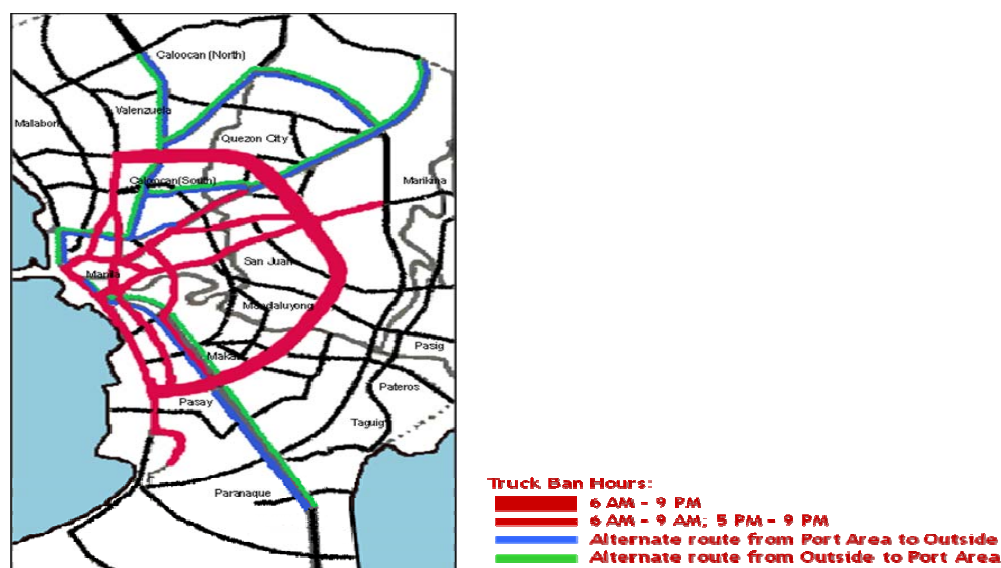
## **B. Implications of city logistics policy in Metro Manila**

The truck ban scheme is meant to illustrate the implications of city logistics policies in Metro Manila. The truck ban has been in force for several years. The common issues, both positive and negative, related to traffic ban in Metro Manila, which are positive and negative, are summarized below:

- a) It is the most commonly utilized vehicle restriction in developing countries;
- b) Banning trucks is perceived as a practical form of reducing traffic during peak hours;
- c) Government usually enforces truck restraints so that public transit modes would not compete for limited road space;
- d) Viable measure during construction periods, when road capacity is greatly reduced, ensuring better traffic movements; and
- e) Truck restrictions can present problems if not fully understood.

Truck ban is considered a powerful traffic management scheme, however, as already mentioned earlier, it affects urban freight transport operations. It is, therefore, important that viable alternatives are presented to minimize the impacts. Figure 6 shows the corridors in Metro Manila where truck ban is imposed; while table 7 summarizes the various truck ban schemes implemented. As mentioned, truck ban has impacts on urban transport system. The most important are economic impacts, which are summarized below:

- a) Changes in truck operating characteristics
  - i. Shortened delivery schedules and reduced delivery hours
  - ii. Reduced quantity of products delivered during banned hours
  - iii. Increased travel time
- b) Reduced truck delivery frequency
  - i. Decreased truck trip frequency per day
- c) Reduced production/supply chain efficiency
  - i. Decreased rate of production due to delays in delivery schedules
- d) Increased transport costs
  - i. Increased costs due to poor productivity are passed on to consumers

**Figure 6. Corridors covered by truck ban****Metro Manila truck ban**

Source: Castro and Kuse, 2005.

The safety impacts of truck ban, as shown in the logic analysis (Castro and Kuse, 2005) indicated the likelihood of increase in accidents when the truck driver:

- a) Operates a trailer-truck;
- b) Has insufficient sleep;
- c) Performs night time deliveries;
- d) Has insufficient knowledge of the truck ban ordinance; and
- e) Violates truck ban rules

**Table 7. Truck ban implemented in Metro Manila**

Truck ban 1 (EDSA only)	6 a.m. to 9 p.m. everyday except Saturdays, Sundays and Holidays. No cargo truck shall be allowed to travel or pass along EDSA.
Truck ban 2 (10 major routes)	6 a.m. to 9 a.m. and 5 p.m. to 9 p.m. every day except Saturdays, Sundays and Holidays. No cargo truck shall be allowed to travel or pass along these routes.
Definition of cargo truck	"Cargo truck" as used in the ordinance refers to motor vehicles, whether loaded or empty, having a gross vehicle weight of 4,500 kg or more, principally intended for carrying cargo.
Violation and penalty	Any person who violates the provisions of this ordinance shall be punished by a fine of not less than 500 pesos but not more than 2,000 pesos or by imprisonment of not less than 7 days but not more than 30 days or both, at the discretion of the court.

Source: Castro and Kuse, 2005.

There is a need for Metro Manila to enhance its environmental improvement policy framework to incorporate city logistics among the alternative approaches addressing the issues in environmental improvement. The case of the truck ban, which is considered an effective policy initiative in the context of addressing not only congestion but presumably environmental deterioration, showed that it has not only social adverse effects but also

negative effects on efficiency and costs. It is, therefore, imperative that policymakers in Metro Manila, and any other metropolitan areas in Asia, should complement truck ban (or similar traffic management schemes) with other city logistics initiatives to have a balance in addressing congestion and environmental improvement.

## CONCLUSION

There are a number of studies that showed the negative impacts of transport, notably freight transport on urban environment. Remedial measures involving transport planning and logistics, within the concept of city logistics were found promising in addressing the negative impacts of urban freight transport on traffic and urban environment. The policy objectives of city logistics, ranging from efficiency/economic to urban structure to environmental aim at improving the level-of-service of the urban freight transport systems. They can ensure economic growth and at the same time address the negative impacts of urban freight transport on the environment.

The concept of city logistics promotes green logistics and reverse logistics, which can also contribute to urban environment improvement.

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# **Transport and Communications Bulletin for Asia and the Pacific**

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### **1. Manuscripts**

One copy of the manuscript in English should be submitted together with a covering letter to the Editor indicating that the material has not been previously published or submitted for publication elsewhere. The author(s) should also submit a copy of the manuscript on computer diskette, labelled with the title of the article and the word-processing programme used, or by e-mail as an attachment file. MS Word and WordPerfect are the preferred word-processing programmes.

The length of the manuscript, including tables, figures and bibliographical references, may not exceed 7,500 words. Manuscripts should be typed on one side of A4 paper in double spacing and pages should be numbered. A list of references should be included. Manuscripts are subject to editorial revision.

The title page should contain (a) title; (b) name(s) of the author(s); (c) institutional affiliation(s); (d) complete mailing address, email address and facsimile number of the author, or of the principal author in the case of joint authors; and (e) an abstract of approximately 150 words clearly stating the main conclusions of the article. Acknowledgements, if any, should appear at the end of the text.

Articles should include a final section containing the main conclusions, which should be broadly intelligible to a non-specialist reader.

### **2. Tables**

All tables should be clearly headed and numbered consecutively in Arabic numerals. They should be self-explanatory. All tables should be referred to in the text. Full source notes should be given below each table, followed by general notes, if any. Authors are fully responsible for the accuracy of the data.

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All figures should be provided as camera-ready copy and numbered consecutively in Arabic numerals. All figures should be referred to in the text. Full source notes should be given below each figure.

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Footnotes, if any, should be brief and numbered consecutively in superscript Arabic numerals. Footnotes should not be used for citing references.

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There should be a complete reference for every citation in the text. References in the text should follow the author-date format, for example (Sadorsky 1994), or (Skeldon 1997: 243). Only those references actually cited in the text should be listed and these should appear in alphabetical order at the end of the manuscript. References should be in the following style:

[Book]

Skeldon, R. (1997). *Migration and Development: A Global Perspective*. London: Longman.

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Krueger, Alan, B. and Lawrence H. Summers (1987). Reflections on the inter-industry wage structure, in K. Lang and J.S. Leonard, eds., *Unemployment and the Structure of Labour Markets*. London: Blackwell. pp.40-49.

[Article in journal]

Wachs, M., 1990. Regulating traffic by controlling land use: the southern California experience, *Transportation*, vol. 16, No. 3, pp. 241-256.