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.

* Transport Studies Department, University of Westminster, 35 Marylebone Road, London, NW1 5LS, UK. Contact details for Michael Browne: Tel: (44 (0)20) 7911 5154, Fax: (44 (0)20) 7911 5057, E-mail: m.browne@westminster.ac.uk

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; Dablanc 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	
Size/weight of vehicles used	
Empty running	
Times at which urban freight activities take place	Traffic levels/congestion, noise disturbance, visual intrusion
Locations at which urban freight activities are generated	
Where loading/unloading takes place	
Goods vehicle engine emissions and noise levels	Air quality, greenhouse gas emissions, noise disturbance
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

Policy measures	Scale of implementation
Land use and planning measures	
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

Policy measures	Scale of implementation
Transport infrastructure measures	
Consolidation centres	Urban
Loading bays and areas	Urban
Lorry parks	Urban
Lorry lanes	National/regional/urban
Managing infrastructure measures	
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
Pricing measures	
Road pricing	National/urban
Tolls	Site specific
Fuel tax	National
Attitudinal and behavioural measures	
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
Information provision measures	
Freight road signing and mapping	National/urban
Development of urban traffic management and control systems	Urban
Road traffic information	National/regional/urban
Modal shift measures	
Improvement of highway, railway and inland waterway connections	National/urban
Subsidies and grants for non-road modes	National
Other measures to reduce environmental impact of vehicle use	
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
Land use and planning measures	
Reducing suburban and ex-urban sprawl of warehouses and logistics facilities	Operator/shipper/receiver
Installation of locker banks for goods collection	Operator
Managing infrastructure measures	
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

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

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