City Logistics

Mapping The Future

Edited by

Eiichi Taniguchi • Russell G. Thompson

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PREFACE

Freight transport systems are essential for the sustainable development of cities by balancing smart economic growth and a better environment and quality of life in urban areas. The concepts of city logistics have been developed and implemented for achieving the efficient and environmentally friendly urban freight transport systems. Comprehensive planning and management of urban freight transport is required for mobile, sustainable, and livable cities, which incorporates reduced transport costs and higher levels of logistics services as well as a cleaner, quieter, and safer environment for residents.

This book contains recent advances in city logistics, including modeling, evaluating, and planning urban freight transport systems. The aim of this book is to provide comprehensive knowledge and experience on city logistics for researchers and students as well as administrators and logistics managers in industry. Because there are multiple stakeholders, including shippers, carriers, administrators, and residents in urban freight transport, we would like to disseminate the important concepts of city logistics to those who are involved or interested in urban freight transport. This book will assist in understanding the background, objectives, methodologies, and governance of city logistics. This includes a mathematical treatment of goods movement in urban areas as well as the evaluation and implementation of city logistics policy measures. A number of case studies in various cities throughout the world are provided to help understand the real applications and issues. Moreover, the future perspectives focus on the new frontiers of city logistics.

Chapter 1 provides an introduction to city logistics. This chapter presents an overview of urban freight transport issues aimed at reducing the cost of logistics activities as well as minimizing traffic congestion and negative environmental impacts. Two important elements of the change in recent years are discussed, including the mind-set of logistics managers and technological innovations. A procedure for urban freight transport management is addressed for better adaptive management toward sustainable and livable cities.

Chapter 2 focuses on partnerships between private companies in logistics and the public sector, which are responsible for urban transport planning. This chapter discusses important issues and success factors in partnerships. Examples of current urban freight partnership approaches taken from three different countries are then presented, showing the similarities and differences between them. Specific guidelines for developing partnerships are also presented based on the outputs from various studies and reports. The achievements of partnerships are then discussed.

Chapter 3 presents the specific roles of the public sector in urban freight transport. This chapter discusses when public sector involvement is required and what the role of the public sector in city logistics is. Insights are provided for the public sector's role as communicators, regulators, and facilitators. An outline and assessment of different types of policy instruments is also provided.

Chapter 4 deals with urban planning aspects of city logistics. This chapter describes truck traffic in urban areas and modern supply chains. The methodology of urban planning for freight is discussed, including the planning process and managing truck-related congestion. Truck traffic associated with the last mile portion of the supply chain is described relating to the demands of final consumers. This chapter highlights the importance of understanding the technological changes and impacts as well as facilitating delivery activities to reduce congestion.

Chapter 5 considers the recent trends of e-commerce in city logistics. This chapter highlights the growth of e-commerce in the U.S., EU, Japan, and China and describes logistics systems for e-commerce, including the location of logistics centers as well as their functions. The role of logistics service providers in e-commerce is discussed, particularly focusing on same-day delivery services. Issues relating to home delivery are also addressed together with solutions including pickup points. Finally, impacts of e-commerce on the total volume of freight and passenger traffic are investigated.

Chapter 6 describes modeling city logistics. This chapter highlights the differences in the modeling of freight transport and passenger traffic; namely, the complexity and diversity of products, and the behavior of the various stakeholders. It covers freight demand modeling, agent-based models, and supply chain networks. The modeling techniques described in this chapter are designed to assist decision makers in increasing their understanding of the behavior of stakeholders and considering expected effects of policy measures before implementing city logistics schemes. The importance of validating models is also discussed in this chapter.

Chapter 7 presents procedures for evaluating city logistics policy measures. The basic tasks of urban freight transport management are outlined, including identifying problems, setting goals and objectives, defining criteria, predicting effects, measuring performance, and conducting pilot tests. Multiple goals and objectives are discussed and a number of key performance indicators are defined. The value of collecting both qualitative and quantitative data before and after implementing a scheme is highlighted. The benefits of conducting a pilot scheme are also presented.

Chapter 8 deals with the specific policy measures associated with Urban Distribution Centers (UDC) for city logistics. UDC is a widely used policy measure for increasing the efficiency of resources utilization and improving the environment. UDCs are defined and developments are discussed, including the functions of consolidation, transhipment, and goods storage from various case studies in Europe and Japan. Criteria and indicators for evaluating UDCs are also addressed.

Chapter 9 provides an overview of Intelligent Transport Systems (ITS) in city logistics. This chapter highlights the important features of ITS in collecting and processing data, as well as transmitting and sharing information. Recent advances in the use of Global Positioning Systems (GPS) and the Internet are discussed in terms of modeling and evaluating city logistics measures. Applications of ITS are given, including modeling city logistics using historical or real-time travel time data, matching systems between shippers' orders and unutilized capacity on trucks via the Internet, parking information and booking systems, and joint delivery systems.

Chapter 10 deals with Off-Hour Delivery (OHD) programs. The theory and two modalities of OHD, including staffed OHD and unassisted OHD, are discussed. The practice and technologies for risk mitigation and low noise operation in OHD are presented. The essential features of OHD are highlighted in terms of the incentives for participation in OHD schemes, the behavior of target industry sectors, and estimating the market share of OHD based mainly on investigations and experiences in New York City.

Chapter 11 considers Cooperative Freight Transport Systems (CFTS). Modeling CFTS is discussed for evaluating the effects of CFTS in terms of reducing costs as well as improving the environment and decreasing the level of congestion in urban areas. Examples of CFTS in Japan, the Netherlands, and the UK are given, describing the management systems, the satisfaction of participants, and the impacts of CFTS on the environment. This chapter concludes that without partnerships between the entities, operators, administrators, and authorities, cooperative measures are not likely to succeed or become sustainable.

Chapter 12 presents an overview of access restrictions and local authorities' city logistics regulations in urban areas. A description of access restrictions is given in terms of time access restrictions and vehicle restrictions. Policy measures are discussed, including low emission zones/environmental zones, vehicle load factor controls, road pricing/congestion charging, and parking and unloading restrictions. This chapter also focuses on the logistical implications of restrictions and regulations as part of urban freight transport management.

Chapter 13 presents a number of future directions for city logistics. The changing nature of cities is discussed in terms of urbanization and aging societies, indicating that city logistics solutions in the future will need to focus on how to cater to the demands of elderly persons. New areas associated with city logistics are highlighted, including disaster issues in humanitarian logistics, alternative transport modes in co-modality, last kilometer deliveries, partnerships between public and private sectors, alternative fuel vehicles, and emerging technologies such as 3D printing.

We believe that this book will provide guidance for researchers as well as practitioners looking for insights relating to urban freight transport to perform research, plan, or implement city logistics policy measures. The modeling techniques and management methods that are presented in the book will allow improved city logistics solutions to be developed for the challenging and complicated urban freight transport issues. Because this book provides a comprehensive and in-depth discussion on city logistics solutions based on investigations and experiences in various continents in the world, it aims to promote further research and practices in an international and interdisciplinary manner by mapping the future of city logistics.

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THE EDITORS

Eiichi Taniguchi is Professor of Transport and Logistics in the Department of Urban Management, Graduate School of Engineering, Kyoto University, Japan. His research centers on city logistics and urban freight transport modeling, focusing on stochastic and dynamic vehicle routing and scheduling with time windows, and multi-agent simulation considering behavior of stakeholders who are involved in urban freight transport. His recent research covers health and security issues, including humanitarian logistics after catastrophic disasters and home health care problems in an aging society. He has published more than 200 academic papers and nine books. He was awarded the best paper award by the Japan Society of Civil Engineers in 2000 and by the Eastern Asia Society for Transportation Studies in 1999 and 2011. As the president of Institute for City Logistics since 1999, he has organized the First through Eighth International Conferences on City Logistics in various venues in the world. He has been actively involved in collaborative research in international organizations including the Organisation for Economic Co-operation and Development, the World Conference on Transport Research Society, the Transportation Research Board, and the World Road Association.

Russell G. Thompson has more than 15 years of experience in city logistics research. He has been involved in a number of local and international studies relating to urban freight, including the Best Urban Freight Solutions (BESTUFS) project and the OECD report on urban distribution. Professor Thompson is a founding director and the vice president of the Institute for City Logistics based in Kyoto and a team leader of the recently established VOLVO Centre of Excellence in Sustainable Urban Freight Systems.

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1

Introduction

Eiichi Taniguchi and Russell G. Thompson

Contents

1.1 OVERVIEW

Urban freight transport is an essential element in the sustainable economic development of urban areas. However, there have been great concerns about sustainable urban freight transport, with issues such as: (1) Can we balance the efficiency and the environmental friendliness, safety, and saving energy associated with urban freight transport? (2) Is it possible to establish sustainable urban freight transport systems in megacities into which an increasing number of people are moving? (3) What are the features of sustainable urban freight transport systems in an aging society? The environment, safety, and energy issues in urban areas are critical not only in industrialized countries but also in developing countries. Recently, rapid urbanization has been observed around the world. Approximately one-half of the total world's population of 7 billion people lived in urban areas in 2010 according to a survey of the United Nations and this is predicted to be over 60% by 2030. Problems relating to urban goods distribution are more difficult in Asia and Latin America, due to the concentration of population living in mega-cities. As well, the change in demographics in terms of the increase of elderly persons generates the demand for more services to homes such as medical, nursing, and other daily services. To address these challenging issues, the concept of city logistics was proposed (Taniguchi et al., 2001b). Several policy measures have been implemented and evaluated using mathematical models in a number of cities in the world (Taniguchi et al., 2006).

City logistics is defined as, "the process for totally optimizing the logistics and transport activities by private companies with support of advanced information systems in urban areas considering the traffic environment, the traffic congestion, the traffic safety and the energy savings within the framework of a market economy" (Taniguchi et al., 2001a). City logistics has multiple objectives, relating to mobility, sustainability, livability, and resilience. Regarding mobility, a smooth and seamless flow of goods is required in operating urban goods movement systems. Alleviating traffic congestion will achieve this. Increasing the reliability of urban freight transport in terms of connectivity and travel times is always requested by transport and logistics companies. Regarding sustainability, the negative environmental impacts including air pollution, noise, and vibration from trucks should be minimized. Concerning livability, safety and security issues are most important for regional communities because residents would like to have quiet and healthy living conditions. Recently resilience has become more important in natural and manufactured disasters (Taniguchi et al., 2010). The relief supply distribution of water, food, and daily commodities to displaced people in shelters after catastrophic disasters requires efficient and agile operation of humanitarian logistics (Zeimpekis et al., 2013).

City logistics is an integrated approach for urban freight transport issues based on the systems approach. As urban freight transport issues are very complicated, including economic, environmental, and social aspects, city logistics solutions require an integrated approach, with contributions from a range of different disciplines such as systems engineering, transport planning, land use planning, information engineering, economics, geography, and social science. This can promote innovative schemes that reduce the total cost, including economic, social, and environmental cost of goods movement within cities (Taniguchi and Thompson, 2002). As city logistics aims at total optimization, it needs to consider the objectives and behavior of several stakeholders who are involved. There are four main stakeholders in city logistics: (1) shippers, (2) freight carriers, (3) administrators, and (4) residents. Shippers hope to maximize their profits by choosing appropriate freight carriers and they want to have reliable logistics services with lower costs. Freight carriers try to provide better services by meeting the requests of shippers who usually set time windows for receiving their goods. Administrators in municipalities generally aim to promote economic development as well as a better environment and energy savings. Residents want their local area to be livable, safer, and attractive. Each stakeholder in urban freight transport has a different perception of the planning horizon. For example, shippers and freight carriers typically plan their business in shorter terms, say 3 to 6 months, whereas administrators make urban plans for longer terms, typically 5 to 10 years. This discrepancy in planning terms can be an obstacle for communication between the private and public sectors. Therefore, urban freight transport issues are very challenging in coordinating different stakeholders with different perspectives toward city logistics.

The history of city logistics is relatively short. Early in the 1970s, a limited number of researchers started to perform research on urban freight generation and distribution of truck trips and commodity flows in urban areas (Hutchinson, 1974; Ogden, 1977, 1978; Roberts and Kullman, 1979). Then city logistics (*city logistik* in German) was studied in Germany, mainly focusing on the cooperative operation of goods distribution in urban areas considering impacts on the environment (Ruske, 1994; Kohler, 1997). The technical term city logistics seemed to have a narrow meaning relating to urban cooperative distribution systems in the German context in the 1980s and 1990s. At the same time in Japan and the Netherlands, a number of researchers began research on city logistics, focusing on optimizing vehicle routing problems, location of logistics terminals, and cooperative freight transport systems based on advanced information technology (Taniguchi et al., 1995, 1998; van Duin, 1997). In 1999, the First International Conference on City Logistics was held in Cairns, Australia. This was the first attempt to present and discuss city logistics in terms of modeling, planning, and evaluation within researchers and practitioners (Taniguchi and Thompson, 1999). Since the first conference, a series of the International Conferences on City Logistics has been held every two years around the world by the Institute for City Logistics. Two review papers have been presented at each International Conference on City Logistics, providing a summary of topical modeling, evaluation, and policy issues relating to city logistics (Taniguchi and Thompson, 1999; Taniguchi et al., 2001a, 2004, 2006, 2008, 2010, 2012, 2014a; Visser et al., 1999, 2001, 2014;

Browne et al., 2004, 2008, 2010, 2012; Nemoto et al., 2006). Taniguchi et al. (2001b) published research on city logistics, which focused on network modeling and intelligent transport systems. In 2003, the Working Group of the OECD published a report on urban goods distribution. This report reflected the first worldwide collaborative effort on discussing the issues and challenges related to city logistics. The OECD report played an important role in encouraging researchers and urban planners to pay attention to urban freight transport issues. A number of books have been published on modeling and innovative solutions on urban freight issues (Taniguchi and Thompson, 2003; McKinnon et al., 2010; Macharis and Melo, 2011; Gonzalez-Feliu et al., 2013; Tavasszy and De Jong, 2014; Taniguchi et al., 2014b).

1.2 IMPORTANT ELEMENTS

There are three important elements for promoting city logistics: (1) technological innovations, (2) changing the mind-set of managers of private companies, and (3) public-private coordination. Technological innovation involves developing and utilizing Information and Communication Technology (ICT) and Intelligent Transport Systems (ITS). Advanced technology allows precise data on urban freight transport to be collected, which can be used to understand the current situation of logistics operation in urban areas. In particular, historical data is important for understanding and improving vehicle routing and scheduling planning on very congested road networks with variable travel times. In addition, the advanced communication systems between freight vehicles and control centers via the Internet are critical for optimizing vehicle operations in real time with dynamic traffic information. ITS-based integrated logistics platforms are helpful for decreasing logistics costs as well as negative environmental impacts.

Changing the mind-set of managers of private companies toward greener freight transport is a good direction for improving urban freight transport systems. A substantial number of logistics companies have obtained accreditation under the ISO 9000 series (quality management systems) and ISO 14000 series (environment management systems). Some companies have put emphasis on sustainable urban freight transport systems using electric vehicles and cargo bicycles to obtain good reputation with consumers and residents. The green image of companies and environmentally friendly products helps companies to be accepted as being good partners for creating a better society. Often, Corporate Social Responsibility (CSR) funds are provided for these green companies.

Public-private coordination is a key issue in city logistics because there are several public and private stakeholders involved and the participation of private companies in discussing policy measures is required to obtain better results. The behavior of freight carriers in response to city logistics policy measures should be examined in advance before implementing them. For example, banning heavy freight vehicles in a city center may increase the number of small freight vehicles there because freight carriers need to deliver goods to customers located in the city center. It may result in increased traffic congestion. This type of side effect of a policy measure should be well considered before implementing a scheme in practice.

1.3 PROCEDURE OF URBAN FREIGHT TRANSPORT MANAGEMENT

The procedure of urban freight transport management can be considered adaptive management, which includes the "plan," "do," "check," and "act" (PDCA) cycle (World Road Association, 2012). Figure 1.1 illustrates the workflow of urban freight transport management. In the design stage, there is a need to identify problems relating to urban freight transport

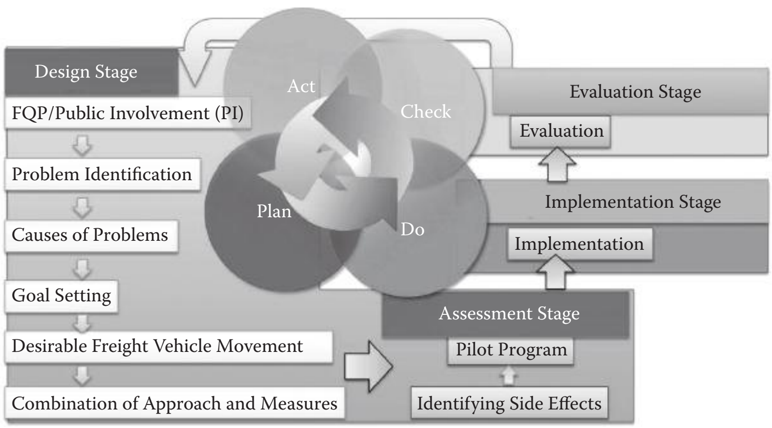

Figure 1.1 Workflow of urban freight transport management. (World Road Association.)

and their causes within the framework of Public-Private Partnerships (PPP). Freight Quality Partnerships (FQP) in the UK and other countries are a typical example of a PPP (Browne et al., 2004). Then goals to be achieved need to be set, including the reduction of costs, CO_2 emissions, the number of traffic accidents, and energy savings. Goals should be clear and simple. The public sector needs to promote desirable freight vehicle movement to alleviate traffic congestion and reduce nuisances caused by freight vehicles. Approaches and policy measures need to be discussed. The World Road Association (WRA) report (2012) provides six approaches: (1) infrastructure, (2) regulatory, (3) logistical, (4) cooperative, (5) technology, and (6) behavioral. It also describes several policy measures: (1) traffic flow management, (2) parking management, (3) time management, (4) vehicle management, (5) joint delivery, (6) intermodal transport, (7) land use plan, (8) improved vehicle movement, and (9) organizational activities. A combination of approaches and policy measures is essential to effectively manage the complicated urban freight transport systems.

During the assessment stage, pilot programs of policy measures are implemented, which allows unexpected side effects of policy measures to be identified. It is useful to assess these side effects in advance and adjust policy measures to the real situation. Mathematical models can also be used for assessing the effects of applying policy measures on the road network. In the implementation stage, we implement policy measures in real cities. Coordination among several organizations, including municipalities, police agencies, trucking associations, and chambers of commerce, is necessary. In the evaluation stage, freight vehicle movements and the emissions of hazardous gases for evaluating the effects of policy measures are monitored. If the results are not good compared with those expected, then it is necessary to go back to the beginning of the design stage. This is a typical PDCA cycle for ensuring effective and environmentally friendly urban freight transport systems.

A number of city logistics schemes have been implemented in various cities in the world. Table 1.1 classifies city logistics schemes. These schemes can be categorized into four management types: (1) traffic management, (2) better transport method, (3) harmony with other urban planning, and (4) others. Traffic management includes traffic flow, parking, time, and vehicle management, which encompasses city logistics schemes listed in Table 1.1. These schemes have been implemented and it was revealed that some of these schemes are effective in reducing the cost of freight carriers as well as alleviating traffic congestion and decreasing the negative environmental impacts (Browne et al., 2012). Better transport methods

Table 1.1 City Logistics Schemes

Management Type	**Management Method**	**City Logistics Schemes**
Traffic management	Traffic flow management	Constructing ring road Truck route Access control to cities Low emission zones Providing traffic information using ITS
	Parking management	Truck only parking space Loading/unloading space on streets Providing parking information using ITS
	Time management	Off-hour delivery Time windows for entering cities Time sharing between trucks and cars
	Vehicle management	Low emission vehicles Optimization of vehicle routing and scheduling Road pricing Load factor control
Better transport method	Cooperative freight transport	Urban consolidation centers
	Intermodal freight transport	Intermodal terminals
	Co-modal freight transport	Pick-up points for delivery Using passenger cars or trams for delivery
Harmony with other urban planning	Land use plan	Restriction for location of logistics facilities
Others	Recognition	Recognition of green freight transport companies
	New transport systems	Underground freight transport systems
	Improving building code	Considering truck size and parking in building code
	Organization	Freight quality partnerships

encourage smart use of resources and transport modes. The concepts associated with urban consolidation centers are relatively old and were successfully implemented in some cases and failed in other cases, depending on their design and operation (see Chapter 8). Co-modal freight transports are relatively new systems and the pick-up points of goods where customers receive their commodity by themselves can be beneficial for carriers to reduce the time and cost of delivering goods to customers. City logistics schemes should also be harmonized with the land use planning, especially the regulation of building logistics facilities.

1.4 MODELING

Modeling plays a vital role in facilitating city logistics. During the assessment stage of the urban freight transport management procedure, models are helpful for understanding urban freight transport and providing insights into the behavior of stakeholders as well as identifying the effects of policy measures. In general, two types of models are used in the area of urban freight transport: (1) optimization models and (2) simulation models.

Optimization models aim to make the best use of available resources under certain constraints. For example, Vehicle Routing and scheduling Problem with Time Windows (VRPTW) models (e.g., Solomon, 1987; Braysy and Gendreau, 2005) have been widely studied and used in practice to minimize the costs of vehicle operations of freight carriers. These models determine the allocation of vehicles to customers and the visiting order of vehicles at customers for delivering goods. Stochastic and dynamic VRPTW models provide very good guidance to improve vehicle operations in cases of variable travel times on the road network. ITS provides a large amount of data on the variability of travel times on road networks. Location models of logistics terminals are optimization models that determine the optimal size and location of logistics terminals usually using queuing theory and cost models (e.g., Taniguchi et al., 1999). These models are useful for understanding the gap between the current level of efficiency in logistics operations and the optimal solutions. Normally in practice, there are so many elements that are not considered in modeling, including the business customs of subcontracts with smaller freight carriers and irregular orders by shippers in order not to lose business. It is challenging to replicate the current situation of logistics operations in the real world. However, optimization models provide a benchmark for the level of costs as well as emissions of hazardous gases.

Simulation models are more flexible for investigating urban freight transport problems. Recently, multi-agent simulation models (e.g., van Duin et al., 2007; Teo et al., 2012) have been used for evaluating the behavior of stakeholders who are involved in urban freight transport. Multi-agent simulation techniques with reinforcement learning based on the Q-learning model are suitable for representing interactions among stakeholders. A major benefit of multi-agent models is that we can understand the response of shippers and freight carriers to a wide range of policy measures that are implemented by administrators and assess the benefits to stakeholders due to policy measures. However, the weakness of multi-agent models is that they are difficult to validate using real data. To overcome this difficulty, more case studies on the evaluation of policy measures in real urban areas are required.

1.5 HOME HEALTH CARE ISSUES

In aging societies, health care issues have become important in terms of providing home health care relating to medical, nursing, rehabilitation, and other daily services. Problems arise because of the limited capacity of doctors and hospitals compared with the increasing number of elderly patients. Home health care issues have been studied in the operations research area (e.g., Benzarti et al., 2013; Rasmussen et al., 2012). City logistics need to incorporate these issues because home health care issues are critical for patients as well as medical and nursing service providers. In addition, reducing total costs of delivering these services is required from a financial point of view.

A number of models have been proposed (e.g., Blais et al., 2003; Bertels and Fahle, 2006) for home health care issues considering the scheduling and routing of home health carers. The structure of models is similar to the normal vehicle routing and scheduling problem with time windows. However, home health care issues are more complicated because different types of home health carers are involved and there are different levels of priority for patients that are directly related to their quality of life. Therefore, collaboration between different types of home health carers, including sharing information concerning patients and co-workers, is needed. The concept of city logistics can be applied to address home health care issues.

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2

Partnerships among Stakeholders

Michael Browne, Maria Lindholm, and Julian Allen

Contents

2.1 AN INTRODUCTION TO PARTNERSHIP APPROACHES

Private companies, in general, have little involvement in the local authority traffic and transport planning process, and until recently there have not been any recognized approaches on how to introduce public-private cooperation on a long-term basis. Furthermore, urban freight transport, in relation to public transport, is low on local authorities' agendas and the most common approach to address freight transport has been that of regulation. Much of this regulation has focused on time of day of operation and limits on vehicle sizes. The roles in urban freight therefore have been that, in general, private companies perform freight transport operations and the public sector regulates those operations. However, in the past 10 years it has become clear that achieving greater efficiency and sustainability in urban freight requires the city/local authority to address the issue with new organizational approaches, which cannot be achieved without public-private understanding, collaboration, and partnerships (Crainic et al., 2004).

In Europe, the White Paper on Transport (European Commission, 2011) recognizes transport in urban areas as an important area on which to focus and presents goals of carbon-free city logistics by 2030. Those goals cannot be achieved simply through regulation nor are they likely to be met by actions taken only by the private sector, so partnership approaches are likely to gain increasing levels of interest (Lindholm and Browne, 2013). Interactions between local authorities and urban freight stakeholders are complex and not well developed as of today, but partnerships with a long-term approach have been identified as one possibility to increase knowledge and awareness of freight transport for all stakeholder groups, leading in turn to the development of suitable solutions to freight issues in urban areas (Lindholm, 2012).

The next section of this chapter discusses important considerations and success factors in partnerships. Examples of current urban freight partnership approaches taken from three different countries are then presented, showing the similarities and differences between them. Specific guidelines to partnerships are also presented based on the outputs from various studies and reports. The achievements of partnerships are then discussed. The chapter ends with key points and conclusions.

2.2 IMPORTANT CONSIDERATIONS IN PARTNERSHIPS

Before discussing specific guidelines that have been proposed for establishing and maintaining freight partnerships, it is useful to review some of the factors that need to be considered when partnership issues are addressed in an urban freight context. Three EU projects provide some helpful insights. Breuil and Sprunt (2009), as part of a project within CIVITAS, noted the following:

- The importance of local political engagement.
- The need to identify target groups that could facilitate the design and implementation of urban freight solutions and then support implementation among stakeholders.

- The need for a strong and rigorous management methodology to establish milestones and objectives (in order to measure the progress of the project and to identify the barriers).
- The scope for the modelling to be used to ensure that the design and adaptation of organizational and technical solutions can be based on reality.

Clearly the last point is of less direct relevance to the establishment of a freight partnership, but the first three (i.e., political engagement, identifying the right stakeholders, and considering organizational and management issues) should be addressed.

The TURBLOG (2011) project compiled a list of issues that were identified regarding transferability of knowledge that were argued to recur in many cases for urban freight projects. These issues included the need to accept the complexity of the situation rather than trying to implement measures with little understanding of the consequences. The complexity of the interactions among stakeholders reinforces the argument that it is often better to avoid seeking single solutions to complex problems. A final issue concerned the importance of considering urban freight measures as business propositions and the need to foster cooperation between actors that in turn required stakeholder involvement and the understanding of supply chain partners' opinions. This last point—recognizing the importance of business issues in urban freight—is important to the functioning of freight partnerships.

The EU START Project (START, 2009) defined a number of important success factors for a freight partnership:

- Decide on a focus and ambition and make sure that the objectives are designed with the participants of the partnership.
- Formulate an action plan for the partnership.
- The network should include stakeholders from local authorities, transport associations, suppliers, retailers, and haulers, as well as other stakeholder groups, for example, property owners, town center managers, chamber of commerce, infrastructure providers, and the police.
- The number of participants should be manageable (10 to 20 was the recommendation).
- Regular attendance by the same participants is also a key factor as it takes time to build trust; therefore, continuity is essential.

Lindholm and Browne (2013) noted that these points overlap to a certain extent and they adapted them to refer to nine main factors that need to be met by urban freight partnerships and against which the partnership cases studied can be assessed. These nine were grouped in three main areas of interest: formation of a partnership, management of a partnership, and the outcomes of a partnership.

A detailed set of guidelines with action points concerning the establishment and operation of a freight partnership can be found in a UK Department for Transport document published in 2003. Table 2.1 is developed from the guidelines proposed in the book.

The final point in Table 2.1 ("Monitor progress of the process, outputs, and outcomes") refers to the achievements of the freight partnership. Such partnerships are likely to lead to a mix of different achievements, some of which can be thought of as "hard" (such as the production of tangible outputs including maps and signage) while others can be viewed as "soft" (such as the implementation of problem-solving procedures within the partnership and the improved understanding of freight transport issues

Table 2.1 Suggested Action Points for Setting Up a Freight Partnership

Action Points in Setting Up a Freight Partnership

1. Set initial objectives that are specific, measurable, achievable, realistic, and timed.
2. Identify and recruit partners that help achieve your objectives.
3. Establish the partnership's management structure.
4. Decide when, where, and how often you should meet.
5. Identify funding sources and seek the necessary endorsement.
6. Try to pre-empt potential problems.

Action Points in Developing a Freight Partnership Plan

1. Identify problems and collect relevant information to clarify their precise nature.
2. Assess the various solutions and reach consensus on what should be done.
3. Draw up a timed action plan for delivering the solutions, identifying who is responsible for each task by when.

Action Points for Maintaining Momentum in a Freight Partnership

1. Consider how you can maintain interest and keep the momentum going.
2. Use publicity to promote the partnership and its activities.
3. Monitor progress of the process, outputs, and outcomes.

Source: Adapted and summarized from UK Department for Transport, 2003.

through communication and information sharing between parties). The monitoring of these achievements is of importance to ensuring that the partnership will continue to be seen as relevant by its participants and will thereby be able to receive their continued efforts and support. This topic of the achievements of freight partnerships is returned to in a later section of the chapter.

2.3 PARTNERSHIP CASE STUDIES

This section presents three case studies of urban freight partnerships from three countries on different continents: Japan, Canada, and the UK. These case studies provide insight into the similarities and differences between such partnerships.

2.3.1 Japan: East Osaka City

In Japan, a partnership in East Osaka City was set up by stakeholders in 2006 to find ways to tackle various problems that occur in the city center and its surrounding area. The main problem was related to illegal parking of heavy trucks, and the Osaka Prefecture considered a partnership approach to be a viable solution in addressing those problems. A partnership involving the stakeholders of freight transport issues in the urban area makes it possible to discuss and find ways of tackling the problems and to find a solution that fits as many as possible.

The partnership is organized as a formal partnership and managed by the Osaka Prefecture and East Osaka City, gathering approximately 20 stakeholders at five meetings yearly. The work with the partnership is funded by the Ministry of Land, Infrastructure, Transport, and Tourism.

Outcomes from the partnership have included providing dedicated off-street parking space for heavy trucks, as well as providing guidance and information about parking spaces to truck drivers. The strengths of the partnership are mainly that it provides a good opportunity for discussing freight transport issues, sharing data, and discussing solutions. Without a partnership it could have been problematic to find the right way to address the problem. It could take longer and would not have been well grounded among all stakeholders. However, the partnership has been focused on reaching consensus in the discussions and that has been proven very difficult. Furthermore, the funding is limited and that makes implementation of measures difficult.

2.3.2 Canada: Greater Toronto and Hamilton Area

Metrolinx established an Urban Freight Forum in the Greater Toronto and Hamilton Area (GTHA) in 2012. This partnership, which is managed and funded by Metrolinx, has the purpose of informing and guiding the development of the actions and strategic directions outlined in the GTHA Urban Freight Study (Metrolinx, 2011). The partnership attracts approximately 30 participants for meetings twice a year. These two meetings are complemented with another two intergovernmental subcommittee meetings.

The partnership is formal in the sense that the members of the group have agreed on Terms of Reference that guide the work within the partnership. The outcomes of the partnership have been new pilot projects in urban freight, data sharing and exchange of information, and guidance regarding urban goods movement projects. The partnership has involved all three levels of government (municipal, provincial, and federal) and has led to networking among the members as well as providing industry insight to the governmental partners.

However, the members of the partnership still lack a detailed understanding of and agreement on urban freight issues (even though it is improving). There is an acknowledged lack of participation from some industry sectors and Metrolinx does not currently have enough resources to dedicate more time to the partnership.

2.3.3 UK: Central London

The Central London Freight Quality Partnership (CLFQP) is a partnership between local government (the seven boroughs of City of London, Westminster, Camden, Islington, Southwark, Kensington and Chelsea, and Lambeth), local businesses, the freight industry, and others with an interest in freight issues within central London. The aim of the partnership is to develop an understanding of freight transport problems and to develop constructive solutions. The partnership was initiated in 2005 by the government after a recommendation from a public-private collaboration. The membership is free of charge and has no formal responsibilities or mission from the government.

However, the CLFQP is used as an advisory board on certain issues. The CLFQP has ordinary meetings three to four times per year plus four to five meetings regarding special issues. The meetings are open to anyone with an interest in participating, but there are usually no more than 30 people attending, with a regular attendance of approximately 20 people (who come to most meetings). After each meeting there is a steering group meeting consisting of 12 people from the boroughs and key stakeholders from industry. The CLFQP and the steering group are managed and chaired by the University of Westminster.

The CLFQP (and the other freight partnerships in London) were initially funded by Transport for London (TfL); however, the direct support from TfL stopped during 2011, which led to a decrease in activity among the partnerships. However, the CLFQP receives funding from the central London sub-region, the boroughs, and the private sector, and it is operating as a "low-cost-solution" in a very efficient way, due mainly to the information exchange focus and the fact that it does not carry out costly activities.

2.4 STAKEHOLDER CONSIDERATIONS FOR FREIGHT PARTNERSHIPS

Ballantyne et al. (2013) concluded that the approach to urban freight transport is very similar in different cities and countries and different types of restrictions are common ways of addressing freight transport. Further, they state that involvement of a broad range of stakeholders is necessary in order to understand the elements involved in freight transport and in order to develop a thought-out planning process and that stakeholders often welcome this type of initiative from local authorities. This is also evidenced by the case studies in Section 2.3 and reflected by the research of Lindholm and Browne (2013), where it is concluded that a wide variety of stakeholders should be involved if the freight partnership is to represent the many different needs and priorities of those groups involved in urban freight. Therefore, it can be argued that the network should include as a minimum, stakeholders from local authorities, transport associations, suppliers, retailers, and haulers. However, to be more effective it should also include other stakeholder groups such as property owners, town center managers, chambers of commerce, infrastructure providers and, possibly, the police.

Sometimes the participation of stakeholders in such partnerships is in the role of observers, whereas in other cases they have a more active role, being involved in decision-making and the implementation of changes. In the case of the public sector stakeholders, this often takes the form of changes to regulations and enforcement, while for the private sector stakeholders this typically involves changes to operations and business practices.

Lindholm and Browne (2013) also demonstrated that participation by the local authority representatives is seen as a key factor in making the partnerships effective. Among the partnerships they studied it could be concluded that it is the act of participating that builds the knowledge and therefore attendance at meetings is important.

Having participants that provide a range of views is clearly valuable but these views need to be relevant to the specific issues that are being addressed. In many cases, urban freight problems can be seen as part of a wider set of problems concerned with urban planning and land use issues. Yet, to achieve short- to medium-term benefits it may be necessary to concentrate on the immediate problems and focus on a relatively small number of issues.

Clearly, the range of stakeholders also has a bearing on the number of participants that need to be involved. Existing research does not currently provide conclusive insight into the most appropriate number of partnership members. Having too many people present at the meetings appears to lead to very complicated discussions and would make it even more difficult to reach any common positions. On the other hand, a relatively large number of stakeholders does reflect the complex nature of urban freight. A rule of thumb would seem to suggest that up to 25 participants is sufficient for a good coverage of issues while remaining manageable. However, it is noted that participants should be able to share information from their respective organizations, as well as to bring back and implement agreed changes from the partnership meetings.

It is essential to have participants from both the public and private sector. In-depth research carried out in London and Gothenburg has highlighted the critical role played by local authority representatives and their continued participation is seen as a key factor in making the partnerships effective (Lindholm and Browne, 2013). This research also indicated the need for clarity and some degree of formality in partnership meetings, including the importance of meeting notes, and that agreements and actions should be documented.

2.5 ACHIEVEMENTS OF PARTNERSHIPS

Interactions between the public sector (represented by city administrations and local authorities) and private sector urban freight stakeholders (transport operators, retailers, and so on) are often focused mainly on complaints (e.g., noise complaints by residents, problems over loading allocations, etc.). However, the establishment of a freight partnership would appear to help reach a better understanding of freight problems and a change in the nature and usefulness of these interactions between the public and private sectors. Sharing knowledge and the transferability of knowledge between partners can be highlighted as among the most important effects of such partnerships.

As explained earlier in the chapter, achievements of freight partnerships can be "hard" or "soft." "Hard" achievements refer to concrete, tangible outputs and outcomes (which can usually be quantified and measured), while "soft" achievements include general improvements in working processes and recognition and understanding of the issues involved (which are more qualitative in nature). It is likely that some concrete achievements will be essential for maintaining the momentum of the freight partnerships in the longer term, but research has shown that the expectations of different partnerships are quite varied and the interest in shorter- versus longer-term improvements is not necessarily the same in all cities.

Quantified evidence of attitudes to achievements is rather scarce and there have been very few surveys of urban freight partnerships. However, work by Allen et al. (2010) demonstrates the views of a sample of 30 partnerships surveyed in the UK. Respondents were asked to describe what, in their opinion, were the most important achievements of their partnership. They were permitted to provide details of up to five such achievements. Respondents provided open responses; during the analysis, these responses were grouped into suitable categories. Figure 2.1 shows the number of partnerships that mentioned each of these categories of achievement as being among the most important they have carried out. This analysis indicates that achievements related to improving public-private sector working were most commonly reported to be among the key achievements by respondents, followed by producing freight maps and signage. Achievements in increasing the understanding and profile of freight transport and developing freight plans and strategies (and providing input to wider transport plans and strategies) were the next most frequently reported categories of important actions carried out by the respondents' partnerships. Figure 2.1 highlights that "soft" achievements (such as improved communication and working between stakeholders, greater understanding of freight issues, and promoting good practice innovations) are viewed as being of equal or greater importance than "hard" achievements (such as freight maps and signage, and dealing with routing, traffic information, and loading issues) by many respondents.

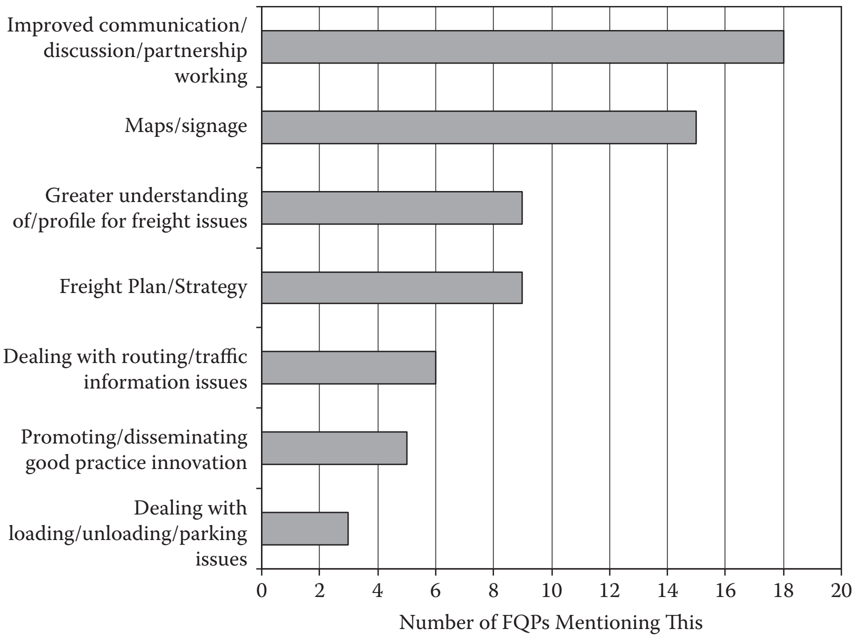

Figure 2.1 Respondents' views on the most important achievements of their freight partnerships. *Source*: Allen et al. (2010).

As reflected by Figure 2.1, partnerships can play an important role in both fostering understanding of freight transport issues between stakeholders and in improving communication between them. Face-to-face meetings are important for cultivating this understanding of the different perspectives of stakeholders through the divergent opinions that inevitably arise, and add considerably to the exchange of information through knowledge-sharing tools and websites. If the participants are sufficiently senior, then the knowledge and understanding will be spread through the stakeholder organizations. The point to reiterate is that the participants have sufficient mandates to bring about change in their respective organizations and ensure that the key issues addressed by the partnership are dealt with by those organizations. The guides and studies prepared by freight partnerships may have value beyond the immediate dissemination of information.

Sharing knowledge and the transferability of knowledge between partners has been highlighted as the most important effect of partnerships (Marsden and Stead, 2011; Marsden et al., 2011). Inevitably working collaboratively can take time; there is a long-term perspective with such partnerships that cannot be disregarded. Short-termism is good for some specific activities and actions, but as a whole, the best benefits of the partnership are the long-term relationships.

2.6 KEY POINTS AND CONCLUSIONS

In this chapter, a number of key points have been presented for how to set up, develop, and manage a freight partnership, based on studies of existing partnerships as well as reports regarding partnership approaches.

It is clear from the evidence that participants in freight partnerships value access to information and the scope or opportunity to discuss developments. An important implication of this is that it is very valuable to:

- Find out what is happening before it is formally and publicly available for dissemination.
- Have the opportunity to be made aware of issues that may not have been considered as important to a particular participant or sector but that may be of special relevance to those concerned with freight transport.

This in turn means that it is important for the organizers of the partnerships to continually perform an information-scanning role and to ensure that this feeds into the meetings.

The guidelines presented in Table 2.1 are valuable, but results from case studies emphasize that partnerships are primarily important to increase the exchange of information and development of freight strategies in urban areas. Focusing too much on a specific action plan and reaching consensus on each question could result in difficulties. Sharing insights and knowledge is an essential first step to finding solutions to many of the complicated problems of urban freight. If the participants have enough mandates within their organizations, the outcomes are likely to be positive without formal terms of reference within the group.

A partnership cannot solve all the freight-related problems within a city but it should be considered an important and necessary piece of the puzzle. A variety of measures and regulations are required together with the appropriate enforcement, but there are major benefits in shaping these regulations in consultation with the private sector. The benefits from the outcomes of the partnerships are not only valuable for the local authorities, but also for the private sector partners who both receive early information about ongoing processes and have the possibility to affect the outcomes of forthcoming policies. Freight partnerships can make a significant contribution to solving urban freight problems because they provide an excellent opportunity to consider the various perspectives of stakeholders and thereby find solutions that can meet the needs of different groups.

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3

Role of the Public Sector

Johan (J.G.S.N.) Visser

Contents

3.1 INTRODUCTION

Freight transport services by road are privately operated with only a few exceptions in the area of city logistics, relating to consolidated, cooperative delivery of goods within urban areas. The public sector has certain responsibilities and public interests toward transport and mobility of passengers and freight. With regard to city logistics, the public sector in general has a more active role. In this chapter, we will focus on the role of the public sector with regard to city logistics.

In this chapter, we will focus discussion on when the public sector is involved with respect to transportation in general. We will then examine the role of the public sector in city logistics. There are several reasons for a public intervention, but when social issues are at stake, there is usually a cry for public intervention. Therefore, we discuss whether there is a role for the public sector when social, environmental, and economic issues are at stake. Not all problems require public intervention. We will look into this. Further, we will discuss some important criteria for ex ante evaluation within public decision-making: effectiveness, efficiency, productivity, and legitimacy. We will describe the different roles of the public sector and the policy instruments that can be used in the field of city logistics. We end this chapter reflecting on public policy making in the near future.

3.2 WHEN IS THE PUBLIC SECTOR INVOLVED?

The role of the government in transport is not the same for every transport mode and in every country and the government's involvement is changing over time. This can easily be demonstrated by looking at the role of the government in rail, roads, and pipelines in Europe.

In Europe, there is a separation between the government-operated rail infrastructure and train services, which are increasingly being operated by private companies. However, this has not always been the case. In most European countries, railways were developed in the 19th century by private capital, the Russian railways being the major exception. During the 20th century, most of the railways were brought under various forms of public ownership (ECMT, 2005). After a period of rising costs and falling market share, in particular in freight, the European Commission intervened with legislation in 1991 through Directive 91/440/EEC. This directive aimed at increasing the financial viability of railway operations, a separation of infrastructure and train operations, and introduction of train access rights to enable competition for freight services. Now, a number of countries are still in the process of implementing this directive. Therefore, the situation differs within European countries.

The responsibility for financing and building roads and highways has always been a common interest and responsibility, either by local communities or by national governments. Roads are generally government owned. In some countries, you have highways, privately built and operated, like the Autoroutes in France.

When we look at pipelines for chemical fluids and gasses, these pipelines are all privately built and operated, except for utilities such as drinking water and sewage. With pipelines, there is no distinct separation between infrastructure and transport operations. Moreover, the customer, the transport operator, and infrastructure provider are the same actor most of the time. It is possible the government facilitates pipelines by providing a special corridor for pipeline tracks, for instance, the pipeline corridor Rotterdam-Antwerp, or making a network of pipelines available for use by others, for instance, the multicore pipeline network in Rotterdam Seaport, but these are exceptions.

Although this is a brief overview, it shows that there is no single overall concept for the role of the government regardless of the transport mode. The role of the government in transport is not the same in every country and in every transport mode and is changing over time. All kinds of factors play a role in this: political and cultural aspects, the social or economic importance of the infrastructure, the option to separate infrastructure and transport operations and characteristics of the service, and the potential to operate as a market with demand and supply. However, an important factor could be the origin of a transport mode and the era in which it was built. In general, the government has a strong responsibility in setting the legal conditions and in infrastructure development and operation, but that does not necessarily mean that the government is always accountable or feels responsible for providing the infrastructure, for instance, when it concerns industrial pipelines and freight railways.

3.3 THE ROLE OF THE PUBLIC SECTOR IN CITY LOGISTICS

The role of the public sector with regard to city logistics has been an ongoing discussion for a long time. Urban distribution centers, consolidation centers, and freight terminals (OECD, 2003) have been proposed since the 1980s in Europe to solve urban freight problems either with little support

THE NETHERLANDS

The role of the government regarding urban freight transport has been on the agenda in the Netherlands since the 1980s. Urban distribution centers were proposed to solve urban freight problems but with little support from the majority of freight carriers. The Netherlands then moved from traditional planning, in which governments act as doctors, using top-down approaches, to progressive planning, in which governments act as educators, to consultative planning, in which governments act as facilitators, using combinations of bottom-up and top-down approaches (Van Binsbergen and Visser, 2001). Following this approach, the National Platform Urban Distribution was very successful in starting new projects as public-private partnerships. The most recent move since 2004 can be best described as the withdrawing of government. This means a government that leaves as much as possible to the private sector. In 2004, the national and provincial governments withdrew from this platform based on a report that stated that urban freight problems are the responsibility of local governments and industry. In 2008, the national Department of Transport concluded that the department played no role in urban freight transport and that only under political pressure urban freight transport issues will be taken seriously. Also at the local level, the government's role is limited. Environmental zoning seems to be taken seriously but no new initiatives for optimizing urban freight transport are undertaken. In Amsterdam, the city cargo-tram project has ceased. The company City Cargo Nederland went bankrupt. An important obstacle was the extra rail infrastructure costs for the new tram, which the local government only wanted to pre-finance. In addition, there are questions about the role of the government. On the other hand, the private sector is capable of providing solutions when it sees market opportunities. For instance, because of vehicle size restrictions within the city center of Amsterdam, local transport companies are able to offer distribution services to other transport companies who do not have the right trucks. In cities such as Nijmegen, Den Bosch, and Amsterdam, private companies organize a collective urban distribution system. In the near future, urban freight transport is starting to get back on the agenda. The main driving forces are the long-term options for energy savings and climate change.

from freight carriers or with strong financial support from local or regional governments. Some governments used a strong top down approach and others introduced public-private partnerships, by means of local, regional, or national freight platforms. The purpose of these platforms has been consultation and coordination (Browne et al., 2004) between the public sector and private actors and often initiating public-private cooperation in new projects. However, in many countries and regions, the public sector leaves as much as possible to the private sector and does not play an active role. Also with respect to urban freight transport and city logistics in countries, the role of the public sector changes over time. Visser and Hassall (2009) describe the changes in the role of the public sector in urban freight transport in the Netherlands (see box).

Regarding city logistics, the role of the public sector is also different between countries, regions, and cities and can very well change over time. An interesting question is what the explanation is for the differences in the role between countries and the change over time. The first explanation is that political principles and institutional factors do play a role.

Institutionally, there is a difference between the role of local and regional governments and national governments. Local governments have a direct responsibility. Urban freight transport concerns local road use and local social issues, such as the access to destinations like shopping centers or residential areas but also issues such as noise, traffic safety, and air pollution.

Regional and national governments (including the EU) are involved because of national and global issues such as energy savings and climate change and have set standards for emissions and vehicle size and weight. However, when a more general and harmonized approach is requested for local issues, regional or national governments are also called upon. It is then up to the national government to set measures for harmonization and standardization with respect to urban freight transport.

3.4 IS THERE A ROLE FOR THE PUBLIC SECTOR WHEN SOCIAL ISSUES ARE AT STAKE?

In general, transport services are set up or changed when someone has a particular interest. The initiative to develop a new transport service, in particular with respect to city logistics, meaning collective delivery of goods in urban areas, comes to the question as to whether there is a private or a public interest. When there is no particular interest from either side, no development takes place. One can speak of private interest when some private company or entrepreneur sees business opportunities in developing a new service. For instance, the new service is the most cost-effective solution for a transport issue, it is technically and socially feasible, and it generates profits to make it commercially attractive. Urban freight transport not only deals with private interests, but also with the interests of larger groups of people and institutions within the social community of a city. There can be a common interest, an interest for us all as well. A common interest occurs when there is a large problem or challenge with important economic, social, or environmental implications. Often the government will need to address this problem or challenge. However, it is often wrongfully assumed that when something is good or needed for society, the government (local, regional, or national) should support this initiative or should be responsible for implementing the solution. Sometimes it is clear that the government is responsible but sometimes it is not that obvious. Why is the option to buy bread important to everybody but the supply of bread is not a public service? In this situation, bakeries can bake the bread the people want.

3.5 DOES A PROBLEM REQUIRE PUBLIC INTERVENTION?

In the case of a major social problem, one should consider what would happen if the government does not intervene. Suppose there is no government. Will the problem be solved by the market? Of course, there is a government necessary for keeping institutional conditions for markets to work. However, if there were no government, would the problem be solved by the market? If this is the case, then the problem does not require government action.

A common interest becomes a public interest when the government becomes responsible for safeguarding that common interest. Is reducing noise hindrance in the public's interest? How should the government take care of the quality of rail transport services? Why is the option to buy bread important to everybody but the supply of bread is not a public service?

One can speak of a public interest when there is a common interest and a government is responsible or is legitimized to take care of this (see, for instance, Lijesen and Korteweg, 2007).

Whether the government is responsible or should intervene can be a political decision but there are some guidelines based on public choice theory and welfare economics to help decide. Figure 3.1 shows the framework

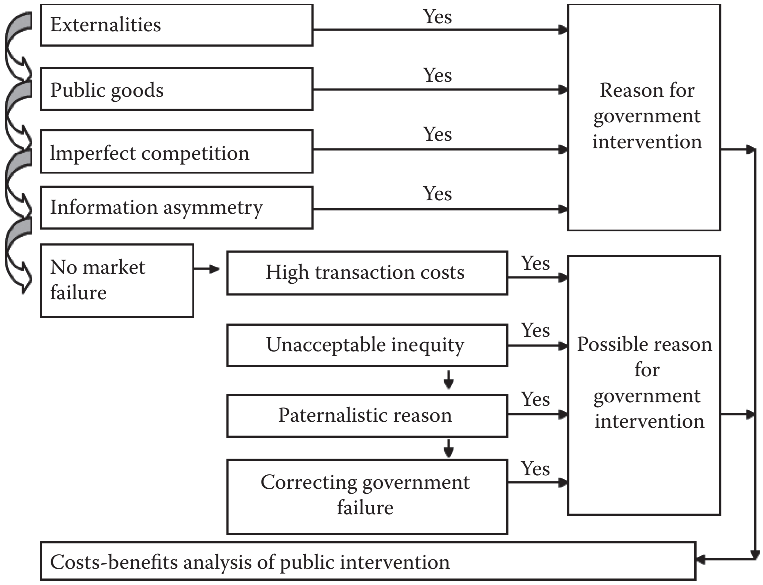

Figure 3.1 Reasons for public intervention (based on Teulings et al., 2003).

that is used in the Netherlands to evaluate the legitimacy for public intervention (based on Teulings et al., 2003).

When products or services markets, like the freight transport market, fail or lead to an undesirable outcome, there is a reason for public intervention. The framework, shown in Figure 3.1, mentions externalities, public good, imperfect competition (through monopoly operations), information asymmetry (between supplier and customer), and possible causes for market failure. When there are no market failures, there can still be reasons for government intervention. These reasons are high transaction costs for market players, inequity, paternalistic, or correcting government failures. In the end, all the costs and benefits of public intervention must be considered. When the costs are higher than the benefits for society, it is questionable whether the intervention must be implemented, but in the end, this is a political decision. This framework only provides a line of thought to decide if public intervention is needed.

The provision of infrastructure, like roads, is a typical example of a public good provided by a government. Although infrastructure is not by definition a public good, local infrastructure is a typical example of a good from which someone can be excluded or provided by the market.

PRIVATE GOOD OF PUBLIC INFRASTRUCTURE

Can infrastructure be considered a public good or a private good? When it is a public good, the government has a responsibility for providing transport infrastructure. In economic theory, a public good is a good that is non-rivalrous and non-excludable. Non-rivalry means that consumption of the good by one individual does not reduce availability of the good for consumption by others. Non-excludability means that no one can be effectively excluded from using the good. In the case of a transport service with the characteristics of a public good, is a governmental or quasi-governmental organization to provide this? However, the classical distinction between public goods and private goods is not a black and white division. Both exclusion and rivalry, which are also called jointness of consumption, are characteristics that vary in degree rather than being all-or-none characteristics. In addition, common pool goods (rivalrous and non-excludable) and low congestion goods (non-rivalrous and excludable) can be distinguished. Transport services can be all four types of these goods as Figure 3.2 shows. It is not a static situation. Road infrastructure in a non-congestion situation is a public good. As soon as congestion occurs, it acquires the characteristics of a common pool good but when toll or pricing is introduced it becomes a club good or even a private good (see Figure 3.2).

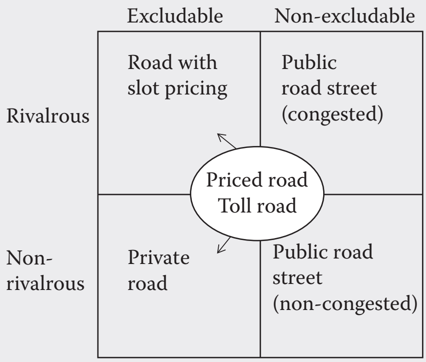

Figure 3.2 Roads: from public good to private good.

Reducing the environmental costs of freight transport in urban areas is a typical example of governments' willingness to control the access to urban areas for freight trucks where transaction costs are set too high for free markets to develop, and welfare raising transactions do not take place.

Other reasons for government intervention are high transaction costs for private initiatives, unacceptable inequity, paternalistic reasons, and solving problems caused through government failure in this market or another related market. Political motives play a role when politicians do not accept the outcome of a free market.

Innovations, such as those seen in transport technology, are often supported through regulation in order to reduce externalities (e.g., environmental costs and damage) with older technologies. Governments can also support product innovations to improve the dynamic efficiency within markets and generate welfare gains, which would otherwise not occur.

When a problem can be defined using one or more of these criteria, then there is public interest, and as such, a government has the legitimacy to intervene in order to create a more appropriate solution. However, the governmental level at which the appropriate action is undertaken, be it local, regional, or national, needs to become responsible for the decision, and its implementation depends strongly on the size of the problem and the most effective and efficient path to deliver a solution.

3.6 EFFECTIVENESS, EFFICIENCY, PRODUCTIVITY, AND LEGITIMACY

In the case when it is legitimate for the government to intervene, the public intervention should be effective and efficient (and, of course, lead to a productive transport system).

- Effectiveness: Related to the extent to which goals or objectives can be reached by the solution/government intervention.
- Efficiency: The balance of social costs and benefits, usually based on cost-benefit analysis.
- Productivity: The financial soundness of the intervention, usually based on a business case analysis.

Legitimacy, effectiveness, efficiency, and productivity are all essential criteria to evaluate proposed government interventions.

What can we learn from an examination of these criteria? The framework presented here shows when there is a role for the government (legitimacy) and what the right evaluation criteria for new proposals in the area of urban freight (effectiveness, efficiency, and productivity) are. It also tells us why feasibility studies are not enough to convince governments to take action in urban freight transport.

3.7 DIFFERENT ROLES

Tessensohn et al. (2000) distinguish four levels of governmental participation in freight transport, as shown in Figure 3.3. The first level is full private initiative and no government participation, like in traditional pipeline business in the petrochemical industry. The role of the government is limited to setting legal conditions. The second possibility of government participation is public support of private initiative. This is a rather passive form of participation: private parties are facing a problem that they have to solve. The government supports by granting a subsidy. The third level is that government is more actively involved by means of a public-private partnership. The fourth level is full public initiative.

When there is no public interest at stake or just with little social ***or*** economic implications, the government will leave it to the freight transport market (see Figure 3.4). It is up to the freight transport market (shippers, carriers, or receivers) to develop city logistics services. The government can help to come to a solution by communication, for instance, by promoting solutions. In case the problem is more urgent, the government will force the market to provide a solution by new regulation. It is still up to the market to implement city logistics; the government participates as a regulator.

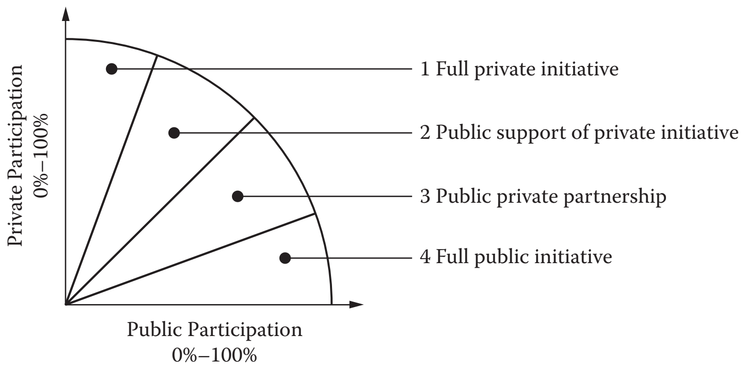

Figure 3.3 Different levels of governmental participation in underground freight transport (Tessensohn et al., 2000).

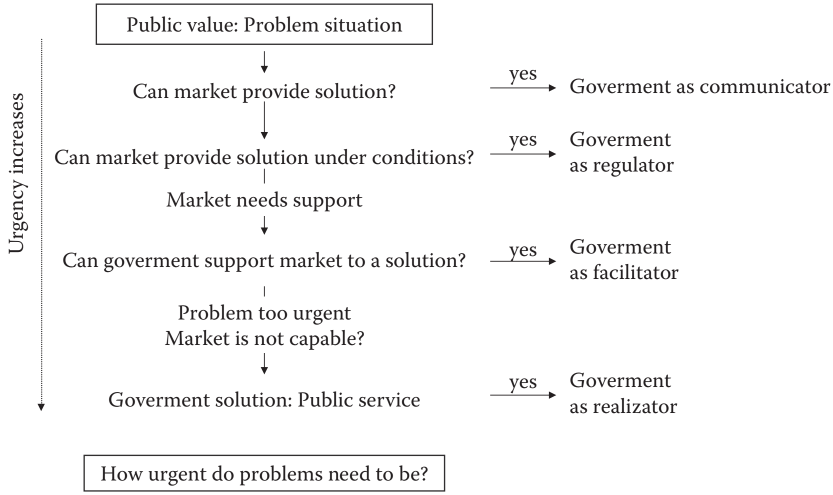

Figure 3.4 The urgency of problems and roles of the public sector (Visser, 2010).

With an increasing urgency, the government can be actively involved as a facilitator. For instance, the government can give subsidies or other support when transaction costs for implementing the solution are too high. The development of city logistics becomes a shared responsibility between the transport market and the government. Finally, when the public interest at stake is too urgent and the freight transport market cannot provide the solution, it is up to the government. Related to city logistics, it means that the government will provide the city logistics services, like in Monaco.

Therefore, are any public interests at stake and are city logistics capable of providing the best solution? In general, you will find the following arguments to legitimate a role of the public sector:

- Environmental arguments. Environmental objectives cannot be met while the environmental costs of city logistics will be lower than current costs of transportation of goods.
- Economic arguments. Congestion makes the accessibility of shopping centers worse and increases transport costs. City logistics might solve this problem.
- Strategic arguments. The amount of transportation of commodities is expected to double within 20 years while existing modes can hardly deal with this growth. New types of transportation could provide a long-term solution.

These arguments refer to problems in the freight transport market in the short term and long term, such as congestion and the environment. The urgency of the problem differs depending on the situation.

3.8 POLICY INSTRUMENTS

Different roles require different policy instruments or policy actions. There are many different types of instruments. A typology of instruments is used that fits as closely as possible to the different roles, described in Table 3.1 (based on Visser, 2006).

3.8.1 What Is the Best Policy Instrument?

It is not easy to determine in advance which instrument is best. Several factors determine the choice of a particular policy instrument (effectiveness, efficiency, support, etc.) and influence design choices. For instance, the level of tariffs with road pricing is an important role.

3.8.2 The First Factor: What Is the Problem and What Are the Policy Targets?

An important factor is the problem that needs to be solved (the problem analysis) and what the possible reasons are for the government to act, such as visions and policy targets. Models and behavioral studies can help analyze a problem. In addition, conceptual frameworks or mind mapping are helpful. When the problem is clear, the scope of possible solutions can be determined. A problem can be solved by intervening at different levels, for instance, looking at the problem of noise reduction from trucks. This problem has two sides: the noise produced by trucks and the nuisance experienced by local residents. There are several possible solutions: reduce the noise of the trucks, reduce the noise heard by residents, or attempt to reduce the annoyance felt by the local residents by raising more awareness of the economic importance for the local community.

3.8.3 What Is the Current Role of Government and What Are the (Political) Preferences?

The current role of government (policy consistency) or the current political preferences affect the choice of a policy instrument. For a certain role type, one instrument fits better than another does.

Table 3.1 Policy Instruments

Policy Instrument	**Examples**	**Category**
Platforms	National, regional, or local freight forums	Communication
Education	Workshops, courses, best practices, workshops for stakeholders	Communication
Naming and faming/shaming	Green awards	Communication
Benchmarking and monitors	Annual traffic reports	Communication
Licenses, labeling, or certification programs	Freight operator recognition scheme	Regulation
Traffic and parking regulations	Daytime or nighttime truck bans, time windows, vehicle restrictions, commercial vehicle parking plan	Regulation
Emission standards	Low emission zones	Regulation
Concessions	Concessions for operating urban distribution centers	Regulation
Covenants and agreements	Protocols, codes of conduct, covenants, gentlemen's agreements	Co-regulation
Consultation	Taskforces, commissions	Consultation
Loading and unloading facilities	On-street loading bays	Facilitation
City logistics services	Public consolidation centers, urban delivery services	Facilitation
Arbitration	Mediation, ombudsman, disciplinary	Law
Pricing and taxation	Road pricing, eco tax	Fiscal and financial instruments
Subsidies	Clean vehicle subsidies, vouchers	Fiscal and financial instruments
Cap-and-trade	Emissions trading	Fiscal and financial instrument
Infrastructure provision	Dedicated lanes, freight routes	Infrastructure planning
Launching customer (first buyer)	Ordering of electric vehicles for own use	Market introduction

3.8.4 Combinations of Instruments

An important notion is that in practice, policymaking combines several policy instruments, in primary or supportive roles. As an example, introduction of road pricing also requires regulation—regulations in this case to support the instrument pricing to ensure the necessary legal basis of the pricing itself, but also for law enforcement.

3.8.5 Design Choices

Design choices influence the effectiveness and efficiency of policy instruments. For instance, with road pricing, the level of pricing is important or with communicative instruments, the choice of media affects how the message is formulated. Each instrument has different parameters with various levels of effectiveness, social acceptance, and costs. This makes it difficult to say something about the effectiveness and efficiency of instruments relative to each other. However, there is much literature in which instruments are assessed on their merits.

3.8.6 Dynamic Use of Policy Instruments

The role of the government can change over time, while different policy instruments will be deployed. After all, many problems have a sort of life cycle. For example, when it comes to promoting the use of biofuels, in the initial stage it is more important to help start up the innovation process and to make the technology available while at a later stage, instruments are needed that help reduce cost differences between regular and biofuels. Major social changes generally use different instruments on several fronts simultaneously in different combinations over time.

3.8.7 Assessment of Policy Instruments

The choice of instruments can be determined based on an assessment of the (social) costs and benefits. Efficiency is often an important decision criterion. In practice, other aspects or criteria play a role, such as effectiveness, equity, complexity, feasibility, the available budget, and what is socially accepted or has political or the people's support. Some criteria work contrary to one another. For example, high road pricing may be effective but can also have little support. Other measures may be less effective but more supported or are easier to implement and cost less.

In addition, policy consistency, political preferences, accumulated expertise, and experience with the effectiveness and efficiency of an instrument play a role. In addition, government actions must fit within the national and international legal frameworks, including the general principles of good administration. The final choice of instrument or combination of instruments is often customized to the situation and will ideally be achieved by an iterative, interactive, and information-rich process of decision-making.

3.9 SOME REFLECTIONS ON PUBLIC POLICY MAKING

In this chapter, we presented a framework for developing and evaluating policy strategies in the field of city logistics. This framework supports policy making but in the end, local or national politics determine what kind of policy actions will be taken. Local circumstances play an important role. In this process, we can learn from previous policy making and from experiences elsewhere but we must keep in mind that new technologies and approaches will become available. For instance, new technology, in particular new information technology, provides new tools for access control but also for cooperative transport services. Measures that were not feasible in the past might work in the future.

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4

Urban Planning with City Logistics

Kazuya Kawamura

Contents

4.1 INTRODUCTION

While the profession of urban planning became institutionalized with the widespread of regulation of land use in the early 20th century, the practice of city planning is as old as cities themselves. Meanwhile, transport of freight has been a constant challenge for most major cities in the world, most of which owe their origins to the geographical advantages provided by access to waterways. Ironically, it can be argued that transport of freight was a more visible issue in city planning before the electrification and automobilization of cities. Until the early part of the 20th century, transportation planners paid a great deal of attention to the need to deliver coal to both residential and industrial buildings in cities for heating. Also, before the segregation of land uses, transporting raw material and manufactured products within and outside of urban areas, which had to rely heavily on rail, was a serious concern. As such, some of the plans included innovative and ambitious strategies to efficiently move freight in cities. For example, the Plan for Chicago, often referred to as the "Burnham Plan" (Burnham and Bennett, 1909), called for the maximum utilization of the 60-mile system of tunnels under the city of Chicago to move freight within the core area of the city (DiJohn and Allen, 2009). Furthermore, Burnham and Bennett (1909) proposed that deliveries to the downtown areas be restricted to the nighttime (from 1 a.m. to 7 a.m.) to reduce congestion (DiJohn and Allen, 2009).

With the advent of automobiles and decentralization of cities, movement of freight took somewhat of a backseat to the need to accommodate the explosive growth in passenger travel. It should be noted that modern urban transportation planning, established during the late 1950s and fully institutionalized during the 1960s and the 1970s, relies heavily on travel demand forecasting models for the development of plans and programming of projects. While the analysis and modeling of passenger travel has enjoyed a series of major advancements over the last five decades, development of freight models has lagged behind. The reasons for the relative lack of progress in freight demand forecasting models are discussed elsewhere (e.g., Regan and Garrido, 2002; Cambridge Systematics and Geostats, 2010), but the lack of adequate analysis tools and quantitative justification to support freight-related projects is one of the contributing factors for the surprisingly poor representation of freight-related projects in the transportation plans in the U.S. and elsewhere (Cambridge Systematics et al., 2007). In addition, the trend toward deregulation of the freight industry that started in many countries during the later part of the 20th century, in some instances, has moved governments to play a lesser role in freight infrastructure planning.

In recent years, however, freight-related issues are starting to attract more attention from decision makers in both the U.S. and Europe. In many of the developed countries, the growth in passenger vehicle kilometers of travel (VKT) has either stagnated or even turned negative. On the other hand, due to globalization and the continuing evolution of supply chain systems, truck traffic is expected to increase at an alarming rate. This has caught the attention of decision makers and there has been a renewed interest in freight transport at the highest level of governments as evidenced by the mandate to develop the long-awaited national freight policy for the U.S. (United States Congress, 2012) and continuing commitment by the European governments to identify and compile best practices for managing urban freight (Allen and Browne, 2007; SUGAR, 2011). However, in practice, the most serious issues concerning freight are often observed in dense urban core areas, and most planning departments at the municipal level are not adequately prepared to address freight issues within their jurisdictions by incorporating the information and techniques that have been assimilated in the research community. With that in mind, the goal of this chapter is to summarize some of the key aspects of freight transport as they relate to the responsibilities/activities of urban planners and introduce opportunities for planners to effectively incorporate urban freight considerations and city logistics strategies in plans and policies.

Before presenting strategies that are available to urban planners for better facilitating freight movement in their jurisdictions, it is important to understand planners' day-to-day responsibilities. The responsibilities of urban planners are much broader than the development of long-range transportation plans and programming transportation projects. In most regions of the world, land use (also called spatial planning) and urban design are the two main domains of urban planning.

Planning and regulation of land use is arguably the most important domain of urban planning. These responsibilities of planners often put them in the position to directly or indirectly (often inadvertently) influence the efficiency and effectiveness of freight transport. These can include planning or reviewing a plan for an industrial park development, developing zoning regulations as well as reviewing parking regulations for a neighborhood. Freight transport systems often require large-scale infrastructure facilities such as terminals and warehouses to function and planners frequently engage in the development of those support facilities. Even in cases where the proposed development is relatively modest and includes only commercial or residential properties, planners should be cognizant of their impacts in generating demand for freight transport.

Design of urban built environments that typically consist of buildings, streets, sidewalks, and open spaces also falls within the responsibility of planners although they work closely with architects, landscape architects, and engineers. While consideration of non-motorized transport, especially bicycles, has become a standard practice in urban design, it is important to ensure that delivery of freight to homes and businesses can be done safely and efficiently.

In addition, in the last two decades, actively involving the public and incorporating their input has become an important component of the planning development process, and urban planners often assume a leading role in public outreach activities. Reaching out to stakeholders for freight-related issues has been a challenge. This is because the stakeholders often do not have a strong political representation within the planning jurisdiction or are too fragmented to voice their concerns in a coherent manner.

4.2 UNDERSTANDING MODERN SUPPLY CHAINS

This section introduces some of the key aspects of freight transport and logistics that are relevant to urban planning. Since most planners are familiar with major issues related to passenger transport, the discussion will focus on highlighting some of the important differences between freight and passenger transportation systems and their implications for urban planning.

It should be recognized that most supply chains extend far beyond any single political boundary that is typically the basis for defining the jurisdiction of a planning entity. Unlike passenger travel, even when the jurisdiction of a transportation planning agency covers an entire urban area, it is not unusual that a majority of goods that are generated or consumed by the businesses or consumers in the area have traveled across numerous other planning jurisdictions. Even for cases where the transport of the final products is contained within one jurisdiction, the raw material and energy are typically obtained from other regions or countries. In most urban areas, with rare exception of cities without major ports or freight terminals, freight that is moving within their boundaries at any given moment is a mix of "last-mile" deliveries on the way to the final consumer, intermediate shipments between a pair of nodes within supply chains, and pass-through traffic. The breakdown of regional freight traffic among those three categories of movement is dictated by the land use, time of day, mode, and type of facility.

Today's supply chains include very little margin of error and a disruption to any of its components creates a ripple effect throughout the system and ultimately affects the businesses' ability to compete. As such, each planning entity must be cognizant of the system-wide effects of its decisions. As most transportation planning entities are too small to contain the entire supply chain, coordination with other planning entities is an essential aspect of effective freight planning. The subject of coordination and partnerships among public sector entities is covered in other chapters in this book and thus will not be pursued in depth here. However, it cannot be stressed enough that collaboration and coordination among transportation planners at various levels, namely national, state/province, region, and cities for critical activities such as data collection, demand forecasting, policy making, and infrastructure planning is essential for the development of coherent transportation strategies and plans that ensure efficient movement of freight over hundreds or thousands of kilometers.

One of the most striking but often overlooked differences between planning for freight and passenger is the time frame between major technical advancements. Compared with urban passenger transport technologies, which have remained essentially unchanged since the advent of the expressway system, freight transport has gone through several major evolutions during the last few decades. Following are some of the most significant changes in freight transport that have occurred during the last five decades as they relate to urban planning.

The introduction and subsequent growth of the intermodal container is perhaps the most significant technological development in freight transport during the last 50 years. The modern intermodal container technology was invented in the 1950s. After going through periods of refinement, adoption, and standardization, growth in containerized freight transport began to explode around 1990. According to the Bureau of Transportation Statistics, world maritime container traffic grew by 215% between 1995 and 2009 while U.S. maritime container traffic increased by 67% during the same period. In the U.S. domestic market, containers have replaced trailer on flat cars (TOFC) as the main technology for intermodal shipments (American Association of Railroads, 2013). Even today, containerized intermodal freight represents the fastest growing segment of freight transport.

The projected growth in containerized freight has prompted the expansion of port capacities as well as the well-known widening of the Panama Canal to accommodate large container ships. These massive projects have a potential to affect global freight flow patterns in a short time period. Containerization has also prompted the proliferation of specialized intermodal terminals to handle the transfer of containers between various modes. In the past, major intermodal terminals were associated with large ports. However, during the last two decades, as shippers and carriers have aggressively expanded containerization, many large-scale terminals have emerged in inland areas. At a minimum, an intermodal yard must be equipped with gantry cranes to lift and move containers and easy access to both rail and trucks to be effective. It is also desirable that intermodal terminals are large enough to accommodate trains that can sometimes exceed 2 km in length.

These requirements often pose a constraint on candidate sites. In the past, facilities such as warehouses and rail terminals were located near the manufacturing facilities or population centers within an urban area. Intermodal terminals, meanwhile, tend to favor suburban or even rural areas due to the availability of land and lower congestion. The combined migration of population and businesses that generate the demand for freight has led to the phenomenon known as "logistics sprawl" (Dablanc and Rakotonarivo, 2010). While the social benefit (or cost) of logistics sprawl is currently not well understood, it is clear that it has had profound effects on the movement of freight within urban areas.

The second evolution that has had a profound impact on urban freight transport is the relentless pursuit of leaner and more efficient supply chains. This evolution has led to remarkable improvements in the efficiency of logistics activities in both the U.S. and Europe during the last three decades. The share of business logistics costs in GDP in the U.S. has decreased from roughly 16% in the early 1980s to less than 9% today (Council of Supply Chain Management Professionals, 2013; Macrosys Research and Technology, 2005).

While the evolution of supply chains is far from over, it has already brought about several major shifts in urban freight systems. Modern supply chains require an unprecedented level of speed and reliability in freight transport to function properly. In other words, any disruption in the transportation system that causes traffic delays and itinerary uncertainties tends to cost more for the businesses than before, and their expectations for the performance of the transportation system, especially in the areas of reliability and resiliency, have never been higher. As the economies in developed countries continue to shift from manufacturing to services, many traditionally industrial cities with large blue-collar labor forces are seeking to replace manufacturing jobs with those in supply chain and logistics industries. It is becoming imperative for those cities to provide transportation infrastructure that can attract businesses to those industries. It should be noted, however, that transportation infrastructure is only one of the ingredients that affects the economic competitiveness of an urban area and job creation. In fact, studies of the effects of transportation infrastructure on the economy at the regional level have generally found only weak or insignificant relationships.

One common strategy for reducing the cost of a supply chain is to take advantage of cheaper transport costs to reduce inventory costs. Strategies

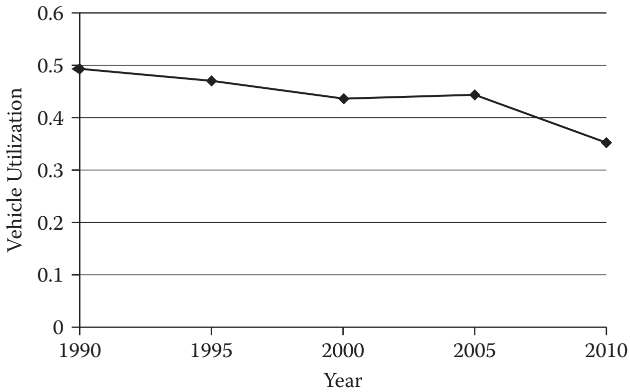

Figure 4.1 Freight vehicle utilization rates in Japan. (Adapted from Ministry of Land, Infrastructure, Transport and Tourism, 2010.)

such as just-in-time inventory typically require frequent shipments that are less than a full load. While such a strategy increases the frequency of delivery trips, the savings in inventory costs can overcome the increase in transport costs to produce an overall net benefit. As a drawback, however, those strategies have contributed to the rapid increase in truck and rail vehicle miles traveled in many countries.

Data from Japan (Figure 4.1) show that vehicle utilization rates, measured in terms of the ratio of actual ton-miles to hypothetical maximum ton-miles based on vehicle capacities, have experienced a steady decline reflecting the effects of leaner supply chain strategies. In the U.S., Hesse and Rodrigue (2004) found that the share of transportation costs within the total logistics costs has increased from 46.5% in 1980 to 58.6% in 2000. More recent data (Council of Supply Chain Management Professionals, 2013) show that the figure is nearly 63% today.

4.3 URBAN PLANNING FOR FREIGHT

As discussed in the previous section, modern supply chains and logistics systems went through several major changes that are directly relevant to urban planners' work in dealing with freight issues. They are proliferation of intermodal terminals, sprawl of logistics facilities, decrease in truck utilization rates and subsequent increase in truck trips and VKT, and greater importance of reliability and resiliency in freight transport systems. This section discusses ways in which planners can adapt their practices to effectively address impacts arising from these changes.

4.3.1 Planning Process

Although long-range transportation planning has guided the development and maintenance of transportation systems for the last five decades, it must be recognized that typical planning horizons for such processes of 30 to 40 years into the future may not be suited for freight. As described in the previous section, supply chains, logistics systems, and freight transport have gone through several major technological evolutions in the last few decades. As a result, projects or policies that were perfectly reasonable to address freight issues back in the 1980s would be completely off target today. Similarly, it is likely that some of today's solutions to freight issues would be obsolete long before the long-range planning time horizon. While it is certain that the evolution of supply chain management will continue in the future, it is next to impossible to predict what exactly those changes will be and how they would impact society. This means that instead of the approach that relies heavily on travel demand forecasting models to quantitatively evaluate plan alternatives for the future that is several decades away, a different approach should be employed to carry out the planning process for freight. In addition, plans should emphasize short to medium objectives, with a time horizon of 10 years or less, instead of longer-term ones. This often means that freight transportation plans should have a shorter horizon than their passenger transportation counterparts should.

Experiences from around the world (Transport for London, 2007; Delaware Valley Regional Planning Commission, 2013; DaBlanc, 2007; Giuliano et al., 2013) suggest that a combination of stakeholder inputs and careful analysis of available data can produce a set of effective strategies to address urban freight issues. In most cases, a panel that consists of stakeholders from businesses and policy makers is formed. Such a panel provides input throughout the plan-making process that typically consists of needs identification, development of alternatives, evaluation of alternatives, and implementation. Although data and analysis still play an important role in the process, they can be more useful for informing the panel and facilitating the discussion rather than predicting the future.

The types of businesses to be represented in the panel vary by the region, but manufacturing, transportation/logistics, retail, commercial real estate development, and utilities are the common sectors. Interviews and workshops are common methods used to obtain inputs, but surveys can be used effectively during the initial phase to assess the overall sentiment of the stakeholders and identify the most critical issues that need to be addressed. Often, the most important and challenging task for adopting such a participatory planning approach is to engage the stakeholders and maintain their interest in the entire process. Planners must be cognizant that businesses would not allow their employees to participate and use their precious time by serving on a panel unless it brings benefits. This enforces the notion that short- to medium-term projects and policies that can be implemented within a relatively short timeframe are more appropriate for freight plans. Ideally, those projects should be included in the final plan to show the businesses that it was worthwhile for the company to let its employees participate in the process.

One likely consequence of adopting shorter planning time horizons and utilizing panels rather than quantitative evaluations to determine project priorities is that compared to other priorities such as passenger transport, freight projects appear to lack legitimacy. As it is rare that freight projects can be evaluated using the same criteria as other projects, it is ideal to dedicate a separate funding pool to finance freight projects. Furthermore, for best results, it is preferable to establish a parallel process for freight, separated from that of passenger transport. However, this does not mean broader impacts of freight projects on passenger transportation or other planning goals can be ignored.

4.3.2 Managing Truck-Related Congestion

As mentioned earlier, congestion is a serious threat to modern supply chain systems. A survey of available data by Giuliano et al. (2013) shows that truck traffic typically accounts for 7 to 15% of VKM in urban areas. Because congestion impacts (i.e., passenger vehicle equivalency) of each truck can be two to three times that of a passenger vehicle on moderately hilly terrain (Al-Kaisy et al., 2005), truck traffic can play a significant role in the level of congestion. It should be kept in mind that truck traffic generated by large-scale facilities such as distribution centers is not the only source of congestion associated with freight transport. Retail stores or even condominiums contribute to congestion by generating demand for freight deliveries.

There are numerous tools to reduce congestion impacts of truck traffic. In general, they can be grouped into demand-oriented and supply-oriented strategies. Demand-oriented strategies are designed to reduce or shift truck traffic through measures such as delivery consolidation, off-peak deliveries, various forms of pricing, and load factor requirements. Supply-oriented strategies, on the other hand, try to improve the performance of transportation systems or promote more efficient use of infrastructure to better accommodate truck traffic. Intelligent Transportation Systems (ITS), various forms of vehicle regulations and restrictions, loading area management, underground distribution systems, and better street design can be included in the supply-oriented strategies. Details of most of these strategies are covered in the other chapters of this book and will not be discussed here. However, street design that can efficiently accommodate delivery vehicles is an important but often overlooked issue for urban planners and is touched on here.

The truck traffic associated with the "last mile" portion of a supply chain is generated by the demand associated with final consumers. In the city core, deliveries associated with restaurants, shops, hospitals, schools, and offices can account for a significant share of total traffic. Furthermore, double-parked delivery trucks can be even greater contributors to congestion. A study in the U.S. by Han et al. (2005) found that illegal parking by delivery vehicles was the third leading cause of non-recurring congestion in urban areas.

Many of the efforts to manage truck traffic arise from citizen complaints. Although the first instinct is to eliminate trucks from the neighborhood, it is important to realize that taking away access would not likely stop trucks from making deliveries even if it means violating the law. Delivery trips are not discretionary in nature because businesses need supplies to operate. Rather than imposing strict restriction on trucks, regulations and urban design should enable delivery activities to take place in as efficient a manner as possible, thereby reducing the dwell times and illegal parking. Figure 4.2 and Figure 4.3 show the contrasting approaches. Figure 4.2 is a case where a wide sidewalk has been carefully designed to accommodate pedestrians and bicyclists (note the parking spaces for bicycles and colored pavement delineating bicyclists and pedestrians), but without much consideration for freight delivery activities. Aside from the fact that there are no designated loading spaces, the barrier that separates the road and sidewalk restricts the access points that the delivery personnel could use to make a delivery. Faced with this situation, delivery trucks have no choice but to park illegally and complete their delivery as seen in the figure.

Figure 4.3 shows an example of a street design that helps reduce dwelling times and parking violations. In this area, a curbside loading zone is

Figure 4.2 Illegally parked delivery vehicle.

Figure 4.3 Dedicated curbside loading area for delivery vehicles.

provided for delivery vehicles. The use of bollards and textured pavement, instead of a barrier, to delineate the sidewalk from the street, combined with low curb height also facilitates loading and unloading of goods.

Although it is helpful to provide curbside loading zones, studies have generally found that the space must be actively managed in order to be effective (Pivo et al., 2002; Bomar et al, 2009; Better Market Street, 2011). Too often, loading areas are occupied by the vehicles waiting for the delivery time windows to start or service vehicles without any freight to deliver because loading zones provide free parking. In addition, many truckers complain that loading spaces, typically set at 9 to 12 m, are not sufficient to accommodate larger vehicles. Shared lanes that can be reserved for use by specific user groups depending on the time of day are an excellent strategy to maximize the utilization of curbside space.

There is no clear rule for setting the schedule for share lane usage because the vehicle mix and frequency and peaking pattern for deliveries vary by location. As such, it is preferable to collect data such as turnover rate, occupancy rate, vehicle types, dwell times, and other relevant information for each case and develop a loading zone management plan that best suits each location. Finally, planners should be proactive in collecting data or simply observing delivery activities in highly congested areas because truck drivers rarely file complaints or provide any feedback even if a severe problem exists.

4.4 SUMMARY

Unlike passenger transport, planners are usually not able to understand the needs associated with freight transportation based on personal experience and intuition. It is rare that urban planners assimilate adequate knowledge about freight industry from their education and training, which undoubtedly has contributed to the relative dearth of freight projects in most urban transportation plans during the past several decades. To this end, this chapter introduced some of the key concepts and shifts in the supply chain and logistics industry and their implications for urban planning.

The following statements summarize the discussion presented in this chapter:

1. The geographical range and the requirement for speed and reliability of transportation characterize today's supply chains. As such, interagency coordination is critical.
2. To effectively incorporate freight in plans and policies, urban planners must be able to understand technological changes and their impacts. Containerization and evolution of supply chain practices are two of the most significant changes during the last three decades.

3. Due to the speed of evolution of supply chain practices and the lack of adequate analysis tools, it may be beneficial to adopt a planning time frame and a planning development process that are different from that of passenger transport.
4. Facilitating rather than restricting delivery activities will reduce dwelling times and parking violations, which in turn will reduce congestion.

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5

E-commerce and City Logistics Solution

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Contents

5.1 INTRODUCTION

5.1.1 Purpose

This chapter reviews the implications of e-commerce (EC), especially Internet shopping, on transport, and discusses how city logistics can solve the last-mile issues of home delivery in EC. It is not always true that an increase of small-lot freight transport worsens road traffic conditions in urban areas. Parcel delivery companies consolidate efficiently the goods ordered, and transport them in a milk-run manner. Furthermore, passenger trips with a shopping purpose could be reduced by EC to some extent.

After defining the term EC, we summarize and compare the situation regarding EC and delivery services in the United States, Europe, Japan, and China. We confirm that qualified delivery services with lower costs are becoming a more important factor for developing EC, although the priority among service quality varies somewhat by country.

In order to provide qualified services, logistics functions including logistics-center related functions and delivery functions should be performed efficiently. In particular, establishing sophisticated large-scale logistics systems is playing an important role in delivering goods with a short lead-time. Following the analysis of logistics systems for EC, we show that the many large-scale logistics centers with efficient goods handling equipment utilizing information and communication technology (ICT) have been established in advanced EC markets, by both EC retailers and parcel delivery companies.

In order to make last-mile small-lot delivery in urban areas efficient, the knowledge and experience of logistics service providers are indispensable. It is likely for EC retailers to outsource the delivery function to the parcel delivery companies. By analyzing characteristics of parcel delivery, the importance of consolidation and systematization of flow of goods are highlighted. We show an example of the most sophisticated delivery services, that is, same-day delivery service provided by Japanese parcel delivery companies. Another issue regarding home delivery is delivering to homes where the occupants are absent, where pick-up points and click and collect are discussed. We also investigate the effects of EC on total freight and passenger shopping trips.

As a conclusion, we stress the importance of innovative logistics systems and sophisticated delivery services in urban areas under the cooperation of EC retailers and logistics service providers in order to solve last-mile issues.

5.1.2 Definitions of EC by the OECD

As policy interest grows in EC, governments or interest groups have introduced definitions of EC in order to understand the actual situation. For example, the OECD provided a definition in 2009 as shown in Table 5.1; EC is the transaction of goods or services by computer networks such as Internet, extranet, or electronic data interchange (EDI). The OECD classified EC into two functional categories—web EC and EDI EC. When orders are made to an online store or via web forms on the Internet or extranet, this transaction is classified as web EC. When orders are initiated with EDI, they are classified as EDI EC (Table 5.2).

Table 5.1 The 2009 Definition of EC by OECD

Definition	**Guidelines for the Interpretation of the Definitions**
An e-commerce transaction is the sale or purchase of goods or services, conducted over computer networks by methods specifically designed for the purpose of receiving or placing of orders. The goods or services are ordered by those methods, but the payment and the ultimate delivery of the goods or services do not have to be conducted online. An e-commerce transaction can be between enterprises, households, individuals, governments, and other public or private organizations.	Includes: orders made in web pages, extranet, or EDI. The type is defined by the method of making the order. Excludes: orders made by telephone calls, facsimile, or manually typed e-mail.

Source: OECD (2009).

Table 5.2 The Classification of EC by OECD

Type	Definition of the Type of EC
Web EC	Orders made at an online store (web shop) or via web forms on the Internet or extranet regardless of how the web is accessed (computer, laptop, mobile phone, etc.)
EDI EC	Orders initiated with EDI. EDI is an e-business tool for exchanging different kinds of business messages. Here, EDI is used as a generic term for sending or receiving business information in an agreed format, which allows its automatic processing (e.g., EDIFACT, XML, etc.) and without the individual message being manually typed. "EDI e-commerce" is limited to EDI messages placing an order.

Source: OECD (2009).

5.1.3 Scope of EC

Although EDI EC streamlines business transactions between companies, it does not have a large influence on home deliveries. Thus, we mainly deal with web EC as defined by the OECD in this chapter.

EC also can be classified by parties concerned (Nemoto et al., 2001). Four types of stakeholders are identified, namely shippers, consumers, governments, and logistics service providers (including carriers). EC from businesses to consumers is often called B2C and EC from consumers to consumers is C2C, and so on. B2C is our main concern because of its importance for city logistics. Often, the term net shopping is used for B2C situations (Figure 5.1).

5.2 GROWTH OF EC AND DELIVERY SERVICES

5.2.1 Consumers' Demand for EC

The Ministry of Economy, Trade, and Industry in Japan points out that consumers value highly the convenience of net shopping because they can compare many net stores and buy merchandise at any time of the day without going out to shop (METI, 2012). Furthermore, websites for price comparison escalate price competition among net stores. As for ordering methods, consumers are now using personal computers, notebooks, mobile phones, and tablets; thus, they are ordering not only at home but also in the office or even while moving. As for the type of merchandise

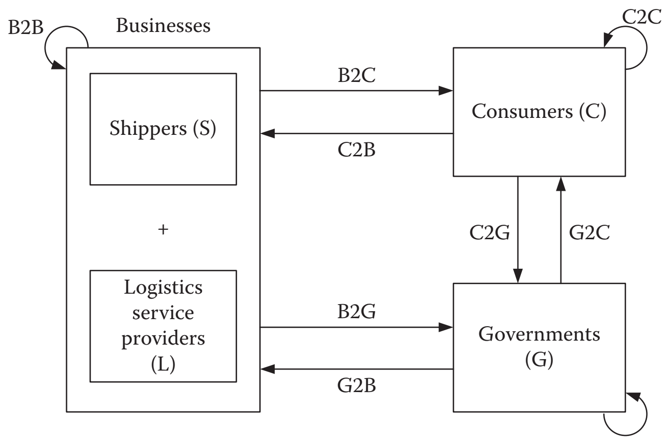

Figure 5.1 Transactions among stakeholders (Nemoto et al., 2001).

bought by net shopping, books, magazines, apparel, accessories, CDs, DVDs, beverages, and alcohol are popular.

The level of service of deliveries is an important factor for net shopping. Consumers are eager to get merchandise as soon as possible and to be delivered at the place where they want it. Same-day delivery service is becoming popular in large cities in the United States and Japan. Consumers can select the location of delivery points such as home, office, convenience stores, or pick up points. Not only the price of merchandise but also the delivery fees are important for consumers. Many net stores are now introducing a policy for free delivery when the total amount of shopping exceeds a certain level.

Consumers demand that net shopping be convenient and cheaper. Thus, delivery services should also be convenient and cheaper. Demand for net shopping is somewhat similar all over the world because net shopping is a global trend. However, the prevalence of net shopping is different in many countries, depending on factors such as Internet usage, income, custom, distribution channels, and so on.

5.2.2 United States

The United States has the largest Internet shopping market in the world. According to US Census Bureau, B2C EC sales rose every year except for 2009 because of the financial crisis and reached $224 billion in 2012

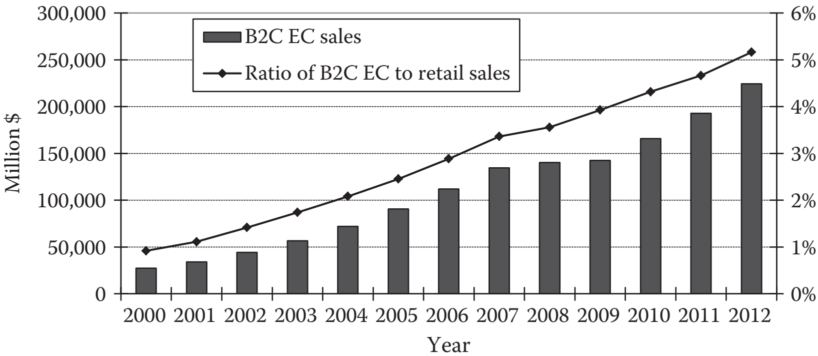

Figure 5.2 Amount of sales by EC and the ratio of EC to total retail sales in the United States (US Census Bureau, 2013).

(Figure 5.2). B2C EC share of corresponding retail sales continued to rise from less than 1% in 2000 to 5.2% in 2012. During this period, sales at department stores continued to decline, and were exceeded by EC sales in 2011.

The Internet shopping sector has been led by Amazon.com since its establishment in 1994. Amazon.com invests in logistics and information systems to increase its level of services and to decrease costs at the same time. In 2012, Amazon.com's revenue exceeded $61 billion and it became the number one Internet store in the world. Amazon.com has expanded its business to many countries and has dominated top revenue positions in Japan and many European countries. Amazon.com takes the long tail strategy by holding many kinds of stock to prevent stock outs and to deliver them in a short lead time. It has been increasing its level of delivery services and now offers same-day delivery services (Local Express Delivery) in 12 cities in the United States for Amazon Prime members.

The second largest EC business, eBay, also introduced same-day delivery service (eBay Now) to compete with Amazon.com. Other EC businesses need to catch up with Amazon's delivery speed. Delivery speed is one of the most important qualities of delivery services.

Real stores have to initiate countermeasures to enter EC by establishing net divisions or by acquiring Internet stores. Walmart has introduced Internet store delivery free of charge when the total amount purchased exceeds $45. It has also started a same-day delivery service for $10 in four cities in the United States. In 2008, it established "site to store" where consumers can pick up merchandise ordered via the Internet at retail stores for free. Other brick-and-mortar stores such as Nordstrom and Sears have introduced the same services.

5.2.3 EU

Civic Consulting (2011) estimates that the B2C EC market in the European Union (EU) was approximately 94 billion Euros (approximately $121 billion) in 2010, which represented around 3.5% of the total EU retail sector.* The situation of B2C EC is quite different in EU member countries. The top country in terms of share of Internet retailing is the UK (7.9%), followed by Denmark (5.4%), Finland (4.0%), Sweden (4.0%), France (3.9%), and Germany (3.9%). In other countries, EC barely registers as a share of the total retail sector (Figure 5.3).

Amazon opened its website in the UK and Germany in 1998, and established its fulfillment centers in both countries in the following year. Amazon has expanded its business in Europe rapidly since then, and now operates websites in France, Italy, and Spain. Amazon is one of the most popular websites in Europe, with revenue in 2012 reaching $8.7 billion in Germany and $6.5 billion in the UK.

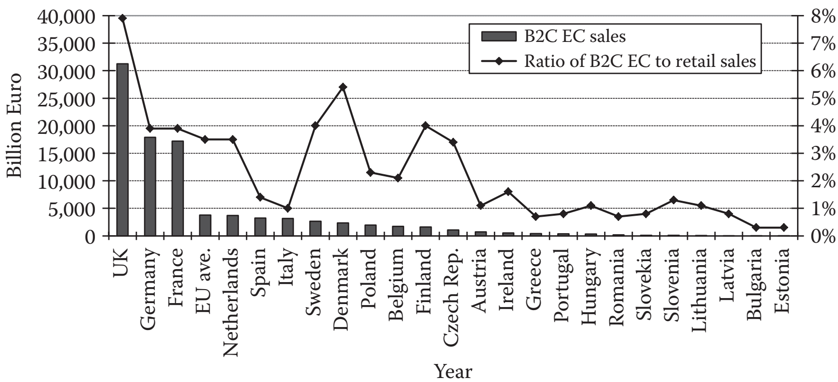

Figure 5.3 Amount of sales by EC and the ratio of EC to total retail sales in the EU (2010) (Civic Consulting, 2011).

* Estimated data from 24 member states (excluding Cyprus, Malta, and Luxembourg). This calculation excludes specialist retailers of motor vehicles, motorcycles, vehicle parts, fuel, foodservice, rental and hire, and wholesale industries.

Recently many European Internet stores have started business, and some brick-and-mortar stores have been trying to compete with Internet stores. The level of delivery services is increasing as competition gets fierce. Amazon has introduced a free one-day delivery service for Amazon Prime members, and other EC retailers have introduced the same kind of service. One of the more interesting examples in Europe is the UK Shutl.com that has started a 90-minute express delivery service from downtown brick-and-mortar stores in London by networking local express carriers with Internet technology. Brick-and-mortar stores can deliver their merchandise in 90 minutes from receiving the order via the Internet using the UK Shutl's express service.

Brick-and-mortar stores in Europe such as Tesco, Marks & Spencer, and John Lewis have also been eager to introduce Omni Channel and became click-and-mortar stores. They have introduced a click and collect (C&C) option that allows consumers to pick up goods ordered via the Internet at their real stores. According to these stores, approximately 30 to 50% of European consumers chose C&C options.

5.2.4 Japan

The total size of the EC market including information services in Japan was estimated to be 8459 billion yen in 2011. B2C EC spending limited to retail and services was estimated to be 5892 billion yen or US $58 billion. Its share of total corresponding retail and services sales remained at 2.83%, which represents a 0.37% increase from the preceding year (METI, 2012). This share has been increasing year by year because more people are using the Internet and are shopping via the Internet than ever before (Figure 5.4). However, the ratio of EC in Japan is still behind that of the U.S. and many EU countries.

The biggest EC retailer in Japan is Amazon Japan with revenue of 780 billion yen, followed by Rakuten with 443 billion yen, and Yahoo! Japan with 343 billion yen. Rakuten and Yahoo! Japan are so-called Internet malls, providing EC opportunities for 40,000 and 3600 stores, respectively. Some real stores also have established their own websites, and others choose to open stores in these Internet malls.

Amazon Japan started a same-day delivery service in several large cities in 2006 and a next-day delivery service free of charge in 2010. It has expanded the number of areas for same-day delivery by establishing 12 fulfillment centers throughout Japan. Internet malls such as Rakuten

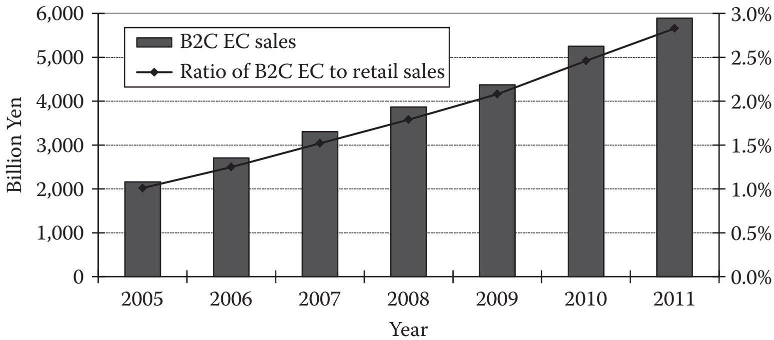

Figure 5.4 Amount of sales by EC and the ratio of EC to total retail sales in Japan (METI, 2012).

and Yahoo! Japan used to leave the responsibility of delivery services to each store in their malls. Thus, the time and charge for delivery service varied by store even in the same Internet mall. In order to catch up with Amazon Japan, larger Internet malls, including Rakuten and Yahoo! Japan, decided to develop their own logistics systems.

As for the type of merchandise being bought online, fresh foods such as fish, meat, and vegetables are becoming popular in Japan. In order to deliver these fresh foods, Internet retailers have established cold chain logistics systems with temperature-controlled distribution centers and delivery trucks.

5.2.5 China

According to China Internet Network Information Center (2013), the number of Internet users has grown rapidly to reach 564 million and the share of Internet users among the total population was 42.1% at the end of 2012. The estimated size of the Internet shopping market was 1304 billion RMB (about US $183 billion) representing 6.2% of the goods consumed in the retail market (iResearch, 2013). Although B2C has grown rapidly, the majority of the Internet shopping market is still dominated by C2C. The Internet shopping market was estimated to consist of 29.7% B2C and 70.3% C2C in 2012. Thus, the size of B2C market was estimated to be 387 billion RMB (about US $54 billion), representing 1.8% of goods consumed in the retail market (Figure 5.5).

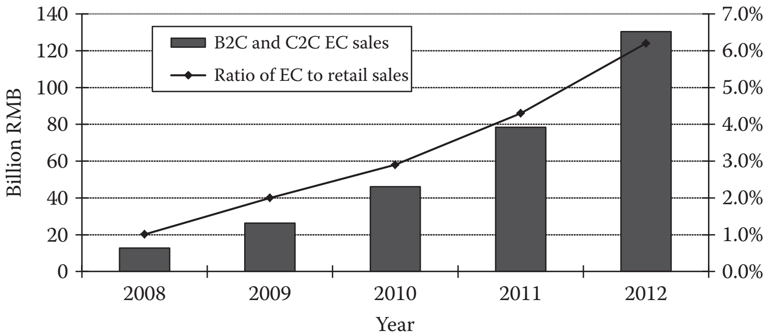

Figure 5.5 Sales by EC and the ratio of EC to total retail sales in China (iResearch, 2013).

Alibaba.com group established in 1999 has led the Chinese Internet shopping market. Alibaba.com group consists of Taobao.com[*] for C2C business, Tmall.com for B2C business, Alibaba.com for B2B business, Alipay for settlement business, and others. Taobao.com dominated more than 90% of the C2C market and Tmall.com occupied 53% of B2C market in 2011. Following Tmall.com, 360Buy.com comprised 17% and Suning.com 3% of the B2C market.

The quality of delivery services in China is still poor because a trustworthy logistics industry has not yet been developed. Chinese consumers complain about delays, and missing and broken goods. Chinese governments have policies and guidelines for modernizing parcel delivery companies. 360Buy.com has established its own delivery networks in large cities, and consumers evaluate its delivery service highly. Alibaba.com group has started to develop nationwide logistics networks in cooperation with Suning, one of the largest parcel delivery companies. Suning has more than 1700 real stores in China and not only utilizes its own stores as a base for delivering goods to consumers, but also has plans to build approximately 60 logistics centers for EC.

[*] Taobao.com invites small retailers in its mall, whose transactions could be grouped into B2C in other countries.

5.3 LOGISTICS SYSTEMS FOR EC

5.3.1 Functions of Logistics Systems

For B2C EC it is important to deliver merchandise as soon as possible at the lowest cost. In mature consumer markets such as the United States, EU, and Japan, same-day delivery with lower charges is becoming popular as a result of fierce competition among EC retailers. In China and other developing EC markets, it is necessary to increase the level of delivery services and to decrease costs of delivery, both at the same time.

In order to achieve this difficult goal, introducing state of the art logistics systems is indispensable. Figure 5.6 shows the functions of logistics systems for EC including logistics-center functions (stock keeping, picking and sorting), transport and delivery functions (inter-center transport and home delivery), and information functions (order processing and parcel tracking).

Logistics centers are often called by distribution centers or fulfillment centers. At logistics centers, merchandise ordered by consumers is picked up, packed, sorted by direction, consolidated to smaller delivery trucks, and delivered to consumers. If merchandise is out of stock at the

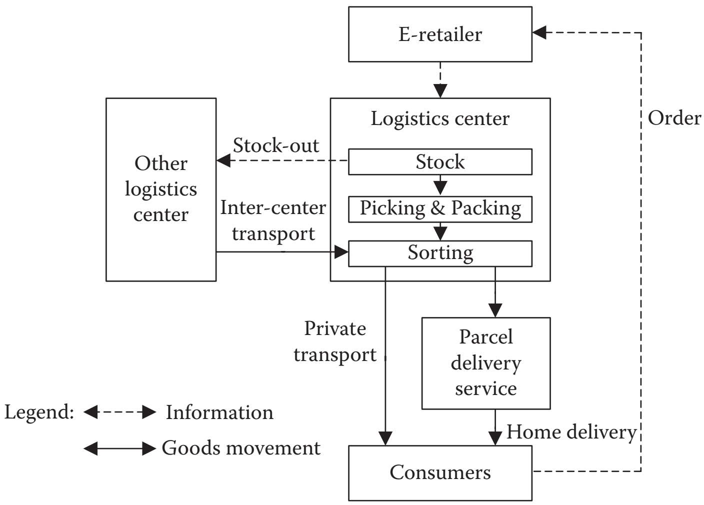

Figure 5.6 Functions of logistics systems for EC.

logistics center nearest to the customer, then goods are transported from other logistics centers to the nearest logistics center, sorted, and delivered to consumers.

One of the characteristics of recent logistics centers for EC is the huge space for stock for the large number of items based on the long tail strategy in order to deliver goods as soon as possible and to decrease the risk of stock-outs. Larger logistics centers also need more truck bays for loading and unloading goods, wider column spans, and higher ceilings for efficient goods handling.

Another characteristic is the utilization of Warehouse Management Systems (WMS) for streamlining the flow of processes such as picking, packing, sorting, and loading of merchandise. The location of each kind of merchandise is managed and inventories are controlled by WMS. All processes are strictly controlled by checking the bar code on merchandise using mobile terminals. Although merchandise in cartons is sorted by automatic sorters, merchandise in cartons is still picked up manually because the sizes of different merchandise vary. Many workers are necessary to pick up a large amount of merchandise in shorter lead-time.

5.3.2 Location of Logistics Centers

One of the important decisions for logistics systems is the location of the logistics centers. In order to deliver goods in a short lead-time, it is necessary to locate the logistics centers close to customers.

The largest EC retailer, Amazon.com, continues to establish large-scale logistics centers close to big cities in the world. In 2011, it had large logistics centers in 47 cities in North America and in 41 other cities throughout the world. The average floor space of centers in North America is 74,000 square meters and in centers abroad is 54,000 square meters. Merchandise ordered via Internet is quickly picked up by workers using bar code readers, sorted by automatic sorters, consolidated by direction, and then loaded on trucks.

In Japan where competition among EC retailers is fierce, many large-scale logistics centers have been built recently near large cities. Especially in Tokyo and Osaka, the supply of logistics facilities cannot keep up with the EC demand, and the ratio of empty space to total space of logistics facilities has decreased to a small percent.

From the viewpoint of city logistics, it is necessary to consider environmental issues from the transport of goods to and from logistics centers.

In 2013 and 2014, some larger logistics centers are expected to be opened in the metropolitan area to keep up with EC demand. One of the largest logistics centers in Japan, Amazon Odawara Fulfillment Center has floor space of 200,000 square meters with approximately 1000 workers. Amazon.com has worked with the local government over issues such as traffic congestion from trucks entering and leaving the center.

5.3.3 Organizing Logistics Functions

Another important decision is how to organize logistics functions, either internally or by outsourcing. EC market leaders such as Amazon.com consider logistics a critical success factor in their EC business and have developed logistics systems by themselves, except home delivery functions, which require many resources, including delivery vehicles and drivers. It seems difficult even for a large EC retailers to utilize the resources efficiently only in EC business.

In particular, it is a common strategy for larger EC retailers to establish logistics center functions by themselves. They regard logistics center functions as a critical part of their logistic systems because the location of distribution centers and their operational efficiency decide the level of service of deliveries. EC logistics centers require investment in very large fixed assets such as land, buildings, and technology. Thus, the larger the volume of goods handled, the cheaper the costs of handling per unit of goods. In order to increase the volume, some large EC retailers have started to provide logistics services for other EC retailers.

Amazon started Fulfillment by Amazon (FBA) service in 2008. EC retailers or stores that want to start EC can utilize FBA for their logistics functions. In its fulfillment centers, Amazon stocks, picks up, packs, delivers, and provides customer service for its merchandise. EC retailers that utilize FBA can concentrate on EC retailing and rely on FBA for their logistics functions but are charged a fee for these services. Other large EC stores also provide the same kind of fulfillment services.

Logistics service providers are also keen to develop fulfillment services that are expected to grow rapidly in saturated logistics service markets. Parcel delivery companies are eager to develop fulfillment services by combining their intensive delivery networks with logistics centers specializing in EC. Logistics service providers that specialize in management and operation of logistics centers are also trying to tackle EC business and succeed in subcontracting the operation of logistics centers from EC retailers. Some of them are providing EC platform services that provide comprehensive support from orders to deliveries relating to EC as mentioned previously as third-party logistics (3PL) service providers. They provide a package of comprehensive services that fit EC retailers' needs to be more flexible and special. By utilizing fulfillment or platform services, smaller EC retailers do not have to invest in or operate their own logistics facilities.

From the standpoint of city logistics, logistics centers operated by logistics service providers or even by larger EC retailers can play an important role as consolidation points for delivering goods to consumers living in the catchment areas of logistics centers. As the number of EC retailers using the same logistics centers increases, they become more efficient and environmentally friendly due to economy of scale.

5.3.4 Logistics Systems of Click-and-Mortar

Internet stores are making rapid inroads into retail markets. Some real stores (brick-and-mortar) are trying to tackle EC markets by using their own websites to get synergistic effects from both channels. Their efforts are sometimes called Omni Channel and store click-and-mortar.

Logistics systems of click-and-mortar are somewhat different from those of EC retailers. Some deliver directly from their real stores to consumers living in their catchment area. Merchandise ordered by a certain time is picked by workers from the shelves in the stores, then loaded on smaller trucks, and delivered to consumers on the same day or the next morning depending on time ordered. For this logistics system, consumer shopping trips are replaced by consolidated deliveries by smaller trucks from stores. Some general merchandise stores (GMSs) or department stores in Europe have established specialized "dark stores" for Internet shopping. Dark stores are separate from original stores, where workers can easily pick up merchandise without disturbing shoppers.

Furthermore, some stores have established larger special logistics centers with special handling machines in order to streamline operations. The logistics efficiency is improved by direct pick-up of merchandise from cartons or returnable containers; otherwise, merchandise should be placed on shelves once and then picked up from there at real stores. Direct pick-up can prevent damage to merchandise especially fresh goods such as vegetables, meat, or fish by eliminating the amount of handling.

Logistics centers for fresh goods are costly because they need cold (temperature-controlled) distribution, safe and careful handling, and more stringent delivery time. Therefore, the establishment of EC logistics centers for fresh goods is limited to larger GMSs. If these logistics systems become prevalent, a large number of shopping trips might be replaced by consolidated delivery from logistics centers.

5.4 THE ROLE OF LOGISTICS SERVICE PROVIDERS

5.4.1 Characteristics of Parcel Delivery

As the vast majority of merchandise for B2C EC retailers is smaller than the capacity of trucks, consolidation is important to increase delivery efficiency. Boyer et al. (2009) show that more deliveries per trip reduce the number of vehicle kilometers per delivery. We can draw the conclusion that more home deliveries resulting from EC do not necessarily mean less efficient freight transport (Figure 5.7).

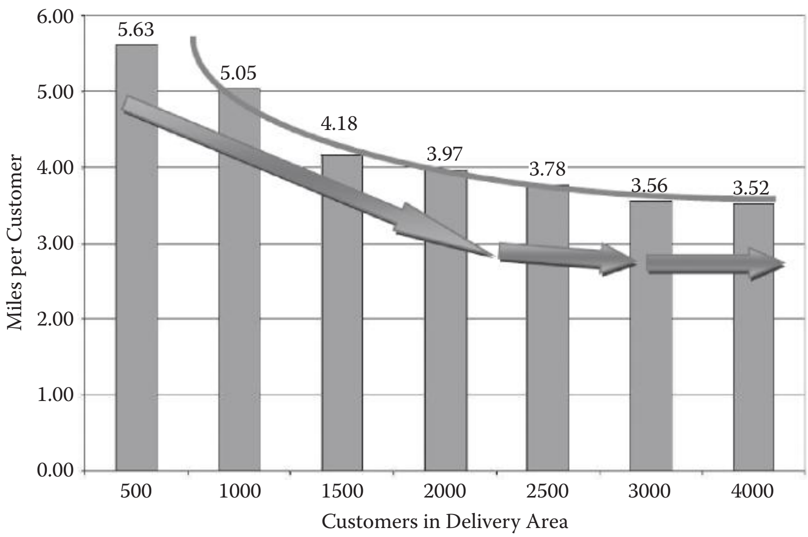

Figure 5.7 The impact on customer density on the average distance per stop in miles per customer. (Based on Boyer et al., 2009.)

Home delivery for small merchandise is usually undertaken by mail organizations, parcel delivery companies, or couriers. Due to the economy of scale of parcel volumes, this freight market tends to be dominated by a limited number of operators in advanced markets. In the United States, UPS, FedEx, and the U.S. Postal Service dominate the small parcel market. In the Japanese small parcel market, Yamato, Sagawa, and JPS (Japan Post Service) play dominant roles. Also in Europe, privatized postal companies and a limited number of private parcel delivery companies play important roles. One of the reasons why EC has grown so rapidly is the existence of trustworthy delivery services by these companies.

Although some parcel delivery companies have grown recently in China, their service levels are not generally high enough to satisfy consumers. Hence, the Chinese government has introduced regulations and guidelines for parcel delivery services. The level of delivery services is also a concern in other developing markets.

5.4.2 Same Day Delivery Service by a Japanese Parcel Delivery Company

In Japan, Internet consumers seem to be more time-sensitive. They tend to change EC retailers and move to other Internet sites if they notice it takes too long for home delivery. This is partly because they have been accustomed to next-day service and delivery time specification service provided by the major parcel delivery companies like Yamato and Sagawa for several decades. Therefore, e-retailers compete by introducing same-day delivery service with the help of parcel delivery companies.

In the case of Yamato, the biggest parcel delivery company transporting 1.4 billion parcels and 2.2 billion pieces of mail in 2011, next-day service is provided by a huge network consisting of 70 terminals, 3900 branch offices, and 260,000 agencies (convenience stores and others). Parcels are picked up by small vans up until the evening and transported from branch offices to terminals. Between the terminals, the sorted and consolidated parcels are transported once a day overnight by large trucks (25 tons gross weight), de-consolidated early in the morning at the terminals, transported to the branch offices, and then delivered to homes.

Same-day service is a new challenge for e-retailers and parcel delivery companies. Recently, Yamato has proposed the concept of "gateway terminals" in order to involve more e-retailers. This newly developed

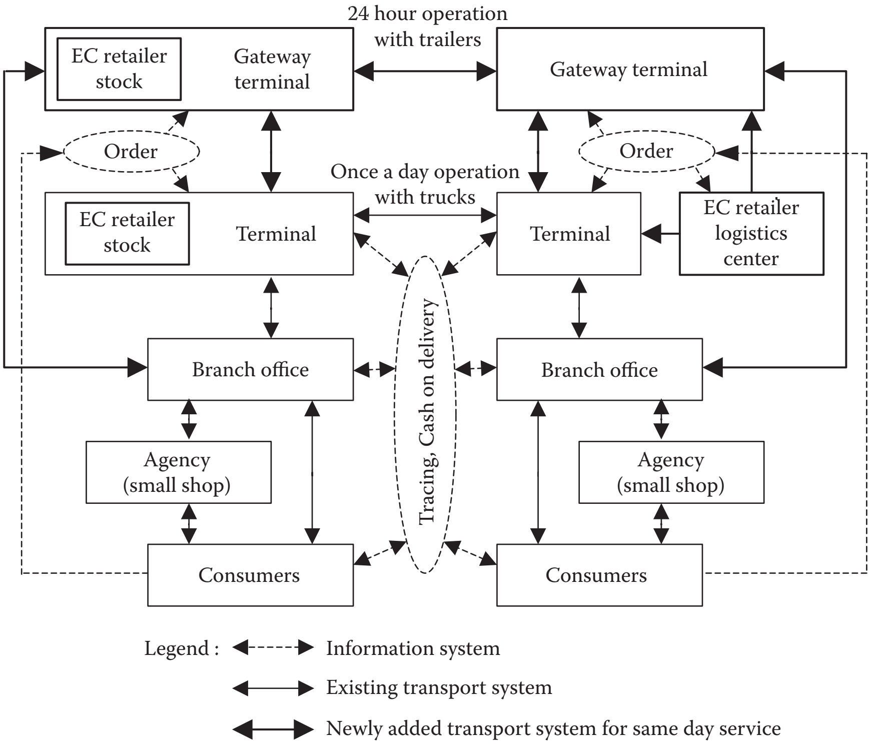

Figure 5.8 New parcel delivery system for same-day service (Yamato's case).

transport system includes gateway terminals with automatic sorting machines and 24-hour transport operation by trailers between gateway terminals. They also request e-retailers to leave their goods on the stock floor in the gateway terminals, or to transfer the ordered goods immediately from their own logistics centers near the terminal (Figure 5.8).

A likely scenario of same-day service can be illustrated by a consumer in Osaka, for example, placing his or her order at 2 a.m. The ordered goods are picked up in the gateway terminal in Tokyo, sorted by destination, and loaded into a trailer bound for the gateway terminal in Osaka by 5 a.m. It takes 8 or 9 hours from Tokyo to Osaka, so the goods arrive before 2 p.m. They are de-consolidated at the gateway terminal in Osaka, transferred to the branch office by 6 p.m., and delivered to the consumer by 8 p.m.

5.4.3 The Development of the Parcel Delivery Market in China

As mentioned previously, the number of people shopping online is rapidly increasing. Accordingly, the number of items related to Internet shopping is increasing in the parcel delivery market. In 2010, 42% of the items delivered were related to Internet shopping, which equals 35% of sales. Many of those Internet shopping related items are delivered by companies with franchise systems;* in fact, 65% of the items delivered by Shentong Express and YTO Express are related to Internet shopping.

In China, there were approximately 7500 companies with permission to provide parcel delivery services at the end of 2011. Most of these are small- and medium-sized enterprises and work as a franchisee. In most cases, these truck operators are not given the job directly from shippers and consumers, but rather they are given the operation of collection and distribution from their franchisers. Although they have the advantage of low transportation charges in these franchise systems, their low service quality due to lack of stable education and training is considered a big problem.

In many cases, the delivery rates for online deliveries are set lower than for normal deliveries, which means that profits are smaller for online order deliveries. However, in the case of online order deliveries, the origin of the transportation is concentrated at a certain warehouse, so the cost of collection is lower as well. The discount competition in Internet shopping is becoming intense in China; thus, free delivery services are becoming the norm in the market. Parcel delivery companies need to deliver a sufficient number of items to survive in such a market.

As the number of deliveries increases, the number of complaints from consumers increases as well. The China Logistics Yearbook in 2010 stated that these complaints are related to either the operation quality or the delivery time. The reasons for the increasing number of complaints are thought to be:

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* The network management can be categorized into two groups—the direct management system and the franchise system. There are two major companies employing the direct management system: one is EMS (China Post) and the other is S.F. Express. On the other hand, five major companies employing the franchise system are intensely competing in the market. They are Shentong Express, YTO Express, ZTO Express, Best Express, and Yunda Express.

1. Low service quality due to low delivery rate as a result of intensified competition.
2. Difficulty of ensuring staff education and training due to the franchise management systems.
3. Consumers' demand for a high quality of service.

5.5 ISSUES REGARDING HOME DELIVERY

5.5.1 Delivering When Consumer Is Not at Home

Although home delivery is appreciated by consumers, a major issue for parcel delivery companies to overcome is when no one is at home at the time of delivery. Most home delivery services only inform the customer on what day the goods are to be delivered and use a time frame of 9 a.m. to 5 p.m. A study in the UK reported that failed first-time home deliveries accounted for approximately 12% of all first-time deliveries (Visser, Nemoto, and Browne, 2013).

To put this figure in perspective, the study estimated that UK retailers generated around 740 million online orders in 2012 and that approximately 1 billion parcels and packets were dispatched in the UK. It was estimated that these failed deliveries cost companies and customers approximately £850 million.

In addition, it is estimated that consumers returned 22% of received orders in 2011 (IMRG, 2012). Larger Internet shops often offer more choices for delivery dates and times to make it easier for the customer and to reduce the likelihood of delivery failure. However, only the carrier can give precise information on time of delivery. With new ICT technology, it is easier to give more accurate information on the time of delivery but the carriers rarely implement such new technology. An alternative for home delivery is the use of pickup points.

Japanese parcel delivery companies have been eager to increase the level of delivery services in order to cope with this issue. Consumers can choose delivery time frames such as 9am–12pm, 12pm–2pm, 2pm–4pm, 4pm–6pm, 6pm–8pm, and 8pm–9pm in the case of larger parcel delivery companies. Even if consumers are not at home at the time of delivery, consumers can ask to have their goods re-delivered. In the case of larger parcel delivery companies, consumers are able to call directly to the driver in charge of the area for re-delivery even later the same day. They are competing with others to introduce the latest ICT for the convenience of consumers. Larger parcel delivery companies have introduced parcel-tracking systems where consumers can search the location and status of their goods by inputting a tracking number via the Internet. Consumers can be notified of the delivery time by e-mail, and can change the delivery time or point via the Internet, if they wish.

5.5.2 Click & Collect and Pickup Points

A number of traditional retailers also have Internet stores. Larger retailers combine ordering by Internet with picking up goods at their stores (C&C). Thus, customers have a much wider choice of products to choose from and have the certainty that the products are available when they pick them up. They do not have to wait for deliveries at home or pay delivery charges. With C&C, the traditional retailers are able to compete with Internet stores.

Particularly in the UK, traditional retailers like Tesco are very successful in the Internet shopping market. They have even introduced C&C points at their drive-through. Also in the United States, some giant stores, such as Walmart and Sears, have introduced C&C. C&C also makes use of consolidated delivery at the stores and is therefore cost efficient.

Pickup points are locations to pick up goods that are ordered by mail or by the Internet. At least two different types of pickup points can be distinguished. The most common are parcel service points (staffed pickup points). This type of pickup point can be found within supermarkets and stores. Not so common are pack stations (unmanned pickup points, using lockers). You can find pack stations in Germany and France. In the Netherlands, there have been some initiatives but thus far, no pack stations have been installed. The number of parcel service points is increasing in the Netherlands, from 900 in 2006 to approximately 4500 in 2013.

Pickup points provide an alternative for deliveries at home when the delivery at home has failed. Internet stores promote the use of pickup points (i.e., Amazon Locker) by not charging for transport when people pick up their goods at a pickup station instead of choosing a delivery at home. Delivery of goods at a pickup station is usually a consolidated delivery and therefore cost efficient. This is a good opportunity for logistics service providers. In the UK, the PUDO (pick up and drop off) service used by operators such as Collect+ has many pickup points, and more than 5000 local stores as well as Internet stores like Amazon and eBay utilize the pickup points.

In Japan, consumers can designate convenience stores as their pickup points. Those who hope to use this service have to register as a member and designate a branch office or an agency from among 24-hour convenience stores. When the ordered goods arrive at the pickup point, the arrival information is e-mailed to the consumer. They can pick up the goods within three days of the date of arrival. Consumers often choose to pick up goods at convenience stores. In addition, some condominium buildings in Japan have recently established unmanned delivery boxes for residents.

5.6 IMPACT ON TOTAL VOLUME OF FREIGHT AND PASSENGER TRAFFIC

Freight transport is influenced by EC. In traditional distribution systems, manufacturers, wholesalers, and retailers have established contracts and the volume of freight transport between them is high, resulting in efficient utilization of trucks and other resources. Last-mile transport is conducted by consumers as passenger trips with a shopping purpose, although there are emerging concerns that old people without driving capability cannot go shopping (Figure 5.9).

In the case of EC, however, consolidated freight transport is used in a limited way while direct delivery to the consumers covers all the other type of goods. Usually small-lot orders are consolidated by parcel delivery companies. Consolidated inter-city freight transport is deconsolidated at their terminals, and the last-mile transport is conducted by small vans or trucks.

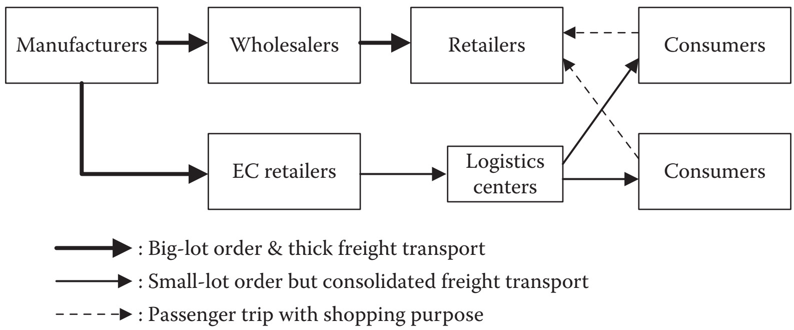

Figure 5.9 Supply chains related to traditional retailing and net shopping.

Small-lot delivery is often criticized for causing an increase in traffic. However, as the last-mile freight transport substitutes passenger shopping trips, it is likely that the total volume of freight and passenger traffic in terms of vehicle-km would not change so much. An important question here is what are suitable city logistics policies to promote efficient last-mile delivery in urban areas?

Several authors (Braimaister, 2002; Weltevreden and Rotem-Mindali, 2008; TNO, 2010) maintain that home delivery leads to more freight traffic, but on the other hand there is less traffic related to shopping. Based on some last-mile scenarios, Edwards et al. (2009) suggested that the home delivery operation is likely to generate less CO_2 than typical shopping trips. Figure 5.10 shows some of the factors that influence increasing and decreasing freight transport (BESTUFS, 2001).

5.7 CONCLUSIONS

This chapter has highlighted that the last few years have been a period of dramatic change in EC and home delivery. The growth in the home delivery channel and the increasingly comprehensive range of services offered by retailers (such as C&C) all lead to changes in the pattern of freight flows and vehicle movements in cities. These changes are complicated and influenced by wider-reaching factors such as demographic changes and the adoption of new logistics technologies.

The impact of these changes remains uncertain. Fragmentation in retail channels could give rise to an increase in vehicle movements in cities as retailers are forced to offer ever-higher levels of service to more demanding consumers. On the other hand, increased levels of service may lead consumers to change their travel behavior and make fewer car journeys as their needs are met by sophisticated home delivery systems (or other suitable alternatives).

The changes discussed here pose major challenges for urban planning. New retail developments may look very different from those of the past 10 to 20 years, and give rise to very different freight flows and travel patterns. Not only are traffic movements affected, however. In addition, there is the need to consider the consolidation points that will be needed in new distribution channels. It is important to consider these changes in a comprehensive way, taking into account travel behavior as well as urban logistics. Only by taking this holistic view is it possible to identify and evaluate the potential impacts of the increased use of home delivery.

General trend		
E-commerce reinforces the general trend in logistics toward smaller consignments, single orders, and thus higher delivery frequency		
Logistic models	**Transport increasing factors**	**Transport reducing factors**
	+	–
Use of existing logistic channels (parcel service, post)	+ larger distances and higher mileage due to global shopping and single order processing	– better bundling and trip optimization thanks to large volumes of goods
New logistic channel: shelf picking	+ only restricted bundling possibilities	– shorter distances for last mile distribution (making it possible to deliver, e.g., by bike)
New logistic channel: dedicated warehouse	+ higher freight mileage because new distribution center has to be served + possibly large distances to pickup points and homes	– better consolidation and trip optimization
Distribution to pickup points (including workplace)	+ higher freight mileage due to high number of pickup points + possible influence on modal choice (might use car for work-journey instead of public transport) + consumers might substitute former shopping trips by other (longer) journeys	– replacement of shopping trips if pickup point is at a location regularly visited anyhow (e.g., workplace) – better consolidation and bundling if delivered to central pickup points – trip optimization as delivery can be at any time of the day – assembly of different orders at the pickup point (replacing a number of single shopping trips)
Home delivery	+ higher freight mileage (replacing shopping trips) + consumers might substitute former shopping trips by other (longer) journeys + reverse logistics	– replacement of individual shopping trips by bundled goods transports – potential in overall traffic reduction depends on ability to bundle transports, set up efficient delivery trips, and make full use of vehicle

Figure 5.10 Factors influencing freight traffic related to Internet shopping (BESTUFS, 2001).

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6

Modeling

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Contents

6.1 INTRODUCTION

Two main factors put tremendous pressure on the future of urban goods movement. First, the United Nations (2012) reports that more than half of the approximately 7 billion people on the planet are living in urban areas. The worrying part is that although the world population itself is expected to grow by around 30% come 2050, the percentage of urban dwellers will rise by 75% in the same period. Second, there is a strong drive to increase the density of urban areas and curb sprawl. The denser the population, the higher the demand for consumables, and freight in general, in those areas. Although the flow of freight is critical for the prosperity of the population, it is also a major contributor to societal problems in the form of congestion, air pollution, and the degradation of the infrastructure and the environment (Browne and Goodchild, 2013).

It would be extremely unwise to either follow a laissez-faire approach to the transport challenges and merely wait and see, or speculate with potential solutions on a trial-and-error basis. Rather, decision-makers employ models to test what-if scenarios, and perform ex-ante evaluation of the potential solutions before embarking on implementation. A model, in the context of this chapter, can be described as a tool that may include a system of mathematical relationships that helps explain the city logistics system; study the effects that different components have on the system; and make predictions about how freight movement will change when the system changes. With freight movement changes, we inclusively mean the changes in behavior of the various stakeholders, vehicle movement, commodity movement, infrastructure, and related information.

Models remain mere abstractions of reality, and not reality itself. If models are to be useful in influencing decisions, they ought to be valid. In this chapter, we consider the recent advances in city logistics modeling that resulted in models that are more valid. That is, models that are (1) better representations of reality in that they replicate what we observe and experience; and (2) able to support improved decision-making. One can argue that a good model is one that provides insight in that it tells you something that you did not tell the model to tell you. In other words, it may reveal unintended consequences that otherwise would have been missed.

A key challenge in city logistics modeling is that many models that are good representations of reality are not only complex, but also very complicated, resulting in decision-makers avoiding them. Rather, the true challenge is to develop models that are simultaneously more valid (scientifically rigorous) and intuitive.

The chapter is structured as follows. In the next section, we consider why city logistics modeling is indeed such a challenging domain, and aim to align a number of recent reviews in the field. In the subsequent section dealing with freight demand modeling, we review the state-of-practice and the state-of-art contributions that introduce logistics decisions into planning models. The chapter then considers the recent advances in agent-based modeling where city logistics stakeholders are represented as autonomous decision-making agents, opening a number of valuable opportunities in disaggregate models. The chapter ends with a brief discussion on emerging ideas in freight modeling that allows even more behavior to be introduced, and then concludes with a research agenda.

6.2 MODELING CONTEXT

Our understanding of freight movement and the associated behavior of freight stakeholders lags that of passenger travel. Indeed, one reason is the increased complexity and diversity of products, and the behavior of the various stakeholders. When modeling city logistics, it is a challenge to address and represent the diversity of stakeholders, each acting autonomously, pursuing their individual (and often competing) objectives.

How does one then make sense of the body of knowledge? Even the terminology is often confusing. Consider the entangled notion of micro and macro models. In freight flow models, commodities are frequently broken up and repacked along the way, and as a result, Liedtke and Friedrich (2012) refer to such commodity models as micro. Yet, many authors refer to macro models as those that use aggregated zonal data (origin-destination flows), even though they too use commodities as their unit of measure. Models in which individual vehicle flows and trip chains are considered are often called micro models as they deal with the vehicles at a disaggregate level. However, Liedtke and Friedrich (2012) refer to them as being macro. According to Anand et al. (2012a), macro modeling, in the city logistics context, is those models that address the social, political, and environmental issues. However, one could argue that emissions modeling at the disaggregate level, as was undertaken by Hülsmann et al. (2011), is much more a micro model. Disaggregate models have the benefit that they can be easily aggregated to any required level. Conversely, aggregated models are much more difficult to convert to disaggregate flows.

In an attempt to address the matter of the ambiguous use of language in city logistics, Anand et al. (2012b) propose a formal ontology, *GenCLOn*, to codify semantics. One of the first steps in modeling the variety of city logistics opportunities is to at least use a common language. A shared vocabulary allows a knowledge base to be built that can ultimately lead to faster development of the field as we can more easily build on one another's efforts.

There are two approaches to classification. One way is through a taxonomy in which the empirical results of the existing body of knowledge are categorized in a meaningful way. One example is the work of Benjelloun et al. (2010), who considered 70 city logistics projects undertaken in 13 mainly European countries. Each project was classified based on a comprehensive description, the business model followed, the functionality addressed, and the scope and the technological focus of the project were identified. The disadvantage of taxonomy, especially in a rapidly developing area such as city logistics, is that it can only accommodate those items that have already been observed. New emergent phenomena and new developments may not naturally fit into the taxonomy, and subsequently will be forced and made to fit somewhere.

Another example is Liedtke and Friedrich (2012), who characterize the methods for modeling logistics networks. Their first characteristic is the ability of the models concerned to map changes in the logistics network, as this has effects if the model is purely descriptive (background load on the transport model), or if the model is useful for evaluating short-term reactions or even long-term behavioral responses. The second characteristic of their taxonomy is the form of the cost function that considers (dis)economies of scale.

A typology, on the other hand, classifies the body of knowledge based on conceptual dimensions rather than empirical cases, allowing for new permutations of the concepts that may not exist yet. Although no formally proposed typology has been found in literature, a number of recent contributions have hinted at a consistent framework. The structure of the next subsections is influenced by Anand et al. (2012a) and forms the basis for the typology.

6.2.1 Stakeholders

One of the main differences between passenger and freight transport is the variety and heterogeneity of decision-makers in freight (de Jong et al., 2004). On one side, we have the networks resulting from transportation science that are those that transport policy makers and traffic engineers are in charge of to optimize and ensure efficient economic activity. On the other side, we deal with the complex supply chain and logistic networks that exist between firms, and even just within a firm in its different geographic locations. The main distinction in the city logistics context is that stakeholders are either public or private. It is important to make this distinction in terms of modeling because these stakeholders have very different objectives, which will be discussed later. Public stakeholders include various traffic and infrastructure authorities, government at various levels, and modal authorities such as railway, terminal, and ports authorities. In their framework, Anand et al. (2012b) refer to these as administrators.

A number of recent reviews on freight transport models consider the field from the administrators' point of view (Browne and Goodchild, 2013; de Jong et al., 2013; Tavasszy et al., 2012).

On the private side, Anand et al. (2012a) aggregate the various players into shippers, carriers, and receivers. These private actors need not be business enterprises, but as discussed in the ontology by Anand et al. (2012b), the roles of shippers, carriers, and receivers may be fulfilled by private inhabitants as well. Consider, for example, the increased occurrence of home deliveries and individuals acting as shippers and receivers of small parcels. As will be discussed later when dealing with agent-based models, Roorda et al. (2010) argue that organizations may fulfill multiple stakeholder roles. A company may be the receiver of raw materials and components, while being the shipper of final products, and even the carrier of the goods to distribution centers or the final customers.

6.2.2 Objectives

Most private stakeholders consider themselves fairly isolated within their supply chains, much like the idea of the single focal company often found in supply chain literature. Each one pursues its own utility, profitability, or reliability objectives. City logistics is tasked with the process of totally optimizing the logistics and transport activities by private companies in the urban areas while considering the overall urban-wide conditions: traffic environment, congestion, and energy consumption, all within the framework of the market economy. Although the private stakeholders are named explicitly, and they indeed are a crucial component, their goals are often aligned with their own objectives: improving travel time reliability and maximizing profit.

Administrators, on the other hand, need to plan with and for all the private stakeholders simultaneously and typically pursue the big-picture modeling efforts that are often directed toward the urban-wide objectives. The ontology proposed by Anand et al. (2012b) classifies objectives first as being social (health, safety, and livability), environmental (emissions, fuel consumption, valuable area protection, and other), and economic (congestion, profitability, road protection, and local prosperity—the latter referring to job creation, an ever-increasing issue worldwide, and establishing competitive industries).

Considering city logistics, though, is indeed multi-objective. The majority of all decision problems are essentially multi-objective in nature (Stewart, 2007). Very often objectives are competing and cannot be reduced to a single unit of measure. Although there is a call for the use of generalized costs (Tavasszy et al., 2012), modelers should be aware of the implications. In a multi-objective context, the idea of an optimal solution becomes a mirage. Rather, the objective should be to at least find a truly efficient point, often also referred to as a Pareto optimal solution. A solution is efficient if no other feasible solution scores at least as well in all objectives and strictly better in one (Rardin, 1998, Chapter 8).

When using generalized costs, modelers end up with only one value as the suggested optimum. However, decision-makers, especially administrators, are very aware of the multi-objective nature of the problems in reality and are not seeking a single optimum. Rather, they seek a spread of solutions, each depicting some trade-off between the various objectives. Following more formal multi-objective interventions can indeed allow modelers to present such a spread of solutions, called the efficient frontier.

6.2.3 Descriptor

One cannot really see a supply chain, but it manifests itself in a number of ways in the real world, for example, the location of the distribution warehouse on the periphery of the city, or the actual trucks carrying goods in the city center. Descriptors are those indicators that one can observe, measure, and analyze. Anand et al. (2012) refer to the descriptors as key performance indicators. For a discussion on different descriptors, see Anand et al. (2012a).

6.2.4 Perspectives

Browne and Goodchild (2013) make a strong case for bridging the gap between those engaged in modeling, and those in policy and business-related research. Practitioners require simple solutions resulting in quick wins. Models that are more rigorous typically become not only complex, but also complicated, and take excessive time to develop, let alone validate.

The perspective of a city logistics model is that strategic viewpoint that a specific stakeholder has in addressing a specific objective, and often employs a particular descriptor or metric. It is therefore possible to consider different viewpoints for the same objective or descriptor. Anand et al. (2012a) give the example of the descriptor freight traffic flow: it can be analyzed by modeling the behavior of carriers, but also by modeling truck trips, depending on the perspective. It is therefore important to be aware of the different perspectives available.

Planning. As urban areas grow both in terms of area and number of inhabitants, the planner's perspective deals with managing current and planning for future infrastructure so that the flow of goods and people are efficient. The recent review by de Jong et al. (2013) limited their study to models used by administrators for transport planning, and then also to mainly infrastructure planning.

Technology. Spatiotemporal data from geospatial positioning systems (GPS) are becoming more readily available, even in real time, and are integrated into Intelligent Transportation Systems (ITS). As such, decision-makers can develop new routing algorithms that are sensitive towards real-time traffic conditions. Communication technologies can also lead to faster inter-organizational data exchange, for example, that can impact production planning and inventory allocation.

Behavior. There has been a strong drive to include more behavioral aspects of stakeholders in city logistics models. A behavioral analysis attempts to understand, describe, and predict how a stakeholder may respond (behave) under specific situations. Such models typically capture decision-making mechanisms through a variety of explanatory variables. In the recent review article, Tavasszy et al. (2012) discuss a number of behavioral elements in logistics. In addition, Chow et al. (2010) review a variety of logistics decision choice models.

Policy. This perspective deals mainly with administrators who implement policies and measures that force (through rules and regulations) or entice (through initiatives) private stakeholders to change their behavior so that certain system-wide objectives can be reached. It differs from the planning perspective in that policy aims to reduce negative externalities, while planning, as the name suggests, deals with the planning of infrastructure and traffic to enhance goods movement. Holguin-Veras et al. (2012) indicate that a crucial step for policy to be effective is to ensure that there indeed is a market failure that justifies the implementation of policy. Only if market mechanisms can be shown to have settled into a suboptimal state will a policy intervention have a chance of improving the state. If a market failure does not exist, a policy intervention is most likely to fail and result in government failure.

6.3 FREIGHT DEMAND MODELING

Although the body of knowledge that deals with freight demand modeling has developed quite a bit over the past decade, much of the state-of-practice remains adaptations of the traditional four-step models that originate from passenger modeling. As a basis for the remainder of this section, a short overview is provided here:

1. *Trip generation.* The study area for the model is demarcated into zones. For each zone, based on the underlying land use and the nature of economic activity within the zones, the number of trips attracted to the zone and the number of trips produced from within the zone are calculated. The unit of measure can be either vehicle trips or (the preferred method) inputs from economic input-output models. Comi et al. (2012) reviewed a number of models converting between commodity and vehicle flows, classifying them as vehicle-based, commodity-based, delivery-based, and mixed models. Chow et al. (2010) refer to the vehicle-based models as Type C models and commodity-based models as Type D in their review. These are considered an improvement over direct factoring methods in which existing flows are merely inflated to account for traffic growth.
2. *Trip distribution.* Each trip produced in the first step is then matched to a trip attracted, often following some variation of the gravity model. The output of this step is an ODP (origin-destination) matrix of vehicle trips between zones. This is different from matrices of production and consumption, as the latter does not yet take intermediate inventory (such as warehouses and distribution centers) into account. In some cases, the OD matrices are sorted based on vehicle type or size, provided information is available.
3. *Mode choice.* Although modal choice is considered for regional, national, and international models, it is often not considered in urban settings, as the majority of urban trips are road-based. Although possible, it is very seldom that modelers will consider different road vehicle sizes and types as mode choice in urban models.
4. *Route choice.* When combined with passenger matrices, all vehicles are then assigned to the road network. The assignment is often by time of day, vehicle type, or class, and follows a shortest path or least cost/travel time approach.

Traditional four-step models for a time now have been criticized as being unresponsive to certain policy changes, for example, access restrictions and road pricing. Although having a potential use in regional, national, and international modeling, they are not able to address and model effects that become quite apparent at a lower level of resolution, for example, spill-backs created because of congestion. Disaggregate information on vehicle speeds along their journeys is also not possible, making environmental analysis inappropriate. The major criticism of the traditional four-step approach is its lack of behavioral realism. If behavior is not endogenous to the model, the model is incapable of even attempting to predict how stakeholders' behavior will change, either over time or because of changes to the system.

Building on the earlier review by de Jong et al. (2004), de Jong et al. (2013) consider the more recent developments in national and international freight transport models. Indeed, one may ask why this is relevant to urban modeling. The review notes that the single most important trend has been the introduction of more pronounced logistics decision-making. That is, strategic planning models are starting, more and more, to incorporate lower-level decision-making formerly only addressed in operational models, typically at the company level. Although focusing on the national and international levels, the review highlights a number of areas that are very important for city logistics as well. Modeling efforts should include the core activity of many firms: production. The choice of production strategy directly influences the level and often placement of the built-up inventory, which, in turn, is moved between facilities within the urban areas. A second area is the need to integrate large-area (such as national and international) freight models with the lower level urban and city logistics freight models. The reasoning is quite plausible: with the majority of consumption happening in urban areas, goods movement ultimately terminates within the boundary of cities. Large-area models will give better context to city logistics models. The third area of focus should be the integration of freight models with passenger models. Much of the freight produced and moved has the objective to (ultimately) satisfy consumer demand. If we truly want to address and include behavioral aspects into freight models, we cannot afford to omit considering the behavior of consumers. In addition, they tend to share the road space, via either private car or public transport, on which we mainly move goods in the last mile. Here, we can also cite the recent work of Russo and Comi (2010).

Replacing trip generation may be a variety of behavioral models, such as consumer activity choices, production location, and choice of production technology (Tavasszy et al., 2012). Trip distribution may be replaced with choices on where to locate warehouses, where to keep inventory, and supply chain construction. Mode choice may be extended to also consider the choice dimensions of shipment sizes and scheduling, transport mode choice, and transport means. Static route assignment can be replaced with firm-level decisions on vehicle routing.

Hensher and Figliozzi (2007) note, in a special issue on behavioral insights into freight transportation, that the basis of how choices are made across the distribution chain must be rethought, and conclude that freight models should account for supply chain relationships and logistics constraints and decisions. The special issue contains a number of contributions that incorporate behavioral aspects of freight movement. Recently, Tavasszy et al. (2012) reviewed the integration of specific logistics decisions, including production location and production planning, sourcing, marketing and sales, shipping, warehousing, and transportation management.

Tavasszy et al. (2012) highlight two dimensions of change that influence logistics decision-making. First, globalization: complex global production networks and trading networks have evolved, primarily to exploit labor cost differences, regional production specialization, global product differentiation opportunities, and availability of raw materials in particular countries. The second dimension is new service quality drivers: strategic logistics decisions are dictated by service quality and costs. Supply chain managers try to minimize their logistic costs (aim for efficiency) while maintaining a certain level of service (achieving effectiveness) that is required for their customers. Service quality acts as an important driver for changes in freight transport through the consumer-oriented evolution of logistics networks. At the same time, this expensive evolution is balanced by cost-cutting strategies, directed at reducing inventory or reaching economies of scale in transport.

Mass production systems that have evolved over centuries are being replaced by responsive systems that produce customized goods. Through time, logistics structures adapt to the degree of customization and the degree of responsiveness required. Firms are now seeking economies by collaboration across company boundaries and horizontal collaboration is seen as one of the transformational innovations, which will change the logistics business landscape in the coming years. New concepts like rapid fulfillment depots (for low demand but urgent products like spare parts) and flexible order production (allowing fast switching in batch size and end-product specifications) are being introduced to allow better responsiveness. The more individualized products are, the more these activities will be located close to consumer markets. Because these markets are mainly in urban environments and cities, it impacts and moves into the domain of city logistics.

Chow et al. (2010) add two categories of freight models to their review. The first, Class F, is called *logistics models* and represents those research contributions where detailed behavior of supply chain decision-makers is included. The model typically considers commodity movement as opposed to vehicle movement. Although a number of contributions in this class focus on regional commodity movement, examples of urban logistics models include Boerkamps et al. (2000), Wisetjindawat and Sano (2003), and Wisetjindawat et al. (2006). The second category, Class G, is called *vehicle-touring models* and is concerned with the commodity shipment or vehicle. The emphasis is typically on embedding a level of behavior from the perspective of the agent aiming to minimize its logistics cost.

In the next section, we continue with the discussion on model developments, and specifically consider agent-based models that include the movement of freight.

6.4 AGENT-BASED MODELS

The integration of logistics issues in freight models can be done by including the main decisions of supply chain agents, starting from those already familiar to the transport modeling discipline using proven techniques (production and consumption, trade, mode choice, route choice) and proceeding with those less common to transport demand models, such as the choice of location of distribution centers and inventory size (Tavasszy et al., 2012). The concept of costs needs to be reviewed in the light of trade-offs occurring in spatial distribution systems, in particular among transport, inventory, and handling costs. Important cost drivers related to products (e.g., value density) or transport alternatives (e.g., reliability) need to be included.

The attractiveness of agent-based modeling is that a variety of different agents can be modeled, each with its unique ability to make autonomous decisions. Agents, in the context of city logistics, can take on different forms and represent vehicles, enterprises, individual persons, or conceptual entities such as administrators. Even emission particles can be represented as agents. The value lies in agents' ability to interact with one another and with the surrounding environment, as well as the autonomous decision-making ability.

Agent-based modeling has already gained momentum in passenger models. See, for example, the Integrated Land Use, Transportation and Environment (ILUTE) model of Salvini and Miller (2005), the Toronto Area Scheduling model for Household Agents (TASHA) of Roorda et al. (2008), and the Multi-agent Transport Simulation (MATSim) toolkit (Balmer et al., 2006; MATSim Development Team, 2013). Both Fourie (2009) and Gao et al. (2010) show the behavioral benefit when using an agent-based approach compared to a traditional four-step approach, albeit still focused only on passenger transport.

It remains a recent development in logistics (Hunt and Stefan, 2007; Liedtke, 2006; Wang and Holguin-Veras, 2008). Liedtke (2009) developed an agent-based model for Germany, explicitly modeling the decisions of two main agent-types: shippers and carriers. Shippers can decide about shipment size and carrier choice. Carriers construct truck tours with a vehicle routing heuristic. Both iteratively interact with each other in a market environment and learn over time from past iterations.

Anand et al. (2013) propose the Situated Multi-agent Urban Freight System (SMUrFS) that focuses on five agent types that are consistent with the city logistics stakeholders discussed earlier in this chapter:

Persons. Consumers' choice dimension is where to shop and is expressed as a function of the price, shop size, and product availability.

Retailer. Being in direct contact with the consumer, the retailer's demand from the supplier is a function of customer demand, inventory carrying cost to balance supply and demand, ordering costs, and the minimum stock level policy.

Shipper. In their model, Anand et al. (2013) assume a single supplier for a retailer, and also that the supplier is located on the outskirts or outside the city.

Carrier. Orders placed by retailers are communicated, via the shipper, to the (independent) carrier. The selection of carrier is done by the supplier and is a function of the carrier's total cost made up of both a fixed and a variable component.

Administrator. The municipality is the agent implementing different policy measures in an attempt to minimize the total negative externalities. The descriptors used in their model are the total vehicle kilometers traveled within the city, and the total number of vehicles entering the city.

The SMUrFS model is demonstrated in a hypothetical city containing 300 retailers, two suppliers, and three carriers.

Another agent-based approach is presented by Tamagawa et al. (2010) in which five similar agent groups are modeled: residents, shippers, (freight) carriers, administrators, and motorway operators. Shippers order deliveries from carriers, who in turn offer the goods by charging transport fees. In delivering, they pay tolls and regulatory fees imposed by the motorway operators, and emit environmentally unfriendly emissions. Residents complain to administrators about the deteriorating environment, who in turn impose regulations and implement city logistics measures. Their model consists of two sub-models. The first is a learning model for the different stakeholders that evaluates the current choice, and chooses the future behavior. The second model is a vehicle routing problem with time windows forecasted that plans and implements the delivery schedules of each carrier's trucks. Iterating between the two sub-models allows agents to independently and autonomously learn their favorite (most rewarding) behavior. They test the model on a simulated grid-layout urban area with 25 nodes and 104 links that include 24 motorway links. They introduce four carriers, each with three different trucks. They showed that the model is able to effectively evaluate policy measures around environmental objectives and the effect of road pricing imposed by the motorway operator.

Roorda et al. (2010) proposed a conceptual framework for modeling logistics using an agent- based approach. The first actor type proposed is the business establishment, an organization at a specific location that produces, processes, or stores commodities, or provides business or logistics services. The objective of the business establishment is one of economic profitability using the available resources. A business establishment may have a number of internal resources; for example, commodity production facilities or logistics service facilities that cater to both transport and inventory. An establishment using its own transport logistics services can be considered as having an in-house fleet or being an own-account carrier. The logistics services can also be sold to other establishments, in which case the establishment is a for-hire carrier or third-party logistics (3PL) service provider. Decisions made by the business establishment are typically shorter term and include the following:

Market interactions. What commodities, services, or logistics should be released into the market? These decisions often result in contracts, which specify quantity, frequency, type, and price.

Operational. How do we most efficiently produce a product or provide a service?

A firm is another actor type and represents an organization that owns and operates one or more business establishments. Firms typically make longer-term decisions, and these include:

Fundamental business decisions. Should we start a new firm? Do we open (or close) a business establishment? What commodities or services should we produce and offer? Should we relocate a business establishment? Alternatively, in the end, should we close the firm down?

Supply chain management decisions. Should we expand or contract a business establishment's resource capacity? Should we increase or decrease the number of employees? Should we change the number or type of vehicles? Should we adjust the number, capacity, or location of warehouses? Should we create an alliance with another business establishment to provide, for example, 3PL services?

Finally, the framework includes end consumers as actors that include both households and government, as these are the initiators of commodity and service demands.

The framework proposes three contract types that business establishments engage in with one another: commodity contracts, business service contracts, and logistics service contracts. Roorda et al. (2010) then proposed how contract formation occurs and the detailed logistics decisions that are executed. They also discuss the handling of multiple representations of time that are required to distinguish between daily operational and longer-term decisions. Arguably ambitious, the authors acknowledge that the data required are beyond those sources currently available. This is in agreement with Browne and Goodchild (2013), who indicate that such disaggregate and detailed models are beyond the majority of (metropolitan) planning organizations.

One of the most attractive features of the framework presented by Roorda et al. (2010) is that it is designed to integrate with the existing ILUTE model that addresses both passenger transport and land use. One of the major challenges that city logistics models face, as highlighted by Browne and Goodchild (2013), is the integration of people and freight movement in the same model.

Joubert et al. (2010) integrated freight vehicles with passenger transport in a large-scale agent-based model in South Africa, but the behavior of freight agents was limited to rerouting and adapting the timing of pickup and delivery activities. Another exciting development that holds the potential to integrate both people and freight movement is the work by Schröder et al. (2012a,b). It builds on the MATSim platform in which autonomous person agents co-evolve in a multi-modal setting. A synthetic population of agents is created, each with a set of plans representing the sequence of activities, connected by travel modes in which the agents will participate throughout an entire day. The agents execute their plans on a physical network that includes both public and private transport. Through an iterative, co-evolutionary approach, agents evaluate their plans and can learn and improve upon them by changing their activity time, rerouting their trips between activities, choosing alternative plans, or changing secondary activity choice locations such as shopping and leisure facilities. The evaluation of a plan can be done using a person-specific utility function that allows policy analysis across a heterogeneous population.

Schröder et al. (2012a) introduced new agent groups to the existing person agents:

Shipper. The shipper is responsible for finished products to be sent to manufacturing plants as intermediate products or as final products to outlets and consumers. In their framework, the shipper is the agent who owns and operates the warehouses, which are currently static attributes.

Transport service provider. This agent is responsible for transporting goods from shippers to recipients. The capabilities of the transport service provider include transhipment centers. The role focuses on constructing shipment chains (not vehicle-related) that may indeed be multi-modal in nature. To distinguish between the roles that can occur in a logistics system, two separate agents are introduced—the transport service provider as mentioned here, dealing with the shipments, and the next agent, the carrier.

Carrier. Designed to model a transport operator, the carrier's capabilities include depots and vehicles. The main decisions made by the carrier are mode choice, that is, vehicle types and quantities, and the routing and scheduling of the vehicles.

As was the case in the framework proposed by Roorda et al. (2010), the stakeholders interact with one another through contracts. The shipment pick-ups and deliveries are assigned to different vehicles in the form of a plan that is consistent with that of person agents in MATSim. Each freight vehicle is represented by a freight driver agent, which is then injected into the mobility simulation of MATSim, along with the other synthetic populations of person agents. The utility function is customized for the freight agents to account for their economic success. For carriers, this includes fixed and variable vehicle costs. It is a generalized cost as it converts both monetary and times to a utility. Transport service providers calculate their cost as the sum of the fees paid to carriers, plus the opportunity costs when violating delivery time windows. Shippers' total logistics cost includes a transportation cost paid to a transport service provider and average inventory holding costs.

The evolutionary structure of MATSim allows agents to improve and learn in an iterative manner until the system reaches a relaxed state. Carriers can re-plan routes, update shipment assignments, and even add or remove vehicles. In doing so, carriers update their cost estimates for the services they offer. Transport service providers learn by changing the layout of shipment chains, and the assignment to carriers based on the updated offers received from carriers. Shippers, in turn, can then update and learn their plans by trading off inventory with transportation. This is done by updating shipment frequencies or choosing another transport service provider. Schröder et al. (2012a) show that the model is sensitive to a number of interventions, including new vehicle types, vehicle restrictions (bans) in urban areas, and the introduction of vehicle type-specific city tolls.

6.5 SUPPLY CHAIN NETWORKS

In the domain of passenger modeling, especially in an agent-based setting, the notion of social networks has been used for a number of years. Individuals are organized and connected into (social) households. They are further connected socially with other individuals which often results in either joint traveling or traveling for meeting socially. Adding the social network layer to modeling transport allows for richer behavioral analysis, for example, planning and evaluation of ride and car sharing schemes, either for leisure or work-related trips.

It was only recently that the idea of social network has been extended to the domain of freight. It has not yet been applied to model freight agents' behavior, as it is currently only being used for decision-support in the form of network analysis. The majority of agent-based research discussed earlier has alluded to contracts and long-term relationships between freight stakeholders, that is, supplier selection and logistics contracts. It would be a very natural next step in freight modeling to consider those relationships in a (social) network context.

For a general overview of complex networks, see Barthélemy (2011), Boccaletti et al. (2006), and Strogatz (2001). Some of the first contributions to extend social networks to supply chains are Borgatti and Li (2009), Mueller et al. (2007), and Joubert and Axhausen (2013).

The essence of a complex network is that nodes are connected with one another by edges, also called ties or dyads. In the context of this chapter, nodes may represent individual agents or stakeholders, firms, or physical facilities (business establishments). Edges may be vehicles, commodities, shipments, information, transactions, or monetary flows, whatever is the objective of the modeling endeavor. It may even be connected using multiple types, in which case the network is referred to as being multiplex.

In their recent review, Bellamy and Basole (2013) identify three distinct themes:

Network structure. The focus here is on the structural properties of supply chain systems, including the components, connectivity, firm-level structural properties, the degree and pattern of inter-firm cohesion, type of flows between nodes, level of multiplicity, and the strength of the ties between firms.

System behavior. Here the contributions focus on how networks are formed and changed, and the evolution of supply chains in relation to robustness, responsiveness, and resilience.

System policy and control. This focuses on strategies that firms employ and leverage to improve the performance of their supply chain.

The field draws from a variety of mature and rigorous theoretical foundations, including social network theory, complexity theory, systems theory, evolutionary economic theory, institutional theory, social capital theory, resource dependence, social exchange theory, and others.

Complex network models also lend themselves to valuable policy analysis in terms of network vulnerability, either in the context of disasters and the logistic responses required after the events or in the context of deliberate attacks on the supply chain or physical network. This is more so in the urban setting where network failures impact people tremendously.

6.6 CONCLUSION

We need to validate models. That means does the model replicate observed reality, and are models able to support improved decision-making? One portion of solving the problem is building an actual model. However, following Rardin (1998), the life cycle of problem solving also requires ensuring the model is a good representation of the real problem, and the interpretation and implementation of the solution. These are non-technical issues, and require that the right stakeholders are involved. Here, the work of Joubert and Ittmann (2006) can be valuable to ensure the stakeholders involved are those who can really influence the outcome positively, and not merely the stakeholders who are often willing players, but who cannot ensure a successful outcome.

Three future areas of research need specific mention. First is furthering agent-based meso-models to bridge the micro-macro gap. Second, our understanding of smaller commercial (freight) vehicles and their behavior is very limited. The increased use of vans and light delivery vehicles in urban areas requires us to improve our understanding if we want to represent accurately the growing number of these vehicles in our planning models. Last, future efforts should consider combining the movement of people and freight because these stakeholders, although pursuing very different agendas, share the same space and are closely interrelated. For example, we move a large volume of freight because people consume goods for their basic livelihoods, and also entertainment and leisure.

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7

Evaluating City Logistics Schemes

Russell G. Thompson

Contents

7.1 INTRODUCTION

Because city logistics considers a broad range of benefits and costs for both the public and private sectors, evaluation of city logistics schemes involves consideration of a wide set of issues relating to the problems they are intended to solve. Within the systems approach to city logistics (Taniguchi et al., 2001), evaluation involves the methodical comparison of the predicted consequences of schemes, based on a set of predetermined criteria. Evaluation is conducted before implementation (ex-ante) to aid the identification of the best option to be put into operation. This is generally done when schemes are too expensive to refine or abandon after implementation.

An assessment of a city logistics scheme should also be conducted after it has been selected and is operating (ex-post) based on actual performance. A review or post-implementation evaluation is conducted to determine whether the scheme has been successful in achieving the objectives and to identify any unintended effects. This entails comparing criteria from data collected before and after the scheme is operating. Evidence on whether the objectives of the scheme have been met is important for accountability.

When reviewing the performance of a city logistics scheme, it is desirable to compare the impacts that were expected with those that were actually realized. It is also important to consider the distribution of costs and benefits for all stakeholders as well as the overall impacts.

Since some schemes have a considerable ramp-up period, it is important that sufficient time is allowed after a scheme has been implemented for its effects to be discernible and to draw accurate conclusions regarding its impact.

Evaluation methods are typically categorized as either single (monetary) criterion or multi-criterion (non-monetary). Monetary methods focus on cost benefit analysis that includes consideration of capital, maintenance, and operating costs as well as user and indirect benefits (Taniguchi and Thompson, 2003). This involves both quantification and valuation of relevant impacts. Multi-criterion evaluation techniques allow both quantitative and qualitative multi-dimensional effects to be incorporated (Macharis et al., 2009).

Quantitative methods such as cost benefit analysis do not encompass all relevant issues for road freight improvement projects. They are poor at evaluating non-quantifiable (but still relevant) issues such as health and the environment, to the extent that it is common practice not to attempt to evaluate them.

Boundaries of the system need to be defined for designing surveys and models. This should include consideration of all impacts including those associated with upstream logistics networks as well as the effects within the immediate area of operation.

Multi-criterion evaluation techniques allow a comparison of options involving a number of quantitative and qualitative effects to be incorporated. However, they require the specification or derivation of weightings relating to the relative importance of defined criteria. Numerous approaches allow the weightings to be determined, but there is no generally accepted preferred method.

Public administrators require evaluation methods for determining the best projects that should be implemented from a set of competing alternatives. This has been stated as, "Specifically, the problem is this: the discovery and effective implementation of measures which will reduce the total social cost of goods movement to the lowest possible commensurate with the freight requirements and objectives of society" (Hicks, 1977:102).

A number of related tasks are required to be undertaken to adequately evaluate city logistics schemes. Careful consideration should be given to identifying specific problems, determining relevant objectives and criteria as well as conducting surveys to measure and predict performance. Multi-criteria evaluation methods provide a useful approach for integrating the information generated by these activities. This chapter provides details of how to undertake these tasks as well as presenting details of several case studies.

Recently, a framework for the governance of urban freight transport has been developed that involves identifying problems, finding approaches and solutions, implementing policy measures, and evaluating policy measures (PIARC, 2012). Here, a quality loop for Road Freight Transport Management based on the Plan-Do-Check-Act cycle was defined, where evaluation following implementation is based on field research with key performance indicators. Case studies of 17 urban freight management projects from Europe and Japan are presented. However, only a small number of these projects have had an evaluation undertaken.

Details of over 40 best practice urban freight schemes in Europe have been documented (SUGAR, 2011). A summary of the underlying issues (problems/needs addressed), impact assessment, and monitoring procedures are presented.

7.2 IDENTIFYING PROBLEMS

Problems arise from the difference between the desired and actual state of the urban freight system (Taniguchi et al., 2001). Each stakeholder has his or her own set of perceived problems arising from the stakeholder's role in urban freight transport.

Key stakeholders in city logistics include shippers, carriers, receivers, and administrators. The problems or issues of each key stakeholder need to be clearly specified to allow goals and objectives to be defined and solutions developed before they can be evaluated.

Administrators from the public sector have a broad role in city logistics by facilitating improvements in freight systems to increase sustainability, livability, and mobility. They attempt to minimize the social and environmental impacts of freight in cities while improving the efficiency of freight transport. Freight transport produces a range of externalities such as air pollution and noise that can reduce the livability of urban areas. Crashes involving trucks and vans also contribute to road trauma.

Freight vehicles contribute to congestion while traveling as well as loading and unloading on the street. Vans and trucks are often involved in conflicts with pedestrians and cyclists in urban areas.

Due to climate change, it is important to reduce the amount of greenhouse gas emissions produced from freight vehicles. Emissions from diesel vehicles have a harmful impact on the health of residents. Fuel consumption of freight vehicles presents challenges in terms of energy security for many countries.

Carriers typically encounter a range of problems when distributing goods into central city areas, such as the location and availability of parking facilities, traffic congestion, and conflicts with pedestrians. Carriers are often under pressure to provide deliveries that are more frequent within narrower time intervals. These have a high impact on the efficiency of deliveries.

Reliability of deliveries is a major issue for receivers because they are demanding deliveries that are more frequent with smaller quantities within narrower time windows to reduce inventory costs.

Forums and roundtable meetings are useful ways of bringing actors together to clarify and increase understanding of specific problems of stakeholders. Surveys also provide information about perceptions and attitudes.

7.3 SETTING GOALS AND OBJECTIVES

Goals and objectives of urban goods movement systems need to be compatible with and reinforce broader planning and city goals and objectives. They should encapsulate triple bottom line concepts as well as incorporate foundation urban planning principles such as sustainability, mobility, and livability (Taniguchi et al., 2003).

The primary goal of urban freight systems involves minimizing the direct costs as well as any impacts. "The freight transport task should be performed at the lowest total social cost possible. The total amount of resources consumed and the dis-benefits created in performing the freight task should be minimized" (Hicks, 1977:102).

Six different types of urban freight objectives have been defined (Ogden, 1992):

1. Economic: improving local, regional, and national economies
2. Efficiency: reducing transport operation costs
3. Safety: minimal deaths, injuries, and property damage crashes
4. Environmental: reduce noise, emissions, and vibration
5. Infrastructure and management: appropriate provision and management
6. Urban structure: interactions with freight, city size, and freight areas

City logistics explicitly recognizes the roles of a broad set of stakeholders, including shippers, carriers, receivers, administrators, and residents. Goals and objectives provide a direction as to what each stakeholder group is trying to achieve. They provide a basis for determining what to measure to determine how the freight system is performing. Each key stakeholder typically has a number of common goals and objectives (Table 7.1).

Table 7.1 Stakeholder Goals and Objectives

Key Stakeholder Group	Common Goals and Objectives
Shipper	Maximize levels of service, including cost, time for picking up or delivering, and reliability of transport (delivery without any delay with respect to designated time at customers)
Carriers	Minimize the costs associated with collecting and delivering goods to customers to maximize their profits
Residents	Minimize traffic congestion, noise, air pollution, and traffic accidents near their residential and retail areas
Administrators	To enhance the economic development of the city and increase employment opportunities To alleviate traffic congestion To improve the environment and increase road safety within the city

7.4 DEFINING CRITERIA

Criteria allow the attainment of objectives to be measured. There are typically numerous criteria for evaluating city logistics schemes due to the range of stakeholder groups involved in urban freight, with each having its own goals and objectives.

At least one criterion or performance measure should be defined for each objective. These permit the predicted or expected impacts of projects to be incorporated. Criteria that directly relate the performance of projects to the attainment of an objective need to be defined. Table 7.2 provides an example of how goals, objectives, and criteria can be related (Thompson and Hassall, 2006).

Key performance indicators (KPIs) for evaluation provide a good means of determining whether the objectives of a city logistics scheme have been met. These indicators can be identified through measurements and inquiry surveys.

A number of KPIs for characterizing good practice for urban freight initiatives in an objective manner have been defined (SUGAR, 2011):

1. Level of impact with regard to transport operations
2. Environmental protection
3. Energy saving
4. Technical achievement
5. Political consensus

Table 7.2 Example of Freight Goals, Objectives, and Performance Measures

Goals	Objectives	Performance Measures
Improve health and safety	Reduce crashes	Number of crashes
	Reduce severity of crashes	Number of fatal and personal injury crashes
	Provide rest areas to meet demand	Number of heavy vehicles passing/using site
Reduce community impacts	Improve access to the arterial road network	Expected increase in number of freight vehicles using the route
	Reduce freight vehicle impacts and intrusion in sensitive areas	Noise levels Number of freight vehicles traveling near sensitive areas
	Reduce impact of freight vehicle noise	Daytime noise levels Night time noise levels

Table 7.2 (continued) Example of Freight Goals, Objectives, and Performance Measures

Goals	Objectives	Performance Measures
Reduce freight operation costs	Reduce delays for freight vehicles	Travel times Level of service
	Reduce congestion	Delay time Freight vehicle volumes Passenger car volumes
	Improve access for freight vehicles to key freight areas	Distance traveled by freight vehicles Appropriate access for truck types Travel speeds on access routes to key freight areas
	Enhance flow efficiency for freight vehicles on critical parts of the network	Journey times Freight vehicle travel times on critical parts of the network Freight vehicle delay times on critical parts of the network
	Improve loading and unloading facilities	Loading and unloading times
Improve business/ supply chain efficiency	Increase the reliability of travel times	Variability of travel times Number of incidents (non-recurrent congestion)
	Decrease transport costs between freight activity centers	Travel times on freight routes Travel speeds on freight routes
	Increase accessibility to intermodal terminals and freight activity centers	Travel speeds for freight vehicles on intermodal terminal access routes Travel times of freight vehicles on access links to intermodal terminals

Source: Thompson and Hassall, 2006.

7.5 PREDICTING PERFORMANCE

Predicting the impacts of city logistics initiatives for evaluation purposes often requires modeling to be undertaken. Computer-based models can be used to predict the effects of city logistics schemes.

Models should describe the behavior of stakeholders. They should also incorporate the activities of freight carriers including transporting and loading/unloading goods at depots or customers. Models must also describe the traffic flow of freight vehicles as well as passenger cars on urban roads. Models are also required to quantify the changes in costs of logistics activities, traffic congestion, emission of hazardous gases, and noise levels after implementing city logistics initiatives. There are three general types of models necessary for predicting the effects of city logistics initiatives: (1) supply models, (2) demand models, and (3) impact models (Taniguchi and Thompson, 2002).

Supply models representing the relationship between traffic demand and traffic congestion are required to predict travel times and delays in urban traffic networks. Demand models are used to predict truck flows on traffic links based on goods generation and vehicle production locations and as well as origin and destination patterns combined with route choice. Impact models are used to estimate a wide range of effects of schemes, including:

1. Environmental impacts in terms of CO_2 or NO_x emissions and noise levels.
2. Economic impacts due to changes in fixed costs and operation costs.
3. Social impacts by alleviating traffic congestion and accidents.

Recently, there has been an interest in agent-based models that can represent the behavior and interaction between stakeholders in city logistics (Taniguchi et al., 2007). Such models can be used to predict unexpected consequences of city logistics schemes and urban freight policies.

Vehicle routing and scheduling models can be used to predict the impact of new vehicle types (Hassall and Thompson, 2011) as well as the effects of urban consolidation centers (Taniguchi and Thompson, 2003).

The criteria of total travel time and CO_2 emissions produced by pickup/delivery trucks were used in an early modeling exercise involving the prediction of the effects of several city logistics initiatives on congestion and the environment (Taniguchi and van der Heijden, 2000).

7.6 MEASURING PERFORMANCE

Problems need to be defined objectively and this often involves conducting surveys to determine the performance of the system. Surveys are required to measure the key performance indicators for determining whether the objectives of the scheme have been met. A major challenge when conducting an evaluation is to determine what types of surveys are required.

There are a number of survey techniques that have been used in urban freight studies (Allen et al., 2012). Twelve types of surveys were identified—establishment, commodity flow, freight operator, driver, roadside interview, vehicle observation, parking, vehicle trip diary, GPS, suppliers, service provided, and traffic counts. The prevalence of methods for undertaking each type of survey such as face to face (pre-arranged or intercept), self completion, telephone, observation (CCTV or in person), or automated data collection were also identified.

Data on benefits often rely on cooperation of the operators. Stakeholder forums and partnerships are important for developing relationships to promote the sharing of data and information.

A vast amount of quantitative and qualitative data can be generated from surveys or estimated using models to assess the effects of city logistics schemes. Quantitative data should be collected for the carriers and operators of the scheme as well as the community.

Quantitative data for operators or carriers relate to their vehicle fleets such as the size, age, and type of fuels used as well as the usage of vehicles such as distance traveled, fuel consumption, emissions, and load factors. Measures of delivery performance can be collected such as delivery times, waiting times, penalties, compliance rates, route times, travel times, time parked (including waiting), crashes, parking/loading bay turnover, number of failed and late deliveries, and delivery reliability.

For the scheme itself, the number of participants, jobs created, and financial costs as well as the number of round tables and meetings are good to record. For the general community, estimates of noise levels, traffic congestion, health impacts of pollution such as the reduced years of life lost, reduced disability adjusted life years (DALYs), and number of years of life lost (YLL) can be produced.

Feedback from key stakeholders provides qualitative data that are crucial for guaranteeing the success of the scheme and to minimize any adverse effects because of the intervention. Perceptions are important and efforts should be made to record these.

For example, with the Freight Best Practice (FBP) scheme in the UK, an independent organization reviewed awareness levels as well as usage levels (PIARC, 2012). Customer feedback was gained from regular workshops for the Freight Operator Recognition Scheme (FORS) to assess the benefits for operators (PIARC, 2012).

It is important to gain perceptions from residents regarding the quality of life, including general ambience and exposure to noise, congestion, and visual intrusion as well as safety and security of walkers and cyclists.

It is also desirable to identify the working conditions for truck drivers including difficult tasks such as parking as well as stress, security, and safety. For carriers, levels of efficiency, reliability, and productivity are useful to identify. Corporate image in terms of sustainability and innovation for operators is also important to assess.

It is necessary to gauge overall support and acceptance of the scheme by the key stakeholders. This can be determined by the amount of dialogue between stakeholders, and improved knowledge and understanding of issues as well as the improved image of urban logistics and the city itself.

It is desirable to gain an indication of the quality of service experienced by receivers. This relates to delivery satisfaction in terms of punctuality, reliability, and flexibility as well as the relationship between the delivery persons and shopkeepers.

Surveys were used to identify problems in Kassel prior to the implementation of a joint delivery system (Kohler, 1997). Two goals were defined for the management of urban freight in Kassel, Germany—"to reduce the distance and number of freight trips as well as the delivery time in the city and the unloading time" (Kohler, 1997). Kohler (1999) presented the results of an early trial of a cooperative freight transport system. Changes in a number of performance measures were presented, including:

1. Mileage toward the inner city (km/year)
2. Mileage within the inner city (km/year)
3. Average distance between stops (m)
4. Delivery weight per stop (kg)
5. Vehicle saturation (%)
6. Average of lorry frequency per retailer (number of lorries per year)

Kohler (2001) also presented results illustrating the effects of a cooperative delivery system operated by a neutral carrier from a city terminal in Freiburg, Germany. The most important aims were stated as reducing the costs of goods distribution as well as fewer truck trips in the city, thus reducing the environmental effects. Substantial reductions in a number of traffic measures, including the number of trips, travel times to/from the city terminal, travel times in the city center, and total times in the city center were reported.

A lack of standardized methods and indicators for measuring the impacts of city logistics schemes was identified in the CIVITAS project (CIVITAS, 2006). The urban freight schemes evaluated had goals of minimizing pollution, noise, and congestion. A set of indicators was defined considering relevance, completeness, availability, measurability, reliability, familiarity, non-redundancy, and independence. It was noted that the temporal and spatial nature as well as level of importance of indicators should be considered. Common problems identified were vaguely defined objectives and a lack of connection between objectives and indicators.

Evaluations were conducted at various levels, including the measure, city, and European (cross-sites). The measure evaluation assessed whether a measure fulfilled its goals and reached its objectives. The city evaluation determined whether local measures fulfilled the objectives set by each city.

Indicators were defined and divided into six evaluation areas: economy, energy, environment, society, transport, and mobility. Common indicators used for evaluating projects for improving urban goods logistics and efficiency were energy use: total and renewable (Joules/year); environment: emissions of NO_x (tons/year), CO_2 (tons/year), particulate matter (tons/year), and noise levels (dB(A)); mobility: number of trips minus total number of goods vehicles moving in demo areas (5-degree scale), quality of service per mode and acceptance per mode; society: living conditions (noise hours) and working environment (noise hours); and transport: Vkm by vehicle type, peak/off peak or total (vehicle km per day), vehicle load factor (%), queuing time/stop time (minutes/trip), small deliveries (vehicles/day), vehicle fleet (vehicles), and total distance (km/trip).

7.7 PILOT TESTS

City logistics schemes are often evaluated after a small-scale trial or pilot test. This allows the feasibility of schemes as well as their unexpected side effects to be identified before full-scale implementation.

The Off-Hours Delivery (OHD) system in New York City provides an illustration of the benefits of conducting a pilot test (Holguín-Veras et al., 2013). This pilot study included careful selection of participants, determining a suitable time period and developing a comprehensive monitoring program. As a result, good publicity was generated. Unexpected problems were also identified that could be addressed before full implementation. This exercise demonstrated that pilot tests involving limited real life experiences are more credible than modeling.

A pilot program for an Electric Reservation System for Freight Vehicle Parking in Tokyo, Japan resulted in a 56% reduction of vehicles parking on the street for loading/unloading near a new parking lot of six spaces (PIARC, 2012). This initiative was estimated to reduce 1262 tonnes of CO_2 per year. Based on the evaluation, a full-scale operation was initiated.

7.8 CONCLUDING REMARKS

This chapter has described a range of issues and methods for effectively evaluating city logistics schemes. It outlines how this involves determining a range of criteria for key stakeholder groups based on defined problems, goals, and objectives. The value of collecting qualitative and quantitative data both before and after implementing a scheme was highlighted. The benefits of conducting a pilot scheme were also presented.

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8

Urban Distribution Centers

Ron van Duin and Jesus Muñuzuri

Contents

8.1 INTRODUCTION

Many cities have tested the Urban Distribution Center (UDC) concept over the last two decades, seeking to reduce unnecessary vehicle movement, and thus congestion and pollution. This chapter contains a description of this logistic concept. Section 8.1 starts with a description of the basic principles underlying the UDC concept, followed by its historical evolution, and Section 8.2 elaborates on the objective-based, practice-based, and future-based evaluation of UDCs.

8.2 UDC DEFINITIONS AND DEVELOPMENTS

8.2.1 Basic Principle: Consolidation

Urban distribution centers (often also called Urban Consolidation Centers, UCCs), with their basic principle of freight consolidation or freight bundling, is a concept that has always existed in one form or another because it is in line with the growth of cities. It is evident that in order to increase the efficiency of the current city distribution system, different deliveries have to be bundled. Binsbergen and Visser (2001) suggested a typology of bundling concepts:

1. *Bundling in time*: In general, this concept focuses on freight bundled by a single transporter [75% of all deliveries, according to Buck Consultants International (2008)]. In practice, however, the average number of stops for the most inefficient transporters (occasional transporters) is only 1.2 stops. Therefore, the *bundling in time* concept will cause no strong increase in efficiency.
2. *Bundling in activities*: Occasional transporters only deliver small amounts of freight and their bundling in activities is not likely to reduce the number of vehicles. The load factor of vehicles could increase in return trips, but the negative effects for the city would still occur.
3. *Bundling in routing*: The same argument as for bundling in time holds here because routes often only have an average of 1.2 stops, so there is not much room for bundling loads.
4. *Bundling in depots:* When bundling in depots is applied, different transport companies are able to combine their cargo. This way the number of trucks in the city center is reduced and the load factor strongly increases. More stops per vehicle can be made and routes or times can be combined.

The last category (Bundling in depots) is the one that works best in practice, from the point of view of improving overall urban distribution. It constitutes the basic principle underlying the UDC concept.

8.2.2 Evolution of the UDC Concept in Retrospective

We have not yet defined UDCs on purpose, as the long history of this concept resulted in some changes in its definition over time. We will therefore cover the UDC concept from the past and analyze how the concept has changed and has emerged as its current definition. However, finding the first definition of urban distribution centers in the scientific literature is a tough exercise because one can never be sure of having found the oldest definition. We found the following citation about a UDC concept from around 40 years ago:

> The distribution of freight in most urban areas is characterized by high concentrations of truck activity in central business districts (CBDs). In this context, the movement of freight from suppliers, to resellers to ultimate customers is typically performed by a very large number of small carriers who duplicate each other's paths with partially filled trucks while each truck is in the process of picking up and delivering a large number of very small shipments. In many communities, this distribution structure results in unnecessarily high levels of congestion, pollution and energy consumption, as well as high distribution costs which are passed on to consumers in higher product costs. Several decades ago, business organizations responded to these pressures and initiated shippers' associations and freight forwarder operations to achieve the economies of consolidated shipments. Since 1942, however, the growth in the number of freight forwarders has been drastically curtailed. (Cadotte and Robicheaux, 1979)

Facing this definition, we can observe not only bundling in depots as a part of the bundling concept, but also bundling of routing because the small carriers duplicate each other's paths with partially filled trucks.

In the same period we found in the United States the following expression of consolidation research (TRID, 1971):

> A special section is presented on physical distribution congestion, including metropolitan areas, freight terminals and highways. New data surveying techniques to be used in the upcoming 1972 census of transportation are described. In one of the articles, "a rational urban cartage system" by R.A. Leighton and R.T. Wood, a proposal is made for significant economies on short-haul pickup and delivery service in the Manhattan area.

A cartage system was based on tricycles and pushcarts used to transport containers and oil drums. The pushcarts and tricycles (pedal or motorized) had the advantage of being able to access small streets. Tricycles could speed up the collection operation and increase the radius of collection in urban areas, transporting containers to transfer stations or to community treatment facilities. From the transfer stations, which could be observed as the UDCs, the containers and drums were loaded onto trucks or tractors, which hauled a larger volume over a long distance.

Tricycles were able to collect door to door and had a larger capacity to collect in larger containers serving a number of houses.

In 1975, McDermott (1975) suggested an alternative framework for urban goods distribution: consolidation. According to this author, the only proposed solution resulting from panel conferences at symposiums that directly faced the problem by attempting to minimize vehicle traffic and improve capacity utilization was the consolidation of pick-up and delivery operations of small shipments moving within the urban area. First, it is impressive to observe that this work based its findings on the development of a simulation model. Second, the article, at that time (1975!), seems to have almost a prophetical value facing the positioning of the scope of the study by saying: "In light of current environmental trends of consumerism, concern about energy reserves, and the increasing emphasis on improving the quality of life of urban residents, this study has attempted to conceptualize a method of improving the efficiency of urban goods distribution while minimizing the societal by-products inherent in this process." In many current research studies on city logistics, this scope is still valid.

In the U.K., McKinnon (1998) showed that between 1974 and 1976 seven studies examined the feasibility of peripheral transhipment in different urban contexts, ranging from a small town (Chichester) to a London borough (Hammersmith). Each of the studies assumed that a new transhipment depot would be set up on the outskirts of the study area. This would be a multi-user facility, owned and operated either by the local authority or by a private contractor. All the studies assumed that use of the depot would be voluntary, although municipalities anticipated that the imposition of tight vehicle size/weight restrictions would indirectly force many firms into using it.

It is remarkable that a period of good research and practices of the UDCs in the 1970s was followed by a decreasing interest in urban freight issues during the 1980s (McKinnon, 1998). The volume of academic research and consultancy work on the subject sharply declined, and it is not completely clear whether this was due to the crises affecting many countries at the beginning of the 1980s. At that time, illustrative words such as "Thatcherism" (U.K.), "Reaganomics" (U.S.), and "Rogernomics" (New Zealand) were added to our vocabulary meaning extremely tight control of money supply and privatization. It is likely that we can assume that both research and public authorities suffered severely from these financial budget cuts. Ogden (1992) explained in his well-cited review of "urban goods movement" research "there is not much post-1980 data." In the early 1990s, ministries of transport developed some ideas about city distribution as part of a new national framework on transport and infrastructure management. Ogden (1992) illustrated that these changes were implemented by governing bodies, that is, the introduction of policies and measures that force companies to change their actions and thereby become more environmentally or socially efficient. While illustrating leading examples, we may mention the Japanese government setting up the shared trucking program, which directly interfered with the use of cooperative freight transport systems (Taniguchi et al., 1995) and the Dutch government promoting the setup of public centers or city distribution centers according to the long-term program for traffic and transport (SVV II, 1990) in the Netherlands. Their aim was to improve the environmental conditions, to accommodate the flow of goods into the city without interference of other traffic flows, and to maintain the nice historical shopping environment for the visitors of the town. In this period, we found the following definition of the city distribution center concept:

> A center for transhipment of goods with a destination in the city, located at the edge of the city with a good infrastructural accessibility. Its main purpose is to achieve a high degree of collection in the goods flows (thick) in order to supply efficient transport from the distribution center to the city center and vice versa. (van Duin and Jagtman, 1999)

In 1999, the European program COST 321 (COST 321, 1999) gave directions to the UDC concept and identified 13 consolidation-oriented measures. These 13 measures were classified into four categories. The first category, which was the largest, focused on the establishment of a genuine additional transfer (AT) point near the city center. The second category of measures aimed at developing or promoting common delivery (CD) points. The last two categories related to the changing and influencing behavior of carriers (BC) and the behavior of retailers and/or shippers (BRS). The following consolidation-oriented measures were suggested within COST 321:

- Shared use of storage space by retailers (CD)
- Promotion of storage facilities in inner urban areas (CD)
- Outsourcing of freight transport (BRS)
- Transport coordination and cooperation of retailers (BRS)
- Goods distribution centers (AT)
- Consolidation by means of ‘urban’ containers (CD)
- Development of lock chambers common to a group of receivers (CD)
- Regional rail network in combination with urban Distribution Center (AT)

- Truck ownership licenses for urban distribution (BC)
- Road pricing in cities (BC)
- Optimization of distribution systems including transport centers (AT)
- Extension of transhipment facilities (AT)
- To revive railway or fluvial central urban sites as urban distribution centers (AT)

Within the COST 321 project, a group of experts assessed these measures in terms of their relative potential. Their assessment showed clearly that more than half of the consolidation-oriented measures were considered to be potentially beneficial, although, at that time, only goods distribution centers had been put into practice. Besides the judgment of this group of experts, the countries participating in the COST 321 Action studied the effects of some of the measures. In general, the consolidation-oriented measures were classified as measures with moderate effects, which did not necessarily imply that they were categorized as generally unworthy for implementation. In practice, we could observe a remarkable opposite effect because the UDC concept was the only concept put into practice massively in many European countries. Following the COST 321 results, the Best Urban Freight Solutions (BESTUFS) European network was established in 2000. The BESTUFS organization gave a strong impulse to bundle the knowledge and experiences between academics, practitioners, and managers of different European cities on urban freight transport. Dedicated topics were addressed in workshops in which the experiences with urban distributions centers were widely shared. Since then, many definitions of UDCs have been provided, but very often they are vague or ambiguous. BESTUFS 1 reported (Allen et al., 2007, 61) that a UDC could be best described as:

> A logistics facility situated in relatively close proximity to the geographic area that it serves (be that a city center, an entire town or a specific site such as a shopping center), to which many logistics companies deliver goods destined for the area, from which consolidated deliveries are carried out within that area, in which a range of other value added logistics and retail services can be provided.

Thanks to the BESTUFS's recommendations, the role of UDCs had emerged to a certain extent, with a series of clearly established guidelines (Huschebeck and Allen, 2005; Stantchev and Whiteing, 2006):

- More publicly organized. UDCs did not have a good track record in terms of implementation and operation. For UDCs to remain attractive to companies and initiate successful initiatives, BESTUFS recommended that they should be led and operated by one or several key commercial players (professional logistics service providers) that had identified the potential benefits of being involved. Similarly, public funding was needed to pay for the research work and pilot studies for any form of UCC that was not related to a major new property or commercial development. Without this initial funding, UDC research and trials were unlikely to start or proceed. Local governments not only provided financial incentives to promote this concept of consolidation, but they also encouraged and assisted pilot-projects, and if necessary, facilitated the provisioning of supportive favorable regulations and measures (e.g., the shared use of bus lanes). As Ville et al. (2012) stated, the UDC's effectiveness seemed to depend heavily on the presence of appropriate local regulations, including vehicle access rules for the zone covered by the UDC and benefits rewarded to UDC operators.
- Awareness. There was clearly a need for raising awareness (including explaining success and failure factors) among local authorities, retailers, and transport operators to enable them to add the UDC concept to their set of possible policy measures for consideration. BESTUFS recommended active support of this awareness during the setup phase of the UDC concept. This was done by developing appropriate instruments (e.g., UDC planning guidelines, handbooks, or tools) as well as training measures for urban freight planners.
- More integral governmental support. BESTUFS recommended that governments should issue guidance to local authorities as to where consideration should be given to the establishment of UCCs when major development proposals were being considered or when town centers were being restructured. Likewise, the OECD (2003) recommended that national/state governments needed to take the initiative and provide clear policy objectives and frameworks under which tailor-made local measures could be planned and implemented. The main national objective should be sustainable urban goods transport, which requires the development of an urban goods transport system on a socially,

> economically, and environmentally sound basis and both short- and long-term policies should be developed under this objective (OECD, 2003, 17).

The practical evaluations, recommendations, and products from the BESTUFS study and the involvement of the OECD were probably the main reasons for the enormous increase in new (European) UDC initiatives. According to the OECD, consolidation was a key to achieving sustainable urban goods transport. The purpose of consolidation was to improve the utilization of the transport system to generate economies of scale, thereby reducing vehicle trips, increasing efficiency, and decreasing the financial and environmental costs of transport. A useful measure for improving consolidation was the implementation of a commercial urban transhipment center, where freight whose destination was the inner city would be sorted (cross-docking) into consolidated loads for final delivery. As consolidated loads generally would be delivered by small(er) vehicles, the highest possible vehicle utilization and route optimization would be necessary in order to compensate for the additional transhipment cost and to ensure the reduction of vehicle kilometers.

Browne et al. (2005) viewed the urban distribution center concept as a range of potential applications along a spectrum dependent upon the split of involvement (or control) of the public and private sectors, with the range of terms used to refer to the UDC concept including

> public distribution depot, central goods sorting point, urban transhipment center, shared-user urban transhipment depot, freight platforms, cooperative delivery system, consolidation center (sometimes dedicated, e.g., retail, construction), UDC, city logistics (or city logistic) schemes, logistics center, pick-up drop-off location, and offsite logistics support concept.

At the same time, we observe in the literature the old UDC concept often renamed the UCC concept. We found no clear reasons for this definition change in the literature, but at least the introduction of the new definition represents a break with the old concept, which was often a concept of failure. According to Browne at al. (2005), a UCC is a logistics facility that is situated in relatively close proximity to the urban area that serves a city center, an entire town, or a specific site such as a shopping center, airport, hospital, or major construction site. Goods destined for these locations are dropped off at the UCC. The UCC operator sorts and consolidates these loads dropped off by logistics companies and makes deliveries to the final destinations, often using environmentally friendly vehicles, for example, electric (Browne et al., 2011; van Duin et al., 2013) and gas-powered goods vehicles, and electrically assisted tricycles (Ville et al., 2012). Stantchev and Whiteing (2006) defined urban freight transport and logistics operations concerning the activities of delivering and collecting goods in town and city centers. According to them, these activities often referred to city logistics as they include the processes of transportation, handling, and storage of goods, the management of inventory, waste, and returns as well as home delivery services. Both definitions show an expansion of the former definitions where Browne et al. (2005) added retail, the service industry, and construction to the definition as well as environmentally friendly transport. Stantchev and Whiteing (2006) added the areas of waste and, returns as well as home delivery services where the latest type of deliveries has shown a tremendous growth of e-commerce activities in the business-to-consumer (BTC) segment.

Meanwhile, Crainic et al. (2009) came up with a logistics view on consolidation and distinguished three levels of consolidation from a multi-echelon perspective:

- *None*: No dedicated physical UCC; consolidation is achieved through information sharing on origins, destinations, and products, and integrated construction of pickup and delivery routes.
- *Single-level*: Consolidation takes place at physical UCCs; from the UCCs, the vehicles distribute loads within the city. The loads transit through one UCC only.
- *Two-level*: Consolidation takes place at two physical locations; the UCCs form the first level of the system, generally located on the outskirts of the city. The second tier of the system consists of satellite platforms or mini-hubs, where loads coming from the UCCs are transferred to and consolidated into vehicles adapted for utilization in dense city zones.

More recently, the two-tier or two-echelon system has gained popularity for medium and large cities. In these cities, one of the most common regulations is the establishment of access time windows, whereby delivery vehicles can only access the most central and congested areas of the city during a pre-specified period of the day. To avoid the costs imposed on carriers by this regulation while maintaining the social and environmental sustainability benefits, the establishment of a system of mini-hubs/drop-off points/vehicle reception points where delivery vehicles may park for the final deliveries and goods are consolidated into small environmental vehicles/tricycles or to be completed by delivery on foot

(Muñuzuri et al., 2012; Ville et al., 2012; Mancini, 2013; van Duin et al. 2013; Gonzalez-Feliu et al., 2013).

In practice, however, there is a large number of field-tested UCCs that have been described comprehensively by Browne et al. (2005), Karrer and Ruesch (2007), van Rooijen and Quak (2010), and van Duin et al. (2010). These pilots and test cases show that many of these freight platforms are granted only a short life because the cost of the additional transhipment prevents them from being cost-effective (Browne et al. 2005; van Duin et al., 2010), especially when the initial government subsidies drop back. Therefore, we can observe two new directions in the research on UCC concepts:

- Financial focus on the business models. In the current research, we can observe a strong focus on how to improve the business model behind the concept and how to add extra value to the market with all kinds of new services (Quak and Tavasszy, 2011) in order to develop a healthy business model for future application, sometimes with a stronger intervention by the government such as pricing mechanisms (Holguín-Veras, 2008; Allen and Browne, 2012; van Duin et al. 2012; Peters, 2013).
- Behavioral concepts with closer vertical and horizontal cooperation. Actually, these concepts move away from the physical bundling principle such as a UCC and try to establish more vertical and horizontal cooperation among the distribution chains of several retailers. With the current IT, more transparency is possible and therefore closer collaboration among retailers and carriers is possible to reduce vehicle kilometers and to improve their loading rates (Figliozzi, 2006, 2007; van Duin et al., 2007; Verlinde et al., 2012; Mancini, 2013).

8.2.3 Summary of UDC Evolution

To conclude this section, we note that each decade brought some changes to the concept of UDC. In the 1970s, positive implementations of the UDC concept were identified, especially in the United States. During the 1980s, there was little focus on urban freight transport in general. In the early 1990s, some pioneer countries (Japan, the Netherlands, Germany, and France) started with their first UDCs. In these years, most initiatives (200 started, 15 projects maintained) ceased due to a lack of volume and government support. At the beginning of 2000, the UDC concept got a serious boost with the knowledge available from COST 321 and BESTUFS. Many countries started with subsidies successfully in their towns. The focus on sustainability grew, and for the UCC concept it was a decisive factor to provide environmentally friendly vehicles, which gave them a better position in the transport market. Still, some UCC concepts encountered serious problems when subsidies declined. Therefore, we can observe nowadays a broader definition of a UCC in terms of more specific flows (construction, health services, waste services, and home deliveries) and a stronger focus on adding value for their customers. The customers have changed from the initial shopkeepers to the national logistics service providers and retailers on the one side; however, the other side has changed more to the municipalities that are specifying their needs with respect to entrances and exits in terms of vehicle emissions, weights, and access times. The attitude of municipalities will change toward more professional procurement of the urban freight delivery with straight and clear terms providing concessions for one or two years similar to the current practice of outsourcing in public transport. Therefore, the UCC concept should benefit both types of actors and we think that in the long run the UCC concept will integrate its (value)-services more professionally and the concept will evolve to a professional logistics service partner taking care of all last-mile deliveries in any town.

8.3 EVALUATION

The cost structure involved in the use of intermediate facilities in the delivery process is clearly defined by works like Takahashi and Hyodo (1999), where the key parameters are defined as follows:

- The different truck sizes used for direct deliveries (C1), for deliveries to the UCC (C2), and for the final delivery from the UCC to the receiver (C3). These different truck sizes result in different costs per ton and per kilometer.
- The different load factors in the three segments (C1, C2, and C3), usually with C3 > C2 > C1, which also has an effect on costs.
- The transhipment cost and time, which is the key figure to take into account when determining the economic feasibility of the UCC concept.

In fact, the early experiences tested in Japan and Europe (Germany, the Netherlands, and Italy) in the 1990s showed that this economic feasibility was very difficult to achieve. Institutional support was discontinued after the first years of operation and carriers did not become fully involved in the scheme due to doubts about the continuing backing of public institutions in the future (Panero and Shin, 2011). As a result, these initiatives did not survive.

Nevertheless, the ongoing financing and support for this UCC concept, and its revival in the 21st century, is due to the fact that the subsequent evaluation processes conducted show positive figures, despite the fact that this is only so when additional non-economic factors are taken into account. This calls for the incorporation of intangible variables into cost-benefit analyses (Pearce and Nash, 1981) or the application of multicriteria evaluation methods. The MAMCA methodology (Macharis, 2005) contemplates the points of view of different actors and decision criteria to perform the analysis of city logistics policies. The list of different actors, or stakeholders, affected by city logistics initiatives is well known, as shown, for example, in Muñuzuri et al. (2005). This list includes carriers, shippers, and receivers, as well as residents, shoppers, urban workers, or local administrations. However, the criteria that should be taken into account when evaluating concepts like UCCs is not so clear. The next sections are devoted to a discussion of the evaluation criteria.

According to Quak (2008), there are two ways to evaluate whether an initiative is successful: Initiatives that were successful in achieving objectives were evaluated as successful in the report; that is, they were called objective-based. Initiatives were successfully implemented in the real world; that is, they were practice-based.

8.3.1 Objective-Based Evaluation

Objective-based evaluation works are found mainly in the academic literature where many urban goods modeling studies have been published in the last 20 years (i.e., since Ogden, 1992), as shown by the numerous scientific works on this subject (see Ambrosini and Routhier, 2004; Anand et al., 2012; Comi et al., 2012; Gonzalez-Feliu et al., 2012a, 2012b; Berends, 2013).

8.3.2 Practice-Based Evaluation

The second type of model is practice-based research. In its city logistics handbook (http://www.sugarlogistics.eu/pliki/handbook, 2013), the Sugar project provided a template to categorize and partly evaluate best practices. This template is not typically related to UDC initiatives, but most of the best practices considered were actually UDC initiatives. The template consists of six categories: general description, policy design details, implementation details, supporting mechanism, results, and key considerations. The framework was not meant to quantify the effects, but instead to provide a framework for qualitative description and benchmarking. Other research approaches that try to seek real applications (FRETURB; CITY GOODS; Muñuzuri et al., 2011) attempt to include forecasting and problem solving into their frameworks, which remain in general too theoretical and difficult to implement (Crainic et al., 2009; Russo and Comi, 2010; Nuzzolo et al., 2011; Gonzalez-Feliu, 2013).

As a part of more practice-based research case studies, ex-ante and ex-post analyses seem to be the best means to evaluate urban consolidation centers properly (Kohler, 2004; Patier, 2004; City Ports Project, 2005; Browne et al., 2005; Marcucci and Daniels, 2008; van Rooijen and Quak, 2009; van Duin et al., 2010; Browne et al., 2011; van Duin et al., 2013). In the literature, we actually found a sort of transformation of the Sugar qualitative template into more properly defined indicators. Gathering input from several compilations (OECD, 2003; Binsbergen and Visser, 2001; Quak, 2008), Table 8.1 with quantified criteria could be used for evaluation purposes.

Table 8.1 Evaluation Criteria for City Logistics Measures

Criteria	Indicators
Accessibility	Vehicle kilometers, size of the vehicle movements, time to reach destination, and obstacles
Environment	Noise, emissions, vehicle movement, citizen complaints, consumer complaints, and safety (number of accidents)
Transport efficiency	Average loading factor per trip, reductions of vehicle kilometers, and energy usages
Logistics costs	Actual costs of (one of) the actors that carry out the urban freight logistical operations
Economic development	Size of office spaces, number of shops, employment in the shops, total revenue, costs, and profits
Social support	Opinions of citizens, the shopping public, transport companies and logistics service providers, retailers, and local governments
Ease of implementation	Ease of implementation of an initiative in reality, duration, pilots
Implemented in practice	Success factors, barriers

Based on the BESTUFS experiences, we can observe a more dedicated set of indicators for UDC evaluation raised by Browne et al. (2005) who presented the impacts quantified in 17 UDC schemes in the literature:

> Changes in the number of vehicle trips, changes in the number of vehicle kilometers, changes in number of vehicles used (the fleet mix), changes in travel times, number of goods/pallets delivered per delivery point, vehicle load factors, changes in loading/unloading times and frequencies of delivery, changes in total fuel/energy consumed, changes in vehicle emissions and changes in the operating costs.

In many studies (City Ports Project, 2005; the BESTUFS handbook [Allen et al., 2007], studies done by Browne et al., 2005; Quak, 2008; and van Duin et al., 2010), the main success factors identified were actually the number of users, the organization of the UCC, the provision of subsidies, and the selection of the right type of distribution vehicle. In the evaluation of these various initiatives with UCCs, similar financial problems were identified, which provided evidence that the financial feasibility of UCCs is a critical point of understanding. Therefore, we observe an enlargement of the feasibility in a broader evaluation framework of Feitelson and Salomon (2004) into the dimensions of technical feasibility, commercial feasibility, and political feasibility. An application of this framework can be found in van Duin et al. (2010). In addition, the business modeling canvas (Ostwalder, 2004) seems to have become an important framework of communication to understand and improve the financial performances of the UDC (Quak and Tavasszy, 2011).

The scientific literature does not contain many contributions that evaluate real applications in practice. A few well-known and well-cited exceptions exist contrary to this trend, such as an evaluation of a new concept of the cooperative use of electric vans for urban freight transport in Osaka (Taniguchi et al., 2000), the UCC evaluation in Kassel (Kohler, 2004), the off-peak deliveries in New York (Holguín-Veras, 2008), and the pilot for a micro-consolidation center with the use of electric and electrically assisted cargo tricycles in London (Browne et al., 2011). It is important to remark that some UCC implementations have sought success by enforcing the compulsory use of the initiative (e.g., the cases of Malaga in Spain or La Rochelle in France), whereas in voluntary schemes carriers will only feel inclined to route their goods through the UCC whenever they perceive advantages for doing it (Panero and Shin, 2011). These advantages may come from either increased economic efficiency or at least from compliance with the new regulations that favor the use of the UCC over direct deliveries. These authors discuss in depth three successful case studies, each one of them achieving success for different reasons:

- Petite Reine in Paris, France: This privately run consolidation system benefits from increased access to certain restricted areas (e.g., pedestrian zones and urban core with narrow streets) through the use of narrow-body cargo-cycles and longer delivery windows as well as a low-cost operation. These cargo-cycles can be parked almost anywhere, decreasing the time spent looking for parking and traveling from vehicle to customer, and they also result in better navigation through congested traffic, as long as the delivery routes remain relatively short.
- Heathrow Airport Retail Consolidation Center, London, UK: With mandatory participation of most retailers delivering goods to the airport, this single-site UCC has achieved large reductions in the number of vehicles entering the airport, plus faster and more reliable deliveries, improved security, and more flexible schedules for the end receivers. The question remains whether this privately established and operated retail consolidation center would be financially self-sustaining without the support of the British Airlines Authority (BAA).
- Tenjin Joint Distribution System (TJDS), Fukuoka, Japan: This was an industry-established UCC, when 30 freight carriers delivering to Fukuoka's city center came together to collaborate on a joint delivery system over 30 years ago. However, while the TJDS has proved successful in removing vehicles from the road and thus decreasing vehicle miles traveled, given the reduced scope of the UDC, other social effects are not significant.

8.3.3 Future-Based Evaluation

Future-based evaluation will have a stronger focus on implementing new city logistics concepts. In many European projects (like COST 321, SUGAR, POLIS, etc.) many consortia are working hard to implement new concepts and measures.

In the near future, we can observe the development of so-called living-labs or city labs as they are called in the city logistics literature. Supported by the establishment of so-called Centers of Excellence (financed by

Volvo), these consortia (like METROFREIGHT, CoE SUFS) bring together a consortium of leading urban freight transport scholars and key private and public partners (cities) to establish a research Center of Excellence. As stated in the startup document of such a consortium, the main goal is to jumpstart an integrative and participatory process—involving cities, private sector, and researchers—that leads to the implementation of urban freight solution paradigms that are sustainable, increase quality of life and economic efficiency, and address environmental justice. Research has shown that these partnerships are extremely useful in gaining a better understanding of freight transport and in generating better outcomes for urban freight activities (Lindholm and Browne, 2013).

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9

Intelligent Transport Systems in City Logistics

Eiichi Taniguchi

Contents

9.1 INTRODUCTION

Intelligent Transport Systems (ITS) plays an important role in promoting city logistics for efficient and environmentally friendly urban freight transport systems (Taniguchi et al., 2001). It is no exaggeration to say that the goals of city logistics, which are mobility, sustainability, and livability, cannot be achieved without ITS. There are two reasons for this. One reason is that ITS considerably helps in monitoring the behavior of several of the stakeholders involved in urban freight transport systems, including shippers, freight carriers, administrators, and residents. ITS assists in identifying improved solutions and implementing policy measures relating to urban freight transport issues. Shippers worry about their logistics costs, freight carriers concentrate on providing reliable goods delivery services in urban areas to meet the requests of shippers including time windows. Residents worry about air pollution, noise, vibration, and visual intrusion by pickup-delivery trucks movements and parking when loading/unloading goods. Administrators in municipalities aim to promote economic development as well as to reduce negative environmental impacts. ITS and Information and Communication Technology (ICT) have the capability of solving these complicated and difficult problems. The other reason is that the efficiency of urban freight transport seems to be contradictory to environmental friendliness, but ITS and ICT can solve this contradiction. A good example can be seen in the optimization of Vehicle Routing and scheduling Problems (VRP) based on ITS as well as joint delivery systems using ITS. ITS is very powerful for collecting precise data on the variation of travel times on road networks and these data can be used to establish probabilistic VRP models and solutions that incorporate the uncertainty of travel times.

ITS also contributes to enhancing the safety and security of urban freight transport systems. Some ITS, including collision avoidance systems and lane keeping systems, are effective for safer driving but these systems are also effective for passenger cars as well as freight vehicles. Other ITS, such as identifying the location of freight vehicles and communication systems between vehicles and control centers for efficient fleet management, are dedicated to freight vehicles. These systems allow freight vehicles to be well controlled and managed in both normal and emergency situations. Radio Frequency IDentification (RFID) tags, which are used in product labeling, are also helpful for fast and accurate identification of products as well as ensuring the security of cargo containers that contain these products. Driver monitoring systems provide a useful tool for evaluating the performance of truck drivers, which leads to improved driving that can reduce traffic accidents. These types of systems are welcome by logistics companies to decrease costs from traffic accidents because delays or damage to goods by crashes can cause severe loss of business opportunities for freight carriers.

This chapter describes the functions of ITS and how ITS can be applied in city logistics. Examples and future perspectives based on recent advances of ITS in city logistics are also presented.

9.2 FUNCTION OF ITS

There are four functions of ITS associated with city logistics:

1. Data collection
2. Data processing
3. Transmitting information
4. Sharing information

Collecting data is a basic function of ITS. Before ITS was introduced, it was very difficult to obtain precise data relating to travel times and the routes of freight vehicles. However, today many freight vehicles are equipped with Global Positioning Systems (GPS), navigation systems, and devices that allow communication to and from control centers. For example, these systems allow data to be collected regarding the location of freight vehicles every second, and the travel times on links of the road network as well as the paths vehicles are using. Figure 9.1 shows an example of probe data of a truck's path in Osaka City. The location of the truck every 2 seconds is shown in this figure and it is easy to observe where the truck has traveled on the road network.

Figure 9.1 Probe data of a vehicle's path in Osaka City, Japan.

Processing the data of freight vehicle movements in urban areas can be divided into two categories: (1) historical data and (2) real-time data. Analyzing historical data of freight vehicles' movements provides a good base for understanding the variation of travel times. Figure 9.2 illustrates GPS probe data from freight vehicles in Nagoya City. It is easy

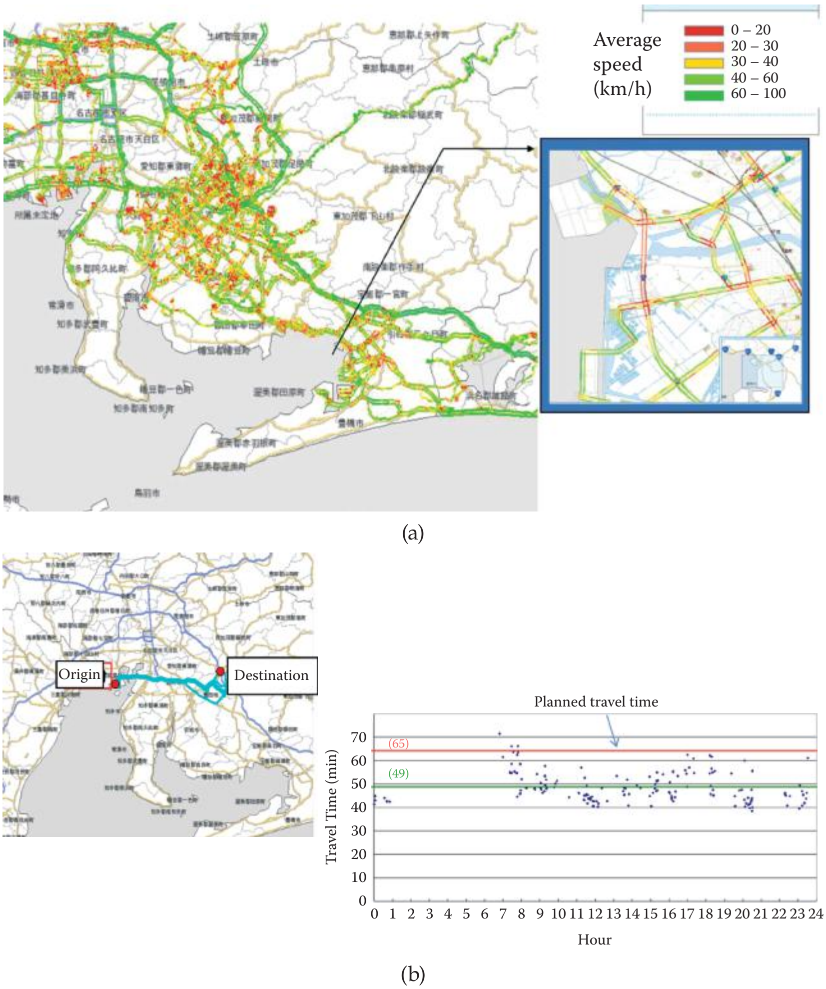

Figure 9.2 Probe data of freight vehicles based on GPS in Nagoya City, Japan. (a) Distribution of average speeds for freight vehicles on road network. (b) Comparison of planned and real travel times of freight vehicles.

to recognize which road links are congested and what the difference is between planned and real travel times of freight vehicles for a certain origin destination pair. This type of data is useful for improving fleet management in the operation of pickup-delivery trucks in urban areas.

Analyzing real time travel time data from ITS is also important for the dynamic operation of freight vehicles. If information about crashes on road links is provided, operators can recalculate the paths of freight vehicles and advise drivers to choose better paths to avoid delays due to traffic accidents.

Transmitting information between vehicles and control centers is an important role of ITS. Today, satellite-based communication systems are available for such purposes. Communication between vehicles and control centers for 24 hours throughout the year is critical for reliable freight transport systems. This is particularly important in disaster situations when communication tools should be available for identifying the location of vehicles and providing appropriate instructions to drivers based on updated road traffic conditions.

Sharing information among private companies and public authorities is required to establish public-private partnerships in city logistics. A good example is the case of the Tohoku earthquake in 2011. Using data from ITS Japan, Figure 9.3 indicates the vehicles that passed road sections

Figure 9.3 Combined traffic information based on public-private cooperation via the Internet after the Tohoku earthquake (ITS Japan).

on the previous day. Several car manufacturers, including Toyota, Nissan, and Honda, as well as the Ministry of Land, Infrastructure, Transport and Tourism and the prefectures provided their data based on probe surveys and these were integrated into one data set. This information was disseminated via the Internet and was very useful for emergency vehicles for distributing medical and relief supplies as well as recovery products. This is a very good example of data sharing among public and private stakeholders.

9.3 APPLICATIONS IN CITY LOGISTICS

ITS has been applied in a number of city logistics solutions and can be categorized into four areas: (1) modeling city logistics using historical or real-time travel time data, (2) matching systems between shippers' orders and unutilized capacity on trucks via the Internet, (3) parking information and booking systems, and (4) joint delivery systems.

9.3.1 Modeling City Logistics Using Historical or Real-Time Travel Time Data

Modeling vehicle routing and scheduling problems for city logistics requires travel time data on road networks. Typically, historical data of travel times can be used for probabilistic vehicle routing and scheduling. Figure 9.4 shows an example of historical data of travel times on a link of a national highway in Osaka that was provided by VICS (Vehicle Information and Communication Systems). This type of historical travel time data can be created using a series of travel time measurements on road links using traffic counters.

Ando and Taniguchi (2006) presented a Vehicle Routing and scheduling Problem with Time Windows-Probabilistic (VRPTW-P) model that was applied to a real situation in Osaka. It showed that considering the distribution of travel times provided by VICS resulted in a decrease in total operation costs of 4.1% and delay penalties of 46.2% compared with the usual operation by a freight carrier. This cost reduction is regarded as the value of information. As well, the VRPTW-P model performed better compared with the usual operation, with estimated reductions of 6.8% in running times, 7.6% in CO_2 emissions, 6.9% in NOx emissions, and 8.0% in suspended particle materials (SPM). Therefore, considering the

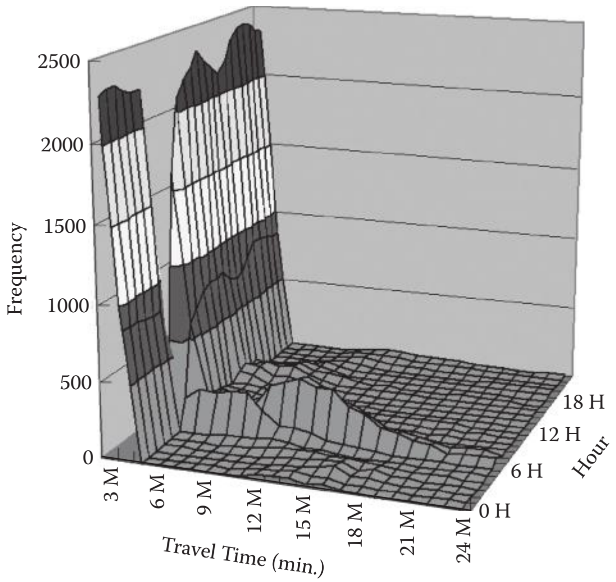

Figure 9.4 Historical data of travel times in Osaka by VICS.

uncertainty of travel times with probabilistic vehicle routing and scheduling can contribute not only to decreasing logistics costs but also to alleviating traffic congestion as well as improving the environment.

Real-time travel time data can also be used in the Vehicle Routing and scheduling Problem with Time Windows-Dynamic (VRPTW-D) model, which incorporates dynamic changes in travel times on road networks. ITS provides real-time travel times, for example, updated every 15 minutes from VICS. Operators of pickup-delivery vehicles can then recalculate the optimal paths for their vehicles based on updated travel times in cases when there are traffic accidents. This type of dynamic operation requires information on the current location of vehicles and very fast calculation of optimal solutions for the VRPTW-D. The visiting order of customers and paths between customers can be updated. Taniguchi and Shimamoto (2004) indicated that the application of the VRPTW-D model with the real-time information of travel times resulted in a decrease in total costs compared with the Vehicle Routing and scheduling Problem with Time Windows-Forecasted (VRPTW-F), which only takes into account the one forecasted value of travel time on each link in a road network. In many cases, the total running time was also reduced. Therefore, the VRPTW-D model is beneficial for both freight carriers in reducing total costs and society by alleviating traffic congestion.

9.3.2 Matching Systems between Shippers' Orders and Unutilized Capacity on Trucks via the Internet

Pickup-delivery trucks are often used inefficiently in urban areas. This includes empty trucks that are returning to depots after finishing deliveries to customers. To avoid such inefficient use of truck capacity, matching systems via the Internet provide a good opportunity for shippers to identify freight carriers to perform deliveries and for freight carriers to use the unutilized capacity of their trucks and to receive more orders to carry goods. Figure 9.5 shows an example of a matching system that is operated by Japan Trucking Association. Since long-term contracts are usually used in freight transport, this type of system is suitable for the spot market in freight transport, at peak times or at times when there is a sudden increase in demand due to commercial reasons.

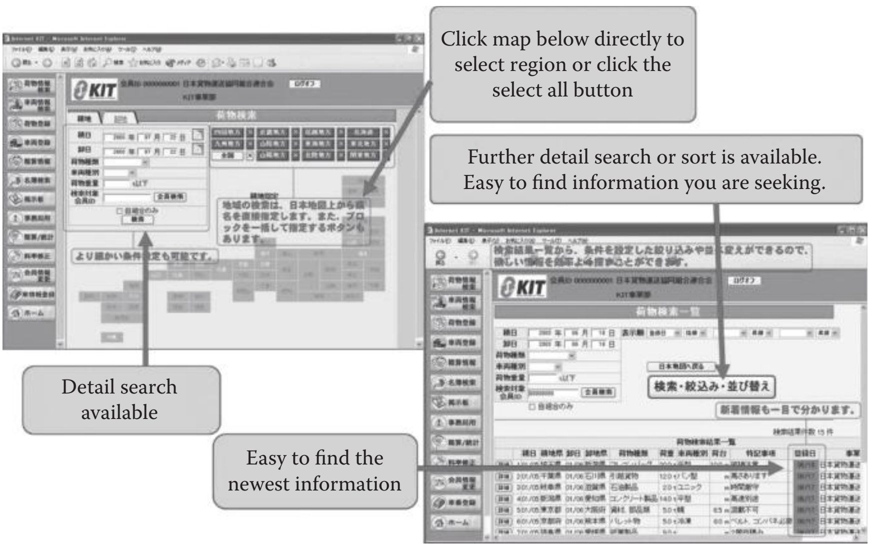

Figure 9.5 Matching transport orders and underutilized capacity of trucks via the Internet (Japan Trucking Association).

van Duin et al. (2007) presented a simulation model of auctioning and rescheduling between shippers and freight carriers using matching systems for cases where shippers provide requests for carrying additional shipments and freight carriers bid to accommodate these shipments. After applying an auction system between shippers and freight carriers on a hypothetical road network, they found that the auction caused the price and punctuality difference between the preferred pickup time by shippers and offered pickup time of freight carriers to decrease, which is favorable to shippers. Assigning a higher priority to punctuality for a freight carrier resulted in the carrier receiving more orders and assigning a higher priority to costs caused a freight carrier to receive fewer orders.

9.3.3 Parking Information and Booking Systems

Finding an appropriate parking space for pickup-delivery vehicles to load and unload goods in urban areas is important from the viewpoints of efficient operation of delivery and reducing unnecessary maneuvering of vehicles. Provision of parking information using ITS is critical for achieving optimal urban distribution operations. Parking information includes where off-street and on-street car parks are located. Booking systems for dedicated truck parking spaces using the Internet or mobile phones are now available in some cities. Figure 9.6 illustrates an example of a booking system for off-street truck parking spaces using mobile phones and electric toll collection (ETC).

Aiura and Taniguchi (2006) developed a facility location model for on-street loading/unloading spaces for pickup-delivery vehicles. This model determines the optimal location of on-street loading/unloading spaces by minimizing the total cost, which consists of delay penalties, fixed costs, operation costs, parking fees, and waiting costs of both pickup-delivery vehicles and passenger cars. Using a test road network, the model was able to determine a configuration of parking spaces that achieved a cost reduction of approximately 3% depending upon the level of enforcement.

9.3.4 Joint Delivery Systems

Joint delivery systems are core schemes in city logistics for more efficient and environmentally friendly urban freight transport systems. Because joint delivery systems involve many freight carriers that compete with each other, ITS plays an important role in coordinating the behavior of vehicles of different freight carriers. In particular, ITS is essential for identifying

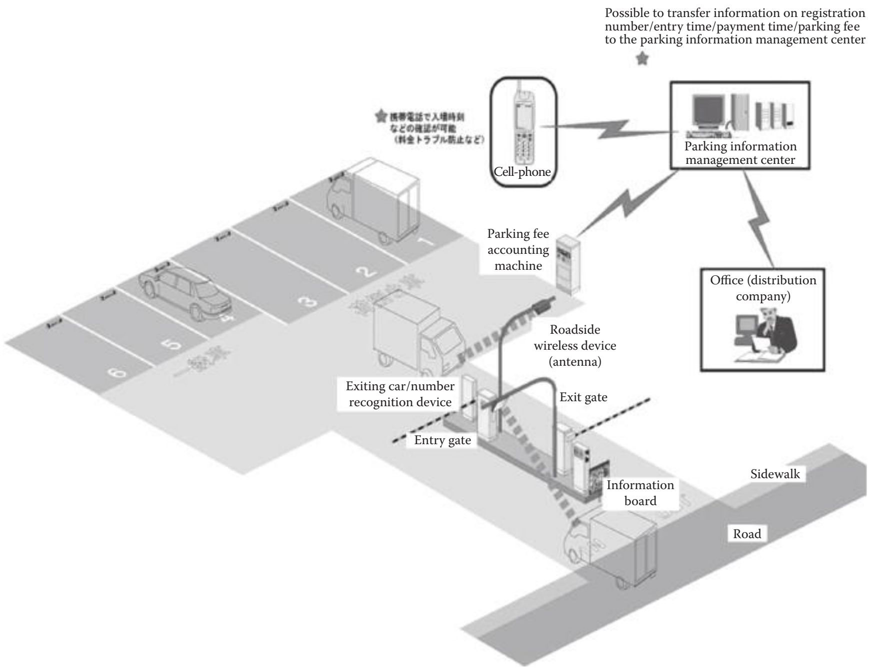

Figure 9.6 Booking system for off-street parking spaces for trucks using mobile phones and ETC. (Highway Industry Development Organisation, Japan.)

the location of vehicles and providing communication between vehicles and the control center. Figure 9.7 illustrates the concept of joint delivery systems in Yokohama, Japan. Before the joint delivery system was introduced, freight carriers collected and delivered goods individually to stores in the Motomachi Shopping Street in Yokohama. After this system was introduced, freight carriers dropped their goods off at the consolidation center and a neutral freight carrier jointly delivered goods to stores and jointly collected goods from stores and dropped them off at the consolidation center. This system started in 2004 and has been successfully operated with the support of the Motomachi Shopping Street Association.

Taniguchi and Kakimoto (2004) presented a dynamic traffic simulation model and a vehicle routing and scheduling with time windows model in an e-commerce environment. Applications of this model indicated that total costs, running times of trucks, and NOx emissions for home delivery of goods due to B2C e-commerce would be significantly

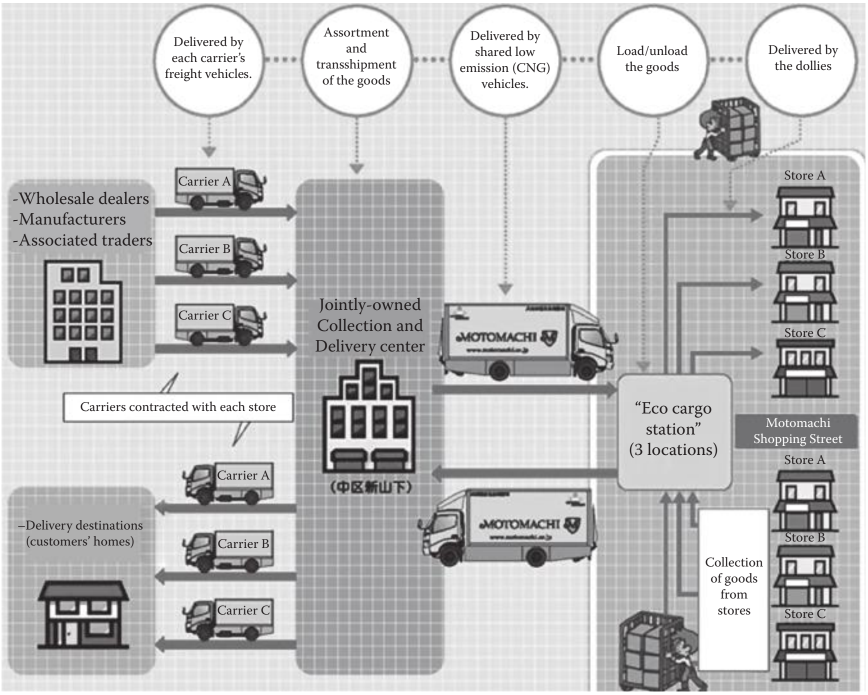

Figure 9.7 Joint delivery system in Yokohama, Japan.

increased compared with traditional shopping at stores. However, if joint delivery systems were introduced among home delivery carriers, the total costs, running times of trucks, and NOx emissions would be reduced by 55.7%, 15.1%, and 14.2%, respectively, in the case when the penetration rate of e-commerce was 10%. Therefore, ITS-based joint delivery systems are effective in preventing an increase in total costs, running times, and NOx emissions compared with individual home deliveries due to e-commerce.

9.4 FUTURE PERSPECTIVES

9.4.1 Platform of Public-Private Partnerships (PPP)

ITS will play an important role in promoting city logistics in the future because the advanced information and communication systems are key components of Public-Private Partnership (PPP) platforms for urban freight transport management. Several stakeholders, including shippers, freight carriers, administrators, and residents, can take part in the PPP platform, identifying issues, finding approaches and measures, assessing the results in advance, and evaluating outcomes. For these tasks, ITS provides a core technology in terms of data sharing, analysis, and integrating the results. Multi-agent simulation (Teo et al., 2012) can be used to analyze the behavior of individual stakeholders. This type of PPP platform is able to allow the public-private coordination of urban freight transport management. For example, if the policy measure of recommended truck routes is introduced, the actual behavior of trucks on urban roads can be monitored and the effects on traffic congestion, NOx, and suspended particle materials (SPM) emissions evaluated. Then some feedback including side effects can be given for evaluating this policy measure. In this case, PPP platforms are vital for effectively implementing policy measures of city logistics and evaluating the results.

9.4.2 Co-modality

The European Green Cars Initiatives report stated that for the common European market to function smoothly, there is a need for an integrated, green, and efficient transport system that allows the free movement of goods and people within, into, and out of the EU territory (EU, 2010). Within this report, city logistics is identified as one of three major areas aimed at full interoperability across modes and networks, down to the last kilometer. The concept of co-modality includes the efficient use of different transport modes at any time for passengers and freight. Therefore, co-modality allows multiple uses of roads, rails, coastal shipping, inland waters, and bicycles in the geographical domain and the time domain. The use of tramways, electric vans, and cargo bikes in Kyoto for urban freight transport by Yamato provides a good example of co-modality for city logistics.

Generally, passenger traffic and freight transport are conducted separately. However, empty trucks make many trips. For example, 27% of freight transport in Europe is undertaken by empty vehicles (EU, 2010). The number of passengers in cars, taxis, and buses is sometimes very low. Then joint use of vehicles for both passengers and freight may increase load factors. In remote areas, buses can be used for transporting small goods together with passengers. Such joint use of unutilized capacity on buses not only benefits bus operators in terms of more revenue, but also benefits passengers by providing a higher frequency of buses for shopping. For interoperability of modes and networks, ITS is necessary to coordinate the operation of different transport modes across entire transport networks because ITS can make reliable, safe, efficient, and transparent transport systems using advanced communication systems. In the future, we may have more integrated transport systems for improving the mobility, sustainability, and livability of cities.

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10

Off-Hour Delivery Programs

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Contents

10.1 INTRODUCTION

As a response to rising levels of freight traffic, transportation policy makers are becoming increasingly interested in implementing projects and programs that mitigate the negative effects that freight activity generates, without harming the local economy. Traditionally, public sector interventions have focused on the supply side by means of improvements such as to the infrastructure, parking/loading areas, and traffic control (Holguín-Veras et al., 2014). These interventions often require large investments and most of them are focused solely on freight carriers. An alternative approach, freight demand management (FDM), targets the freight agents that create the demand to foster more sustainable distribution practices.

Although travel demand management (TDM) strategies have been used to alleviate the congestion produced by passenger travel, there are few examples of FDM. One of the possible reasons is the multiplicity of economic agents involved in freight activity. While in passenger transportation it is easy to identify the passenger as the key decision maker, the multiplicity of agents involved in freight lead to a situation where it is not always obvious which agent is the key decision maker in a given situation. This is important because the carriers' operations have to account for the constraints imposed by their customers, most notably receivers and shippers. Successfully implementing FDM interventions necessitates a clear understanding of the relationships between these agents and how best to induce them to undertake the desired changes in behavior. Off-hour delivery (OHD) programs are a good example of a successful FDM strategy. This initiative seeks to change the behavior of receivers by offering them incentives to accept deliveries during the off-hours (7 PM to 6 AM). In most cases, convincing receivers—who are the agents with the power to decide on delivery times—to accept OHD will lead carriers and vendors to switch deliveries to off-hours. Shifting entire supply chains to the off-hours reduces delivery traffic during the regular hours and the negative externalities produced by the freight traffic.

The main intent of this chapter is to consolidate the large body of research conducted on OHD to make it easier for practitioners and researchers to find the information they may need to design and implement OHD programs. To this effect, the chapter discusses the theory that supports OHD, the modalities of OHD, and its supporting technologies, followed by a discussion of potential incentives, the selection of target industry sectors, estimation of the OHD market share, and stakeholder engagement. The chapter finishes with concluding remarks.

10.2 THEORY

The main objective of OHD programs is to induce a change in the time when deliveries are received. The desired change in receiving behavior translates into reduced congestion during the day hours, and reduced conflicts between delivery trucks, pedestrians, and bicyclists. OHD is a business-friendly alternative FDM initiative that overcomes the limitations of freight road pricing.

The experience with freight road pricing clearly indicates its limited effectiveness as an FDM tool. The main issue is that most carriers cannot pass the additional toll costs to their customers, and even if the carriers were able to pass on the toll costs, the increase in the cost per delivery is typically not large enough to change receiving behavior (the tolls would need to be so high that they would be politically unfeasible). A study in New York City revealed that only 9% of the carriers could pass the extra cost from tolls to their customers and, as a result, receivers only experienced a marginal increase in delivery costs, which is insufficient to offset the extra cost of accepting OHD (Holguín-Veras et al., 2006a, 2006b). Most receivers, including the minority that is asked to pay for the toll increase, have no incentive to change to the off-hours.

This happens because the decision concerning delivery time is the result of the interactions between the shipper/carrier and the receiver. Holguín-Veras (2006) described these interactions using game theoretical concepts and concluded that it conforms to the Battle of the Sexes game (Rasmusen, 2001). In the resulting payoff matrix, it is clear that there are only two feasible outcomes: (1) deliveries are done during regular hours, and (2) deliveries are done during off-hours. In the former case, the receiver benefits from receiving deliveries during regular hours because it will not incur the extra cost of OHDs, while the carrier is the party that will experience extra costs. In the latter case, the carrier benefits from OHD because of the faster travel speeds and productivity gains, although the receiver experiences higher costs associated with staff, energy, and security. Essentially, carriers and receivers are inharmonious. However, because receivers are typically the ones with the power to decide on delivery times, the outcome that most often materializes is regular hour deliveries. Not surprisingly, approximately 95% of deliveries are made during regular hours and only about 5% during off-hours (Holguín-Veras et al., 2007).

Although OHDs are the best outcome from a societal point of view, as clearly shown by the estimates of Holguín-Veras et al. (2011b) and Yannis et al. (2006), it is not likely that they acquire majority status in *laisser-faire* conditions. The main reason is because receivers have power over carriers, they will not consent to OHD if they have to bear the extra costs. If the carriers' savings from OHD were large enough, the carriers could use part of the savings to compensate the receivers for the extra costs. In this scenario, both the carriers and the receivers would be better off and would switch to delivery during off-hours. However, after decades of deregulation, the carriers' profit margins are so small that the extra profits produced by OHD are not large enough to compensate the receivers. Thus, there is a market failure that prevents the market from reaching the most efficient outcome. Removing this market failure requires providing incentives to receivers so that they find it worthwhile to accept OHD. A similar outcome could be reached by charging receivers for the number of deliveries produced, although this approach is bound to encounter significant political opposition from the business sector.

From the political point of view, however, there is no doubt that a voluntary program fostered by incentives is easily implementable. Moreover, the voluntary nature of such a program guarantees an increase in economic welfare because the public sector will offer an incentive only if there is a societal gain (assessed through a cost-benefit analysis) and the receivers involved will only change their practices if they can benefit from it.

10.3 MODALITIES

In practice, OHD can be implemented using two modalities. The first is the staffed OHD where an employee from the establishment is present to accept and check the shipments received during the off-hours. Although this type of delivery minimizes the risk of a negative experience such as accidental damage to the establishment, the costs that receivers experience increases due to extra staff, security, and electricity, among others. In this case, the incentives provided to the receiver must exceed the extra costs produced by the off-hour operations. In the case of large traffic generators such as large buildings, OHD can be received by the staff of the delivery room and then distributed to the individual receivers during regular hours. Such schemes increase the feasibility of OHD as extra costs are divided among multiple receivers. This is a very attractive solution for large buildings as they could represent a large amount of the deliveries made to the core of a large urban area. In Manhattan, for instance, approximately 56 skyscrapers are estimated to produce approximately 4% of the delivery traffic in the island (Jaller et al., 2013). Fostering OHD at these buildings could lead to noticeable reductions in the congestion produced by delivery traffic. Moreover, the owners of these buildings could reap significant profits if, in return for their commitment to implement such OHD programs, the city authorities give them a variance to reduce the number of loading bays. This would enable them to use the space of the loading bays for income-generating space, which would more than compensate for the costs of OHD. An alternative to staffed OHD is unassisted off-hour deliveries (UOHD), which are those where there is no staff present at the time of the delivery. UOHDs are appealing for receivers that get their supplies from a parent or related company and for those receivers that have a trusted vendor, as they do not need to incur extra costs to receive OHD but can still benefit from its advantages.

Essentially, the receiver can choose between OHD and UOHD, but it can also choose among a number of UOHD alternatives made possible by a wide range of supporting technologies. The best choice depends on operational constraints and receiver preferences. However, from the standpoint of public policy, it is clear that UOHDs are the most cost-effective alternative as there is no need for an ongoing incentive, which is the case for staffed OHD. At the same time, the number of establishments willing to participate in UOHD is smaller than those that are able to implement staffed OHD. Transportation sector agencies considering OHD programs should consider these factors when deciding which modality of OHD to foster in their jurisdictions.

10.4 TECHNOLOGIES

There are a number of technologies that could be used to foster participation in OHD by either reducing the risk to receivers or minimizing noise impacts on local communities (Holguín-Veras et al., 2013). In the case of risk mitigation technologies, their importance depends on the modality of OHD being used as the associated risks are different. In staffed OHD, the receivers minimize risks by use of their staff to ensure that "nothing bad happens." In UOHD, in contrast, the absence of a staff member when deliveries are made entails higher risks and could be a deterrent for participation. Although risk mitigation technologies could be of interest to receivers using staffed OHD, they are essential to UOHD. In contrast, both staffed OHD and UOHD stand to benefit from using low noise delivery practices and technologies that reduce the noise impacts on local communities. These aspects are discussed further in this section.

10.4.1 Risk Mitigation Technologies

These technologies seek to provide access and internal surveillance, as well as access control. Access surveillance technologies rely on video recording equipment installed at the access points to the businesses or the delivery areas, while internal surveillance allows the verification of the deliveries made, and that the individuals who enter the establishment only perform their authorized activities. In both cases, cameras are key. The criteria for selecting the devices are mainly cost, picture quality, viewpoint range, and network capabilities. In addition to these devices, complementary system components provide different security levels depending on the needs. In basic systems, the camera is integrated into a network for digital video recording for an off-line supervision in the case of a negative outcome. In the case of high-end retail stores, more advanced technologies can provide real-time monitoring. Video surveillance systems are frequently used during regular hour deliveries and can easily support UOHD operations.

UOHD requires the implementation of operational concepts that rely on access control technologies to decrease risks. The first decision that the receiver has to make is whether to provide restricted or full access. In the case of restricted access, the driver and the delivered goods are separated from the rest of the establishment. Alternatives include the use of delivery lockers, double doors, and virtual cages (Ogden, 1992; Holguín-Veras et al., 2013). Delivery lockers, or parcel boxes, are appropriate for small size deliveries. The units are located outside of the establishment and their access is controlled through a central system. A low-cost option is to integrate a SIM card into the lock; the driver calls this number and is granted access through a numerical code. More advanced schemes are based on barcode readers; in those cases, the driver uses his or her personal card to open the locker door. Some of these systems are integrated with the receivers' inventory systems, which allows for real-time updating of the inventory.

In the case of double doors, the driver is provided with the key of the main door which allows access to an area separated from the rest of the establishment by a second door (the drivers do not have the key for the second door). However, these systems require additional space that may be scarce in large urban areas and, in some cases, need installation of additional equipment to support UOHD, for example, refrigerators. In the case of virtual cages, a laser system delimits a space inside the store where deliveries can be made. The sensors are connected to the store's private security systems, which are triggered if an attempt is made to trespass the virtual cage. This technology could allow, for instance, deliveries to be made in the lobby or the corridors of buildings without having access to individual establishments.

Table 10.1 Alternatives for Receiving OHD

Type	System	Description	Risk	Cost
Staffed OHD	Standard	Delivery accepted and verified by employee	+	+++
	Large traffic generators	Delivery received in a common room by a common staff	+	++
UOHD	Electronic doorman	Driver is granted access by a remote operator assisted by security cameras and radio/phone	++	++
	Double doors	Driver is provided with a key to an outside door that leads to a separated storage area	++	+
	Key deliveries	Driver is provided with a key to deposit the delivery in a preset location (e.g., walk-in refrigerator). Can be monitored with a camera	+++	+
	Electronic key box	Driver is provided a password to open the key box and get a key to open the establishment. Can be monitored with a camera	++	+
	Virtual cages	Driver is provided with a key to an outside door that leads to a storage area. Driver is restricted by a virtual cage marked by four sensors	+	++

Source: Adapted from Holguín-Veras et al. (2012)
Notation: (+) denotes a low risk/cost. (++) denotes a moderate risk/cost. (+++) denotes high risk/cost.

In cases where the store owner provides full access, the keys are given to the drivers or stored in a key box protected by an electronic code. Keys can be replaced by electronic locks that require a pin code, an access card, or more advanced recognition systems such as biometric scanners. An alternative system is the electronic door attendant service, where a remote operator grants access to vendors after verification through security cameras, radio, or phone. Table 10.1 summarizes the main alternatives and technologies used to receive OHD, as well as a qualitative assessment of the risk and cost associated with each of them.

In essence, the choice between staffed and unassisted OHD entails tradeoffs between operational costs and risks. There is a wide range of technologies available to decrease the risks for UOHD and make it an appealing alternative. OHDs lead to high costs but low risks, while UOHDs entail lower costs and higher risks. For further analysis, see Holguín-Veras et al. (2012).

10.4.2 Low Noise Technologies

Another consideration for a successful implementation of OHD is to address the noise impacts on local communities. Thus, an OHD program must provide guidelines to mitigate and control the contributing factors to noise, such as engine noise; horns and back-up alarms; refrigeration systems; lift and hydraulic systems; forklifts, carts, ramps, and other handling equipment; and driver behaviors such as excessive acceleration or braking, shouting, and loud music. Noise studies have shown that these factors produce high levels of noise compared to ambience noise, although in the form of noise peaks that only last a couple of seconds (Holguín-Veras et al., 2013). There are technologies and programs already available to address these noise issues. For instance, the Netherlands' PIEK program attempts to lower noise levels by fostering quiet behavior through education campaigns, development of low noise trucks, improvement of handling equipment, development of low noise technologies to retrofit trucks and establishments, and retrofitting and redesign of loading facilities (Shoemaker, 2005; Finlay, 2008).

In terms of education, it is important to train staff on noise abatement. This is the easiest and most inexpensive method to mitigate noise levels. Training must focus on improving driving behavior: speed and revolutions management; reducing additional noise from conversation, radios, and other communication devices; not slamming the doors; and careful handling of the cargo and use of handling equipment (Goevaers, 2011).

Truck solutions to noise issues could entail high costs as it could involve a shift from diesel engines, which usually operate at 80 dB(A), to much quieter technologies such as electric trucks. Other alternatives include engines using (liquefied or compressed) natural gas or even hybrid trucks (Colruyt Group, 2011; Wieman, 2010; Daimler AG, 2011). However, there are low noise accessories that can be installed on trucks to reduce noise at a lower cost. For example, retrofitting the refrigeration unit of a truck to place it in an insulated box under the chassis of the trailer can lower noise levels, or using cryogenic nitrogen tanks to maintain temperatures would considerably reduce noise (MotorTrader.com, 2008; Haldex, 2010; Dhollandia, 2011). Some of these technologies have other benefits such as fuel savings and emission reductions. Such truck improvements must be accompanied by quieter cargo handling equipment. It is important that such equipment uses the most adequate type of wheels to reduce noise and vibration, and that they are equipped with suspension seats, smoother controls, and noise- and shock-absorbing materials (Toyota Industrial Equipment, 2011a, 2011b). Noise-absorbing materials could also be used at the receiving location placed in and around the rooms where they could mitigate noise (Noisetek, 2011).

These technologies could be used to mitigate the noise impacts produced from delivery operations and to comply with local regulations. In New York City, for example, the Local Law 113 provides noise guidelines (The City of New York, 2005). For the operations of freight vehicles and delivery operations, this law implemented in 2007 provides the following considerations: using vehicle horns is illegal except when used as a warning in dangerous situations; prohibits excessive sound from the muffler or exhaust system of a vehicle when operating on public right-of way of 35 mph or less; and requires that vehicles that weigh more than 10,000 pounds do not produce audible sounds at distances greater than 200 feet. These regulations are provided to the public through different websites, and there is a noise hotline (311) where residents can register complaints (The City of New York, 2005; Holguín-Veras et al., 2013a). The New York City Department of Environmental Protection (DEP) sets rules that are more specific. The DEP issues citations to vehicle operators or establishments when they produce noise levels of 10 dB(A) over the ambient level during the day hours (7 AM to 10 PM), and 7 dB(A) over the ambient level during the night hours (10 PM to 7 AM). However, they make exceptions for up to 15 dB(A) over the ambient level when the noises are short-term (defined to be less than 1 minute) (NYC Department of Environmental Protection, 2007). As already discussed, noise analyses during the UOHD program identified factors that produced high noise peaks that only lasted a few seconds. Although the law allows these, they should be mitigated to reduce the impact on communities.

10.5 INCENTIVES

As indicated before, most receivers need to be incentivized to accept OHD. The reality is that, although an occasional receiver could decide to participate in OHD for the sake of society, in most cases, incentives will be needed to enact a significant change in freight traffic. Without some form of incentive mechanism, most receivers will find it difficult to take the step and accept OHD and the associated risks. A great deal of research has been conducted to determine the kind of incentives that could be used to induce the desired change in receivers' behavior. Holguín-Veras et al. (2007) and Domínguez et al. (2012) found that an ongoing financial incentive increases participation in staffed OHD and that different industry sectors exhibit different propensities to participate. Holguín-Veras et al. (2014) found that UOHD could be fostered by a one-time incentive, discounts from carriers, business support services and public recognition provided to participants. Incentives of a monetary nature are the most effective way to foster OHD. From the standpoint of the source, the incentives could come from either the public or the private sectors. Among the former, it is important to mention: (1) an ongoing incentive for OHD (both staffed and unassisted), and (2) a one-time incentive for participation in unassisted OHD. Examples of a private sector incentive are the discounts that vendors and carriers could provide to the receivers that accept OHD. There are several possibilities as sources of the public sector incentives, including: (1) specialized funds to support OHD programs, such as those that could be authorized by appropriate legislation; (2) toll revenues generated by a small surcharge to regular hour traffic to fund an OHD program (Holguín-Veras and Aros-Vera, 2014); and (3) "re-purposing" of existing funds such as those intended to foster economic development, energy conservation, and environmental improvements. In financially constrained environments, where the creation of additional funding programs may be a challenging proposition, "re-purposing" of funds may be a viable option on account of the significant benefits of OHD on the economy and the environment. Obviously, whether this could be done depends on the specific terms of applicable laws and regulations. Private sector incentives are also important. It stands to reason that because carriers/shippers would benefit from delivering during off-hours, they should offer shipping discounts to the customers that accept UOHD. Carrier discounts can increase receiver participation in UOHD if combined with other incentives (Holguín-Veras et al., 2014).

Non-monetary incentives can also be offered by the public sector to foster OHD. Business support programs provide assistance and advice to receivers participating in OHD on issues related to their operations, for example, tax preparation. In these programs, the public sector could provide a service that otherwise would be costly for receivers, particularly small businesses. The research conducted indicates that business support is equivalent to offering a one-time incentive ranging from $1,078 to $3,049 depending on the industry segment (Holguín-Veras et al., 2014).

The provision of public recognition, widely used to foster sustainability programs (Care4Air, 2013; Transport for London, 2013), is indeed another incentive for OHD. Public recognition programs use awards, a branding logo, press releases, and other mechanisms to publicize the good public deeds of a company. By being recognized, receivers will stand out as socially responsible businesses and will attract environmentally sensitive customers. Holguín-Veras et al. (2014) estimated that providing public recognition could be as effective as a one-time incentive of $666 to $1,885 to induce participation in UOHD.

Another alternative to promote UOHD is the creation of a trusted vendor certification program (Holguín-Veras et al., 2014). The research conducted by the authors revealed that having a trusted vendor is the single most important factor in the decision whether to accept UOHD. If translated into monetary incentives, the availability of a trusted vendor is equivalent to a one-time incentive of $36,538 for some industry sectors. Although having a trusted vendor is an attribute of the firm, not an incentive, its importance highlights the potential of creating a trusted vendor certification program. In such a program, a business association credible to both receivers and carriers could provide the role of a certification body that attests to the credentials of a carrier/vendor as a "trusted vendor." Such a program, if properly done, could mitigate receivers' concerns, making it easier for them to accept UOHD.

Although these incentives can be implemented separately, the best way to foster a UOHD program is to use them together, as part of a multilayered approach. The public sector could provide monetary incentives and public recognition, carriers may provide shipping discounts, and private sector trade groups could offer a trusted vendor certification program. The combined use of all incentives, together with an aggressive publicity campaign coordinated with private sector groups, provides the best chance of inducing a rapid shift in deliveries to the off-hours.

10.6 TARGET INDUSTRY SECTORS

A critical success factor for implementing an OHD program is to identify and target the industry sectors that offer the best payoff in terms of trips switched to the off-hours. The determination of such a "payoff" requires the estimation of the freight trip generation created by the various industry segments and the willingness of the receivers in these sectors to accept OHD or UOHD. There shall be no doubt that collecting local data about freight trip generation and willingness to participate is the best alternative although it may not always be possible. In the case of American cities, freight trip generation estimates are available (Holguín-Veras et al., 2011a, 2012; Lawson et al., 2012); and estimates of the willingness to participate could be obtained by using the models reported (Holguín-Veras et al., 2007, 2013; Jaller and Holguín-Veras, 2014). Estimates of willingness to participate for the Spanish cities of Santander and Barcelona can be found in Domínguez et al. (2012). Table 10.2 shows a summary of the chief findings of the behavioral research conducted. It is interesting to note that there is a great deal of agreement among the various studies conducted.

Table 10.2 Behavioral Research Summary

Variables	HV 2007	HV 2013	DOM-S 2013	DOM-B 2013
Industry Sector				
Food and beverage stores	*	+++	+	+++
Press and book	*	*	+++	++
Clothing stores	*	+	++	*
Apparel manufacturing	*	++	*	*
Accommodation	*	*	*	++
Non-durable wholesalers	*	+	*	*
Miscellaneous stores	*	+	*	*
Performing arts	*	+	*	*
Furniture stores	*	*	*	+
Personal laundry services	*	-	*	*
Commodity Received				
Commodity: Alcohol	+++	*	*	*
Commodity: Wood Lumber	++	*	*	*
Commodity: Food	+	*	*	*
Commodity: Textiles/clothing	+	*	*	*
Commodity: Medical supplies	+	*	*	*
Commodity: Office supplies	+	*	*	*
Commodity: Paper	+	*	*	*

Table 10.2 (continued) Behavioral Research Summary

Variables	HV 2007	HV 2013	DOM-S 2013	DOM-B 2013
Incentive				
Tax deduction	++	*	+++	+++
One-time monetary incentive	*	+++	*	*
Trusted vendor	*	+++	*	*
Shipping discounts	++	++	*	*
Public recognition	*	+	*	*
Business support	*	+	*	*
Other Receiver Attributes				
Type of facility is single	+++	*	*	*
External warehouse	*	*	++	*
Employment	+	*	*	*
Number of vendors	+	*	*	*
Number of deliveries	*	-	*	*

Notes: HV 2007: Holguín-Veras et al., 2007; HV 2013: Holguín-Veras et al., 2014; DOM-S 2013: Domínguez et al., 2012 (the case of Santander); and DOM-S 2013: Domínguez et al., 2012 (the case of Barcelona).

Notation: (*) denotes not considered or not found statistically significant. (-) denotes a low negative effect. (+) denotes a low positive effect. (++) denotes a moderate positive effect. (+++) denotes a high positive effect.

10.7 MARKET SHARE ESTIMATION

Several approaches have been proposed to determine the market share of OHDs that could be attained in response to a given incentive. The first one uses discrete choice models to determine the percentage of carriers that would accept OHDs given the receivers' response to incentives (Holguín-Veras et al., 2008). This approach, the first one developed, is based on the use of two discrete choice models that sequentially estimate the response of receivers in reaction to an incentive and the response of carriers in reaction to the receivers' decisions. This approach has been superseded by other methods (Silas and Holguín-Veras, 2009; Holguín-Veras, 2012; Holguín-Veras and Aros-Vera, 2014) that are better able to capture the role of carrier costs in the decision to participate in OHDs.

Holguín-Veras (2012) developed an approximation model that estimates the joint carrier-receiver response based on the probability of a typical receiver participant in OHDs, and a tour-length distribution. Such approximation provides a useful and inexpensive way to estimate participation in OHD programs. However, this approach has the limitation of not considering the role of the geographic location of the participants. Using a Behavioral Micro-Simulation (BMS) (Silas and Holguín-Veras, 2009; Holguín-Veras and Aros-Vera, 2014), the relationships between carriers and receivers, geographic characteristics, and costs can be incorporated. The BMS determines the receivers' response to incentives using discrete choice models using characteristics of the receiver and the incentives as input. As mentioned before, the decisions of the receivers will split the delivery network into receivers willing to do OHDs and receivers that stay in the regular hours. Therefore, the carrier evaluates two scenarios: (1) base case, which corresponds to making deliveries to all receivers during regular hours; and (2) mixed operation, which includes two delivery tours, one in the off-hours for the receivers accepting OHDs and another one for the receivers staying in the regular hours. An enhanced version of the BMS (Holguín-Veras and Aros-Vera, 2014) incorporates realistic routing procedures, freight trip generation, and industry characteristics of the city under analysis. The research conducted shows that, for the practical range of conditions, the approximation model and the BMS produce the same results.

10.8 STAKEHOLDERS ENGAGEMENT

Implementing FDM programs such as OHDs requires engagement and cooperation of the private sector. To this effect, it is necessary to identify the stakeholders (e.g., businesses and communities); listen to them; understand their needs, their expectations, and the constraints under which they operate; and plan accordingly. An effective stakeholder engagement process requires constant communication to identify risks and potential solutions and to secure commitments to a strategy of improvements (Holguin-Veras et al., 2014). The public sector's disposition to solve problems of particular interest to the industry or modify a course in response to input from the private sector is a good way to foster a collaborative environment. Past experience in the implementation of OHD programs has resulted in some important lessons that can be useful for future applications (Holguín-Veras et al., 2013): designate a freight-person at the key city agencies as the point of contact for freight-related issues; create an Industry Advisory Group that represents the various industry segments; and foster an industry-led best practices dissemination program to sensitize the private sector on the importance of adopting some practices.

In dealing with the typically cautious private sector companies, pilot tests can play a key role as they allow businesses to test an innovative concept before it is finally implemented by the public sector agencies. Among other benefits, a properly designed pilot test could be of great value to test new concepts and identify and address potential issues. Pilot tests offer an opportunity to gain public and private support as they can receive attention from policymakers and from the industry. However, pilot testing requires careful consideration and design. A poorly designed pilot could lead to a bad idea being considered a "success" and to a good idea being rejected as a "failure." Essentially, a pilot test can only enlighten public policy if it is properly designed.

10.9 CONCLUDING REMARKS

The research conducted and the implementation of OHDs in Manhattan provide a number of important lessons as they show: (1) the potential of FDM as a tool to foster economic efficiency and productivity, while fostering sustainability, quality of life, and environmental justice; (2) the necessity of creating an environment of cooperation where the multiple stakeholders involved—including communities, and public and private sectors—could cooperate in the solution of freight issues; (3) that noise in the off-hours could be properly dealt with by using low noise delivery practices and technologies; and (4) that significant portions of the industry sectors in urban areas can participate in UOHD. Taken together, it seems clear to the authors that exploiting the full potential of FDM should be a high priority for both practitioners and research communities.

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11

Cooperative Freight Transport Systems

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Contents

11.1 INTRODUCTION

Cooperative freight transport systems (CFTS) are significant measures for solving urban freight issues. CFTS can be defined as "systems in which multiple entities cooperatively use and operate the whole or a part of the transport elements of their logistics activities." Cooperative use of information and communication technologies, as well as transport systems, is often incorporated. As the definition implies, CFTS could lead to a reduced number of freight vehicles used, an increase in their utilization, and a decrease in their total travel time. Therefore, these systems have a high potential for achieving many of the aims of city logistics, such as alleviating traffic congestion and improving the environment.

Allen et al. (2007) defined a consolidation center as "a logistics base located in the vicinity of the place of performing services where numerous enterprisers deliver goods destined for the serviced area from which consolidated deliveries as well as additional logistics and retailed services are realised." As such, consolidation centers, including public distribution depots, central goods sorting points, urban transhipment centers, shared-user urban transhipment depots, urban distribution centers, and logistics centers, inherently play a crucial role in implementing and operating CFTS not only for collecting and delivering goods but also for receiving, processing, and disseminating information (Browne et al., 2005). Consequently, the establishment of a consolidation center has the potential to produce more positive effects on the environment with the CFTS being simultaneously introduced.

11.2 MODELING THE EFFECTS OF CFTS

There has been a large amount of research on CFTS using a reduced number of freight vehicles for collecting or delivering the same amount of goods. This section describes the typical research conducted thus far on modeling the effects of CFTS.

Taniguchi et al. (1995) studied CFTS using a questionnaire of shippers and freight carriers in the Kyoto-Osaka-Kobe area of Japan. Responses were received from 445 companies out of the 1630 companies that were sent questionnaires, where various companies were randomly chosen from all industries. It was found that 57 companies (54 shippers and 3 freight carriers) were involved in some sort of CFTS. Results showed that the main benefits of CFTS were the cost reduction for shippers and freight carriers, while the following issues for introducing this type of system were also explored through the answers from the companies who did not participate in it: limitation of pickup/delivery time, unclearness of safety and responsibility of goods, difficulty in tracing own goods, and leaking of companies' secrets. It was also determined that consolidating at a public logistics terminal could give a good opportunity to start this type of system.

Yamada et al. (1999) revealed through a questionnaire conducted in Japan that consolidation centers were useful to implement CFTS, and the construction of such facilities could facilitate cooperation of freight transport. The results also indicated that the problems and anxiety about CFTS from companies that had already operated CFTS were not associated with the difficulty in the pursuit of goods, unidentified responsibilities, and leakage of secrets but had more to do with restrictions of delivery times, difficulty in meeting customer needs, and limitations on the type of goods.

Taniguchi et al. (1999) analyzed the effects of CFTS on CO_2 emission reduction within small road networks using a dynamic traffic simulation. They found that CFTS could substantially contribute to a decrease in emissions, ensuring that CO_2 emissions remain at the same level as the base case without the systems for pickup/delivery vehicles when the demand for goods is doubled. Duin and Jagtman (1999) investigated the location of consolidation centers with a cooperative vehicle routing and scheduling procedure. They indicated that several stakeholders were involved in CFTS, and therefore their behavior should be incorporated within the location decision.

Yamada et al. (2001) and Yamada and Taniguchi (2006) developed a simulation model based on vehicle routing and scheduling procedures for determining the optimal location of consolidation centers to be used for CFTS. Notably, this model takes into account the behavior of freight carriers, cooperative freight organizations, and administrators. Results demonstrated that CFTS could offer benefits to the whole community and freight carriers as well as that road pricing would be effective if introduced in conjunction with CFTS. Cordon pricing would have the potential to reduce the number of vehicles entering the city center and could provide as much effect as area pricing if implemented with the CFTS.

Holguín-Veras et al. (2008) focused on behavioral models estimated with data collected as part of a major investigation on policies to foster off-hour deliveries in New York City (Holguín-Veras et al., 2007). This analysis was conducted using stated preference data and discrete choice modeling. Two alternatives relating to CFTS were considered: a joint delivery service to do the last leg of deliveries and a joint staging area for off-hour trucks. The results showed that large companies and carriers that make a large number of deliveries per tour would be very reluctant to participate as well as that there were industry segments that were more inclined than others were to participate.

Akiyama and Yano (2012) analyzed data on the number of truck deliveries to large-scale retail stores in Tokyo, Japan, and estimated total truck deliveries and the potential reduction in truck deliveries. They also investigated a scenario where deliveries made by smaller trucks are consolidated and delivered to the same store or district by larger trucks. Results showed that this type of CFTS could decrease the number of truck deliveries by 20%.

11.3 EXAMPLES OF CFTS

11.3.1 Japan

In 1989, 11 department stores in the Kyoto-Osaka-Kobe area started a CFTS (Taniguchi and Nemoto, 2002). After discussing the problems relating to home delivery of commodities, the presidents of the department stores made a decision not to compete in home deliveries, while still competing in sales. Specifically, this involves competition in sales but cooperation in delivery. This system was very successfully applied and produced considerable benefits by reducing the distance traveled by pickup/delivery vehicles and labor hours.

Tenjin is a commercial area of 37 ha located in the center of Fukuoka that contains 2200 offices producing wholesale and retail goods, valued at around 2 trillion Japanese yen per year. In 1994, 36 companies established a new cooperative delivery company dedicated to CFTS. In this district, on-street parking spaces for loading/unloading were provided solely for freight vehicles. Nemoto (1997) analyzed the CFTS implemented in Fukuoka and explored the social effects generated by this system.

A CFTS with a consolidation center has been implemented by an association of retail shop owners in the Motomachi Shopping Street in Yokohama. This is the first CFTS where a retailers' association, consisting of about 300 shops, is responsible for managing the system partly supported by Yokohama City government and local police. The objectives of this CFTS are to improve the environment as well as to ensure road space for pedestrians by preventing road traffic accidents. There was a heavy concentration of car traffic in Motomachi Street—500 vehicles/day of through traffic. Despite the increasing traffic volume, there were insufficient parking spaces in the area, which led to many vehicles parking illegally on the street. This resulted in deterioration of the environment and traffic safety problems.

A project team of shop owners involving concerned stakeholders was established in 1999, selecting appropriate tasks for introducing the system with a consolidation center, securing parking spaces for freight vehicles, eliminating illegally parked vehicles, improving street crossings, and introducing low-emission vehicles. The project team was composed of the Motomachi Shopping Street Association, the trade association for truck carriers of Kanagawa Trucking Association, a neighborhood community, local police, a local road authority, and the related organizations of Yokohama City government. A consolidation center was established and started operation in 2004. The consolidation center is located 1 km away from Motomachi Street. Truck carriers are requested to deliver their parcels destined for Motomachi Street to the consolidation center, where a newly established operator of the system transfers the parcels to low emission vehicles. Almost all truck carriers, around 20 companies, joined the CFTS, paying 150 JPY for the delivery/pick-up of each parcel. This CFTS reduced the local emissions not only by decreasing total vehicle kilometers by increasing the load factor of cooperative vehicles compared with carriers' trucks, but also through lower emissions from CNG vehicles and human-powered carts compared with diesel-powered trucks (Browne et al., 2012).

11.3.2 The Netherlands

In the Netherlands, there has been a long tradition of supporting consolidation centers and city logistics services. Most of them were actively supported by the government but did not achieve their intended outcomes in terms of environmental improvements. More recently, market-led schemes have been developed that have achieved greater success. Two such initiatives are greencity distribution and Binnenstadservice.

Greencity distribution can be considered as a sort of CFTS, a joint cooperation between different transport companies. They consolidate their deliveries for large national operating clients and offer services in a large number of cities, including The Hague and Amsterdam. This results in the increased efficiency of vehicle operations, and hence a reduction in vehicle kilometers (Browne et al., 2012).

Binnenstadservice, which can be translated as inner-city services, started business in Nijmegen in 2008. This initiative focuses on receivers rather than carriers. Receivers, mostly shop owners, ask binnenstadservice to receive their goods from carriers and then to deliver the goods when they are required by the shop owner. A consolidation center is set up to enable this operation. This service is currently operating in eight cities, including Rotterdam and Utrecht (van Rooijen and Quak, 2010).

11.3.3 United Kingdom

A two-year trial project referred to as the London Construction Consolidation Centre (LCCC) operated from 2005 to 2007. The LCCC was located in South Bermondsey, approximately 5 km south of London. Its objective was to serve four major construction sites in London. It was intended to reduce the number of deliveries going directly to the construction sites and thereby reducing traffic congestion and vehicle emissions. It was estimated that this resulted in a 70 to 80% reduction in CO_2 emissions. Taking account of all deliveries from suppliers, there was a reduction of approximately 40% in total vehicle deliveries to the Unilever House building site. Consolidating goods at the LCCC eliminated trips to delivery sites by articulated goods vehicles traveling, and significantly reduced the use of vans (Transport for London, 2008; Browne et al., 2012).

In 2009, a major supplier of stationery and other office products to businesses in the UK made the decision to pilot a new urban delivery system in London in order to reduce the environmental impacts of their delivery operations. The trial was supported by the Clear Zone Partnership, which was comprised of the London Borough of Camden, the City of London, and the City of Westminster. The trial involved the use of an urban micro-consolidation center located within London together with electrically assisted tricycles and electric vans. The customers to whom deliveries were made were all located in the City of London, which is the historic core of London. Neither of these electric vehicles resulted in any fossil fuel consumption or CO_2 emissions as the electricity they used was produced from renewable sources. The results show that the use of the micro-consolidation center together with the complete replacement of the diesel van fleet by electrically assisted tricycles and electric vans led to a reduction of 20% in the total distance driven per parcel delivered between the suburban depot and the customer delivery locations. Total CO_2 equivalent emissions per parcel delivered was 54% lower than before the trial (Leonardi et al., 2012).

CIVITAS is a large European Commission funded program to support sustainable urban mobility, including urban freight logistics. The CIVITAS initiative involves 53 innovative urban freight logistics measures conducted during the last decade, which had been implemented and evaluated in different European cities (van Rooijen and Quak, 2013). The CFTS-related schemes were also included among them. An urban freight consolidation center was established to serve Bath for reducing the number of goods vehicle deliveries to businesses in the city to reduce vehicle emissions as well as to alleviate traffic congestion. In 2010, DHL established the Bath consolidation center at its depot, close to the M5 Motorway near Bristol from where it also operates a freight consolidation scheme for the City of Bristol. Goods are consolidated for onwards dispatch in pre-arranged time slots using low emission/low carbon Smith Newton 9 tonne electric delivery vehicles into central Bath. The service was free to businesses in Bath for an initial period of 15 months, after which a cost of £9 per cage and £12 per pallet was charged to participating businesses. The contractor DHL marketed the scheme to 140 businesses in Central Bath during the demonstration project of which 19 joined the scheme. The electric vehicle used by the center reduced energy consumption by 55.7% compared to diesel trucks. From January 2011 to the end of April 2012, the number of delivery trips into Bath was reduced by 1016, and on average the number of deliveries to participating outlets has been reduced by 76%, exceeding the target of 70% set at the start of the project.

11.3.4 Others

Kassell is a city with about 200,000 habitants in Germany. In the CFTS there, goods are delivered cooperatively to retailers and department stores in the city center to solve traffic problems. A "neutral" freight carrier outside the city collects goods from 10 freight carriers and delivers them to 350 retailers in the city center. A considerable reduction in travel times as well as the required number of trucks for delivering goods in the central area of Kassel was achieved (Kohler, 1997).

Monaco is a small country with a population of about 32,000 and an area of 195 ha. In 1989, Monaco initiated a CFTS together with traffic regulations for freight vehicles coming into Monaco (Dablanc, 1998).

Similar concepts to CFTS with consolidation centers have been emerging in Westpomeranian Region in Poland (Chwesiuka et al., 2010), the metropolitan area in Barcelona, Spain (Roca-Riu and Estrada, 2012), and Belo Horizonte and Fortaleza in Brazil (de Oliveira et al., 2012).

11.4 SUMMARY

It has been shown through modeling and implementation that CFTS can reduce costs, time losses, bottlenecks on road infrastructure in urban areas, environmental emissions of CO_2, and road traffic crashes. CFTS creates a win-win situation for both the users and managers of road infrastructure.

There are also gains for the cooperative freight organization. Assistance to the cooperative freight organization from the public sector for management costs is useful for successfully operating a CFTS.

However, to successfully implement these systems, it is crucial that local business entities like the shippers and freight carriers accept such cooperative freight measures. Without partnerships between the entities, operators, administrators, and authorities, cooperative measures are not likely to succeed or become sustainable. It is essential that meetings with all stakeholders be held to define regulations about the systems and to ensure their acceptance.

Carriers are often opposed to introducing CFTS because they are afraid their sensitive commercial information will be obtained by others. They also fear losing contacts with their customers when they do not have to deliver goods to them. In this situation, shippers, producers, wholesalers, and retailers can play a vital role in increasing the demand for these systems and encouraging carriers to cooperate. It is also crucial to let the residents and consumers know the problems and costs generated by urban freight transport as well as the beneficial measures that can help solve the problems and reduce costs. In addition, productive cooperative relationships generally take some time to be established. Therefore, ongoing continuous effort is required to develop and implement CFTS.

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12

Access Restrictions and Local Authorities' City Logistics Regulation in Urban Areas

Hans J. Quak

Contents

12.1 INTRODUCTION

Urban freight operations are usually recognized for their unsustainable impacts on the environment. Even though the modern urbanized civilization requires an efficient urban freight transport system in order to sustain both the demands for goods and services as well as to remove waste, counteracting the negative impacts of the system takes most of the efforts of local authorities. Urban freight operations have negative impacts on all sustainability indicators in several ways:

- People: consequences of accidents with large vehicles and vulnerable road users, as in cities these groups share the infrastructure, nuisance (noise), and the consequences of local emissions for public health.
- Profit: logistics inefficiencies due to last-mile issues and local regulations, but also contributing to urban congestion.
- Planet: adding to CO_2 emissions.

One of the difficulties in city logistics is that many different actors with different (and sometimes even conflicting) interests are involved as well as with a different geographical scope and viewpoints. This makes it a challenge to actually come up with sustainable solutions for all stakeholders. Van Rooijen and Quak (2013, 505), for example, mention, "compared to the other thematic clusters of CIVITAS, the urban freight logistics cluster has not reached the results that was hoped for. A large part of the measures in this cluster is not continued after the project or not completely implemented at all during the project. The main reason for that is that for freight transport the participation of private companies is needed because these measures take place in a competitive market." This conclusion highlights one of the problems in city logistics: even though local authorities and residents are the most affected by the sustainability problems in cities (e.g., emissions and nuisance, both local and global), solutions to improve sustainability often lie within the scope of influence and action of private companies (especially carriers). The most important stakeholder groups and their interests, relationships, and objectives are (see also Figure 12.1):

- Local authorities: their scope is local (i.e., the city or even a smaller area). The main issues are air quality, traffic safety, city accessibility, and congestion.
- Carriers: a very heterogeneous group—and with that a heterogeneous scope as well—containing private carriers and for-hire

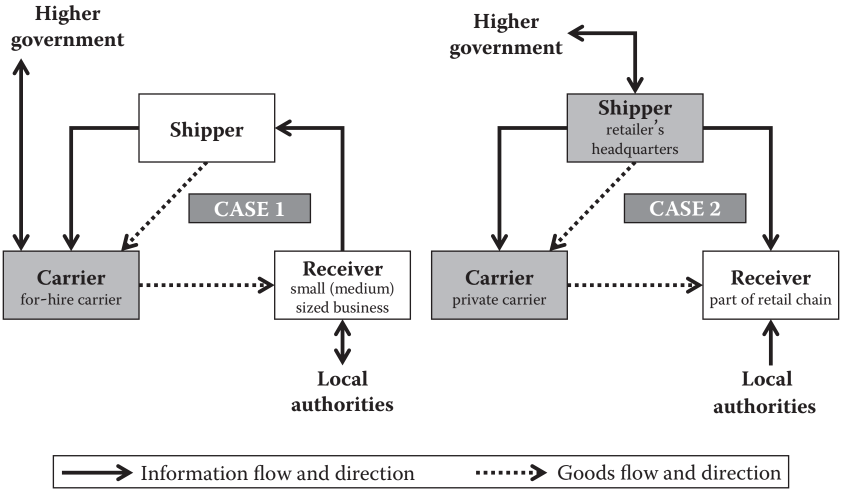

Figure 12.1 Heterogeneity in relationships between stakeholders. A large retail chain and a small sized business (Quak, 2008).

carriers, (small) local carriers as well as global express services. Their interest is in organizing transport operations as efficiently as possible and, in doing so, carriers often consider local regulations in various cities as a major barrier together with receiver demands and typical city issues such as congestion and difficult maneuverability in small streets (see also Quak, 2012).

- Residents: their scope is very local (sometimes as narrow as their own street); most often residents do not want nuisance (noise, visual, vibration, and smell) from urban freight transport.
- Shippers: quite often shippers do not consider themselves as having an interest in urban freight transport. However, shippers are often responsible for hiring (or actually operating in the case of private carriers as part of a chain of stores) transport operations and form, therefore, the stakeholder group that determines many of the actual urban freight transport characteristics. Therefore, shippers are a group that is necessary to involve in finding solutions for the issues mentioned. The shippers' scope is usually not local but wider (regional, national, or international).
- Receivers: their scope is local; these stakeholders are actually the group responsible for urban freight transport operations by ordering products in the first place. Their interest is therefore the

reliability of deliveries. On the other hand, they are also interested in a pleasant shopping environment, in which freight vehicles cause minimal nuisance. Receivers are usually not responsible for contracting carriers (see also shipper) and often see the carrier only at the time of delivery; as a result, receivers often have the idea that they cannot influence urban freight transport operations.

Many local authorities' actions concerning urban freight transport relate to logistical operations (the carriers' work). These are largely carried out outside their local scope and are usually limited. On the other hand, carriers also usually lack knowledge about the sustainability objectives of local authorities because this does not correspond to their interests (Quak, 2008). The lack of interaction between local authorities and carriers (see also relationships in Figure 12.1) prevents a greater understanding of each other's issues. In the main, carriers often organize their operations as efficiently as possible within their ability. The carriers' solution space is limited due to local authorities' restrictions (e.g., time access windows), infrastructure in inner cities, or commercial requirements (e.g., delivery times specified by receivers).

However, from a city perspective, the situation is not as optimal as it is from most carriers' perspectives—where carriers plan the most efficient roundtrips within their capabilities, they visit the same streets and shops with only limited volumes. From a city perspective, it would be far more optimal to bundle goods based on their destination, thus decreasing the number of vehicles entering the city. This is not how most supply chains are designed and this results in (as it appears from a city perspective) a poorly organized urban logistics system (e.g., Dablanc, 2007).

Although the city context seems very complex, we can distinguish three main solution directions for improving the sustainability of urban freight operations (see Figure 12.2):

1. Technology (which includes vehicle technology and ICT solutions)
2. Policy
3. Logistics

Very often these solution directions are implemented separately (and are initiated by different actors), whereas to really make urban logistics more sustainable a combination of efforts in each of the directions is required. This contribution focuses on one part of the policy solution direction, that is, access restrictions for urban freight transport operations. This contribution, however, is not limited to authorities' restrictions only

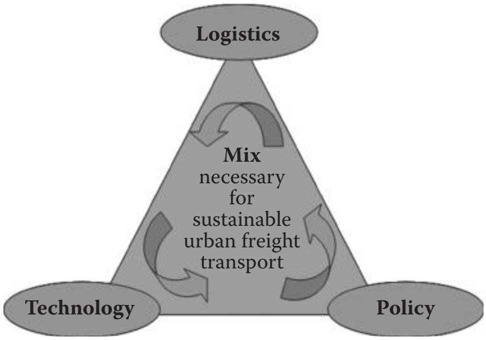

Figure 12.2 Three main solution directions to improve urban freight transport (Quak, 2011).

because very often the regulations are not used in isolation. The policy solution is often used to stimulate other (often private) actors to improve sustainability through logistical or technical solution directions.

Authorities can have different roles that require different effort (see Figure 12.3) in the city logistics context. This means that even within the solution direction policy, there are many different actions that can be undertaken. The degree of freedom for the affected actors (in the city logistics context it is usually the carriers) is higher, when local authorities' efforts (e.g., in enforcement) is lower. The regulating role, which is the role in which local authorities use access restrictions, requires the most effort on the part of the authorities and allows other stakeholders the least

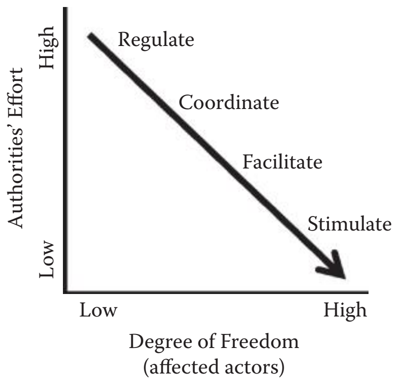

Figure 12.3 Roles of authorities in city logistics context.

degree of freedom. As a result, by assuming this role the involvement of other actors is high (because there is simply no alternative, if enforcement is good). However, carriers' willingness or motivation to cooperate is usually low; carriers cooperate because they are obliged to. This reasoning is opposite for the other extreme shown in Figure 12.3 (i.e., high degree of freedom, low effort). In this situation, usually only a limited number of carriers cooperate, but their motivation is high. They choose to cooperate rather than be obliged to do so.

One of the problems in many city logistics initiatives is that private actor involvement is often relatively low. As a result, the impacts and results of these initiatives in a city center are also low. Therefore, in many cases this implies that if local authorities really want to improve the sustainability of urban freight transport, it is best to make sure carriers are involved.

The different regulations that local authorities can take are covered in the next section. For the different restrictions, the objectives, effects, and (enforcement) efforts are discussed, as well as some examples. The following section discusses the logistical implications of some of these restrictions. Since these restrictions actually force carriers to obey, carriers very often see these restrictions as one of the main problems in conducting efficient urban freight operations. Next, the role of these regulations is discussed in a wider context; for example, their contribution to stimulate other solutions (i.e., technology and logistics). The chapter ends with conclusions.

12.2 AN OVERVIEW OF ACCESS RESTRICTIONS

Most regulations affecting urban freight transport are not aimed specifically at this form of transport, but apply to all (urban) traffic, for example, speed limits, parking restrictions, one-way streets, etc. (MDS, 2012). Some measures, however, are directed at urban freight transport. The main idea of these regulations is that local authorities oblige carriers by legislation to adapt their behavior in order to reduce the negative impacts (from local authorities' perspective) of urban freight transport operations on the city. Ideally, these regulations are not used in isolation, but are in place to support or be used in combination with other initiatives or are only a part of a larger urban freight strategy.

Several studies categorize measures local authorities can take concerning urban freight transport (see, for example, Lindholm, 2013; MDS, 2012; Muñuzuri et al., 2005; NCFRP, 2012; OECD, 2003). Summarizing these studies, we can distinguish the following urban freight restrictions: environmental zones, time windows, vehicle restrictions (weight, length, or area), fill/load restrictions, night distribution, loading/unloading zones, traffic segmentation, and road pricing.

This chapter focuses on the local authorities' regulating role, which implies that it specifically discusses restrictions. It is important to keep in mind that these restrictions are often meant to do something other than just restrict urban freight transport operations in the city. For example, restricting one type of truck can be considered an incentive for other trucks. These traditional kinds of local authority policy measures regulate or control urban freight transport essentially based on three different ways (or a combination of these): in time, in space, or in vehicle type, depending on the local situation and the local authorities' objective.

More details of this overview of access restrictions can be found in Quak (2008), as well as a framework for evaluating urban freight transport sustainability initiatives. This framework contains a classification of initiatives including policy initiatives (i.e., pricing, licensing, and regulations, including time-windows, vehicle restrictions, vehicle load-factor controls, low emission zones and dedicated infrastructure, and parking and unloading). These categories are updated with publications that are more recent.

12.2.1 Time Access Restrictions

Time access restrictions, also known as time-windows, restrict trucks from entering a certain area within a certain time. The time-window area is often the city center or even a smaller part, the pedestrian area within the city center. Sometimes time-window restrictions allow delivery trucks access for a certain time period to areas where normally no motorized vehicles are allowed, such as pedestrian areas.

Objective: Time-windows usually allow urban freight transport vehicles access only during periods in which residents or the shopping public are not impacted. This implies, for example, no night deliveries, as these often cause noise nuisance for residents, and no vehicle movement in the afternoon as it would mingle with the shopping public (walking in the center and needing parking spots for their private vehicles). Improving the traffic safety of vulnerable road users (i.e., the pedestrians in the shopping centers) is the main objective for separating these groups. In short, time access windows reduce urban freight vehicle nuisance by forcing deliveries to take place during a period when only a few people notice it, usually the morning. In addition, time-windows are also expected to improve the attractiveness of shopping streets. This is especially the case for narrow streets, where vehicles cannot overtake. In these streets, vehicles are usually queuing at the time the first vehicle is making a delivery. Imposing time-windows ensures such a street is free of delivery trucks during periods when the shopping public visits the stores. Visual intrusion, from a store and shopper's perspective, is minimized in such a way.

Effects: The effects of time-windows are obvious—depending on the times when freight transport (large trucks) are not allowed in the area, the streets are not blocked with trucks. Next to the effects on the city, time-windows have an influence on the carriers and the efficiency of their operations. These effects differ for each carrier, but in general, carrier operations become less efficient as time-window pressure increases, either smaller time windows or more of the carriers' addresses (drop-offs or pickups) are located in a time-window area (see Quak and de Koster, 2007). Harmonization of time-windows between different municipalities can have a positive result on the carriers' efficiency depending on the type of harmonization (see Quak, 2008). Carriers are used to working with delivery time-windows, as many customers require a certain time-window within which a delivery should take place; however, the strict local authorities' time-windows are often mentioned (in the Netherlands) as one of the major carriers' irritations—especially in combination with receivers' time windows (due to opening hours of stores) and the lack of possibilities for undertaking night (or off-hour) deliveries, even if this can be done with low levels of noise.

An example is the delivery to supermarkets in the early morning. In the Netherlands, time access restrictions prevent supermarket chains from supplying stores in the off hours. Most Dutch supermarket chains have invested in quiet equipment in order to supply their stores without (or with a minimum) noise nuisance. Since time-windows are typically local measures, these national operating chains have to negotiate exemptions for these relatively quiet deliveries with different local authorities time after time. In general, MDS (2012) states that where the time-windows coincide with peak commuting hours, these restrictions can lead to an increase of traffic congestion and are likely to lead to the poor utilization of vehicles.

Enforcement: The enforcement of time-windows varies; for example, where time-windows only apply to pedestrian areas, the enforcement is often very good by utilizing rising poles (see Figure 12.4), preventing vehicles from entering the time-window area at times when they are not allowed (or even making sure trucks are outside the area before the poles rise because otherwise the drivers lose time in finding the person able to

Figure 12.4 Example of enforcement by poles.

lower the pole as well as being fined in order to get out). For time-window areas that are larger, or where many "keys" for poles are circulated, the enforcement is often more difficult, as it requires officers at the locations to notice the violation. In many cities, time-window violations are not considered a high priority by officers; as a result, enforcement might be lacking sometimes.

Examples: Time-window restrictions are used in many western European countries (see OECD, 2003). Related restrictions exist, such as night truck bans (which is a time-window with a large area, for example, a city, and a large time period, all times outside the night).

Interviews with 33 city policy-making officials responsible for their municipality's time-window policy provide insights into Dutch local authorities' objectives for time-window policies. The interviews were conducted in early 2006, mainly by e-mail and telephone, and focused on four elements: the main objective, the effects of time-windows, the measurement of these effects, and the official's opinion on the effects of time-windows on the environment, noise, safety, quality of shopping environment, accessibility, and economic development. Almost all policy-making officials interviewed mentioned improving the shopping climate and the attractiveness of the center as (one of) their main objectives for using time-windows. Reasons for improving a city center's attractiveness turned out to be twofold:

- It is considered local authorities' role to provide their residents with an attractive center and it increases the quality of life for city residents.
- Different cities are competing for visitors, as the density of cities is high in the Netherlands, and people can choose between different nearby city centers for shopping.

Some policy-making officials mentioned reducing the inconvenience (noise, stench, traffic blockades by unloading vehicles) or improving the safety of pedestrians in shopping areas. Finally, some officials expressly cited reducing noise nuisance for residents in the early morning as an important objective (about 10% of the responding officials). The vast majority of the officials argue that time-windows did improve the attractiveness of their shopping centers and the quality of their shopping environments, although none of them (objectively) measured or examined it. They argue that anyone can see that the city center is more attractive without (large) vehicles. Table 12.1 summarizes the opinions of the policy-making officials

Table 12.1 Officials' Opinion on the Effects of Time-Windows

Official's Opinion on the Effects of Time-Windows on:	Positive	Neutral	Negative	Other
Local environment	6	8	3	
Global environment	3	10	6	
Noise nuisance reduction	7	3	1	10 (overall positive, but during the time-window period negative)
Safety (e.g., accidents, safety of pedestrian and cyclists)	15	1		Also subjective safety feeling increases
Quality of shopping environment	24	1		
Accessibility	6	6	2	3 (during time-window negative, outside time-window positive)
Economic development	8	4	1	

Source: Quak, 2008.

on the effects of time-windows. Some officials explicitly stated that this was not merely their own opinion, but it was based on what they learned from entrepreneurs and residents.

12.2.2 Vehicle Restrictions

Vehicle restrictions prevent vehicles that have certain characteristics from entering a certain area (e.g., city center, specific streets). Vehicle restrictions can apply to various vehicle characteristics, such as length, width, height, axle pressure, and weight. A specific vehicle restriction, the amount of emissions emitted by the vehicle's engine, is discussed in another restriction, the low emission zone.

Objective: The objectives for using vehicle restrictions for local authorities are various. One main reason is that the infrastructure simply does not allow large vehicles to enter a maximum weight for bridges, a maximum height for viaducts, or length restrictions for narrow streets (based on the turning circle of a vehicle). Next to these obvious reasons, other objectives can be to improve traffic safety (i.e., prevent large vehicles from sharing urban space with vulnerable road users such as cyclists), reduce traffic problems, protect infrastructure (e.g., special pavement or historical buildings). In addition to these objectives other reasons are mentioned, such as the idea that reducing the number of large vehicles in a city increases the quality of life because smaller vehicles cause less visual nuisance and are considered less intimidating for other road users.

Effects: In general, vehicle restrictions result in more small vehicles to replace larger trucks. Therefore, vehicle restrictions often have a negative effect on city accessibility (congestion increases due to the use of more vehicles), on the environment (two small vehicles produce more pollution than one big truck), and an increase in logistics costs. Obviously, relaxing vehicle restrictions has the opposite result. The fact that vehicle restrictions vary between cities (and even within cities) is one of the carriers' major irritations. Imposing different vehicle restrictions forces carriers to use specific trucks for specific streets, whereas harmonization would make the usability of trucks in different cities easier for carriers. Dablanc (2007) provides an example of this lack of harmonization; in a certain French urban area, there are about 30 different restrictions on trucks, which makes it impossible for a driver to obey all regulations in that area.

Enforcement: On average, vehicle restrictions are difficult to enforce; it is obvious that some restrictions, such as height in the case of a low bridge, are relatively easy to enforce: a vehicle gets stuck under the bridge. For other vehicle restrictions, enforcement is difficult and usually requires visual inspection by officers, which is the case for weight and axle pressure. In addition, other access restrictions such as length restrictions are sometimes difficult to enforce. Cases in which an officer notices an offense and knows the regulations (which is not always the case) will result in fines. For example, with the case of a weight restriction of 3.5 tons, implying only vans can enter, a semi-articulated truck obviously will be in the wrong. However, an officer usually cannot weigh a small vehicle entering this zone, and therefore it can enter (no matter what its weight) without being fined.

Examples: Vehicle restrictions exist in many countries; Dablanc (2009) mentions examples of these restrictions used in cities in Europe (see also MDS, 2012), the United States, Asia, South America, and many developing countries (due to road limitations).

12.2.3 Low Emission Zones/Environmental Zones (Engine Restrictions)

Low emission zones (LEZ) or environmental zones restrict polluting vehicles from entering a defined area. This is a special form of vehicle restriction because it focuses only on the engine type of the truck.

Objective: Local authorities use LEZs to improve the air quality in the city. In Europe, these requirements are usually related to the EURO norm (the European emission standards) of the truck, in which the local pollutants CO, NOx, HC, and PM are defined, which limit the exhaust of emissions of new vehicles sold in the EU market. The standards are becoming progressively more stringent.

Effects: Large trucks emit relatively more local emissions, compared to smaller vehicles, such as passenger vehicles. Therefore, many cities limit the number of these heavy polluters. The effect of LEZs is that due to the decrease in the polluting vehicles, the amount of local emitted pollution in the zone is reduced. In most cases, this reduction results in an improvement in air quality. This improvement is sometimes small because large vehicles are only responsible for a relatively small amount of the total local pollutants in an area. For carriers, LEZs might result in an increase in costs in cases where the carriers have to procure newer vehicles to be able to enter the zone. Some argue that LEZs are affecting small carriers more than large carriers because large carriers might be able to use their older and more polluting vehicles in areas where no LEZ is established, whereas small carriers have fewer options to do so (Browne et al., 2005).

Ellison et al. (2013) present the effects of the introduction of the LEZ in London (for large vehicles and later for commercial vans). They show that first the vehicles used in London are cleaner than those in other areas of the UK, but after some years, the fleet composition is comparable to that of other cities and areas (due to fleet improvement in these areas). The LEZ has a small effect on improving the air quality (in PM, not in NOx). This suggests that an LEZ can be a stimulating measure for carriers to accelerate fleet renewal, as well as to use these new vehicles in that area. It also suggests that it is wise to have moving standards in time (as is common practice with LEZs), so that it motivates carriers (and manufacturers, see EURO norms) to keep investing in cleaner vehicles. These standards should not be moving too fast in time, and should be announced well in advance so that carriers know what depreciation periods they should count on for their fleet/truck investments.

Enforcement: As with all restrictions, enforcement is necessary to make these effective in practice (although the degree of carriers' compliance with regulations not only depends on the degree of enforcement, but is also partially country dependent). In some countries, enforcement is more necessary than in others; see, for example, Muñuzuri et al. (2012). In the Netherlands, the enforcement of LEZs differs between cities as the local authorities are responsible. In Amsterdam, for example, the LEZ is enforced by cameras detecting the vehicle's license plate, and with that the EURO standard of the vehicle. Such an enforcement system is also used in London (together with the London congestion charge scheme). In other cities (e.g., Utrecht), officers are responsible for enforcement, but these officers have many other duties and cannot always identify the EURO class of a vehicle. Therefore, in practice this often means that the LEZ is rarely enforced. Sometimes exemptions are made for special vehicles, for example, large construction vehicles, moving vans/trucks, and exceptional transport, which are allowed to enter a zone without satisfying the LEZ requirements.

Examples: Low emission zones exist in many cities in western European countries (see www.lowemissionzones.eu).

12.2.4 Vehicle Load Factor Controls

A vehicle's load factor should ensure that only fully (or at least to a certain extent) loaded vehicles enter an area, such as the city center. Urban freight vehicles have, on average, a low load factor (due to several reasons). The idea is that, for example, due to better bundling based on destination instead of origin (e.g., the carriers' depot), which is the case in many supply chains, the number of trucks entering and driving in a city center can be decreased.

Objective: Local authorities mainly use vehicle load factor controls to improve the accessibility and the livability in urban areas. The main objective of enforcing a high load factor is to decrease the number of vehicles entering the city center due to stimulating consolidation outside the city center in order to increase vehicle utilization. This restriction is not exercised very often because it is difficult to enforce, but the idea of many other local authorities' restrictions and initiatives is to increase bundling. Because the success of many of these initiatives is limited, the idea of this vehicle load factor restriction is simply to oblige carriers to have a high load factor. If that requires using another initiative, such as an urban consolidation center, that is fine from the local authorities' perspective.

Effects: The effect of vehicle load factor controls has not been examined on a large scale in practice. Theoretically, an increase in vehicle load factors and a decrease in the number of vehicles necessary to make all deliveries can be expected (see, e.g., Teo et al., 2013). MDS (2012) discusses a Gothenburg pilot that showed it was easier for large companies (e.g., postal services) to comply with a load factor target than for small companies (which might have only a couple of deliveries in the central area). Since this measure cannot be applied equally, the acceptability to carriers is reduced. Following these results, it could be expected that large carriers can easily comply, and as a result are allowed access or privileges in the area as their load factors are high. Smaller carriers, or carriers with only a few drops (in the affected zone), cannot comply and are therefore confronted with higher costs (penalty costs or disadvantages compared to competitors that can comply) for the deliveries they make in the restricted area.

Enforcement: Enforcing a single vehicle's load factor is not practical. This access restriction usually comes with a certification scheme. Carriers are obliged to show that they were able to deliver in the area with vehicles that were, on average, filled with at least the required load factor in a certain time period. If they can show this, relating to drops or volume, based on their administrative records, they receive a certificate that allows these carriers to enter the area. The certificate can be a sticker on the vehicle, or be based on the vehicle's license plate. In this way, officers on the street only have to determine if the vehicle entering the area possesses a certificate. In cases where this is linked to the license plate, enforcement could be similar to that of LEZs and road pricing schemes.

Examples: Kjaersgaard and Jensen (2004) report an initiative from Copenhagen, in which heavy vehicles required a certificate to enter the (medieval) city center. This certificate was granted for those carriers that on average utilized 60% of their vehicle's capacity and that used vehicles with engines less than 8 years old.

12.2.5 Road Pricing/Congestion Charging

Congestion charging or road pricing is an access regulation that usually affects not only freight transport, but all transport, although the prices might discriminate between passenger and freight transportation. A congestion charge, road price, or road user charge in cities is usually established to reduce congestion by pricing the use of road infrastructure at specific times (congested time periods are priced higher) or for certain vehicles (e.g., depending on how polluting a vehicle is). A congestion charge therefore is more of a traffic management measure than an access restriction for urban freight transport. A local authority's role regulating this is similar, though.

Objective: The main idea of road pricing is to make the scarce road capacity subject to market forces with the idea that it is better to spread the traffic volume over time to reduce congestion. A reduction in congestion and an improved traffic flow leads to fewer pollutant emissions, which could be an underlying objective for road pricing.

Effects: The amount of research on the effects of road user charging on freight transportation is limited (Holguin-Veras et al., 2006), and very often all traffic is monitored and no specific groups (such as freight) are reported (see, for example, TfL, 2008). Link (2007) mentions two reasons (based on the LKW Maut) why the acceptance of these schemes in the freight transport sector is higher than for passenger transport: fairness (a pricing scheme forces all trucks to pay for infrastructure, where fixed taxes only charge non-foreign companies) and revenues are used for improvement and maintenance of infrastructure. A reduction in congestion, due to fewer passenger cars, and with that a more predictable and faster travel time are also reasons why freight transport companies sometimes support these schemes (Quak and van Duin, 2010).

Enforcement: Although there are many different ways of collecting tolls on toll roads, for the city congestion charge we discuss the system used in London (as well as Stockholm and Gothenburg), automatic number plate recognition (ANPR). This system has already been mentioned for enforcement of LEZs and vehicle load factor controls. To enforce the London

Congestion Charge (LCC) over 1500 cameras are used with ANPR technology. The vast majority of vehicles moving within the area are caught on camera. The video streams are transmitted to a data center where the ANPR software reads the license plate of the vehicle. The license plate is then compared with a list of trucks whose operators have paid to enter the zone; those who have not paid are fined. The registered owners' details of such a truck are located in the database of the Driver and Vehicle Licensing Agency. This type of enforcement is relatively expensive in comparison to the enforcement methods mentioned for vehicle restrictions and time-windows. However, the area to enforce is large, all traffic is enforced (not only trucks), and the enforcement relates to revenues from the system (in contrast to the other regulations). The users' compliance with the charging scheme with this enforcement is high.

Examples: Congestion pricing is used in several cities; well-known examples are the London Congestion Charge, the Stockholm congestion tax, and Singapore's Electronic Road Pricing.

12.2.6 Parking and Unloading Restrictions

Finally, parking and unloading restrictions regulate the locations in an area where large vehicles are allowed to park in order to unload deliveries or load pickups. Parking and unloading regulations are often closely related to the parking policy of a city and therefore are sometimes executed by another agency other than the one dealing with other access restrictions.

Objective: Local authorities use parking and unloading regulations for two reasons: to enable urban freight transport trucks to actually load or unload in spite of the scarcity of available space in often crowded cities, and to prevent traffic problems caused by illegally parked trucks (e.g., double parking).

Effects: The types of parking and unloading restrictions (or regulations) local authorities can use are diverse. The local authorities' role here is not only regulating, but also very often stimulating. The effects of efforts in the area of parking and unloading regulations are a reduction in the effects of illegal and double parking. The effect of illegally parked passenger cars on unloading areas is that trucks have to travel extra distance in search of a parking location; these extra kilometers in a congested city can be reduced by regulations. The effect of double-parked trucks is a reduction in traffic circulation; traffic flow can improve in a city by ensuring trucks can find unoccupied unloading areas close to the delivery premises.

Enforcement: Illegal parking of loading and unloading vehicles (e.g., double parking or at the curbstone) and passenger vehicles (at unloading locations) causes problems and the activities of the vehicle types are sometimes related. If passenger cars park in unloading areas, trucks have no alternative than to park illegally. Strict enforcement tends to elevate these problems. Usually this is part of the parking enforcement practices, where officers supervise parking fees and monitor illegal parking. Experiments with recognition schemes using sensors or cameras have been undertaken (see, for example, EMEL in Lisbon, www.straightsol.eu/demonstration_G.htm), but their use is not common practice (yet).

Examples: Quite a lot of parking and unloading regulations exist, and these are diverse. Some well-known examples are:

- Shared infrastructure use; see, for example, Barcelona; SUGAR (2011), where lanes are used at different times; or the use of bus bays for unloading during time-window periods (Mizutani, 1999).
- Reservation of parking or unloading areas (see www.straightsol.eu/demonstration_G.htm).
- Creation of specific or extra unloading areas (e.g., at curbstones, in parking areas, etc.).

12.3 LOGISTICAL IMPLICATIONS OF RESTRICTIONS

In this section, the logistical implications of time-windows, vehicle restrictions, and road pricing are discussed based on other studies. Quak (2008) and Quak and de Koster (2007) examined the logistical impacts of varying time-window pressure, that is, the number of time-window restricted areas and the time-window length. Based on a multiple case study (of 14 Dutch retail chains that are affected by time-window policies from four lines of industry—one drug store retail chain, four department store retail chains, five fashion retail chains, and four food retail chains), they show increasing time-window pressure results in an increase in logistics costs, due to inefficient roundtrips. Time-windows force carriers to make a large number of all their urban deliveries during the morning, and as a result the carriers cannot make optimal roundtrips because many deliveries have to be made at the same time. Time-windows cause queuing of freight vehicles in often small and narrow city center streets, so that deliveries can be made only after waiting for other vehicles to be finished and out of the way. As a result, carriers have to use more vehicles and these vehicles have to make inefficient roundtrips (compared to no or low time-window pressure). Time-window regulations increase both local and global pollution and increase carriers' costs as well. Increasing time-window pressure leads to a more than proportional increase in both environmental burden and carriers' costs. Obviously, relaxation of the time-window pressure has the opposite effect.

Based on a cross-case analysis for the different dimensions of the carriers' logistical concept, Quak and de Koster (2009) examine the factors that determine the carriers' cost sensitivity to urban freight regulations. An experiment with two cases shows that the cases are affected differently by time-windows and vehicle restrictions. The way to cope with these restrictions is similar for the cases, but their most efficient way of organizing the distribution is slightly different. Two dimensions explain the differences: (1) the planned load factor, that is, the constraint that limits the vehicle roundtrip, either vehicle capacity or time, and (2) the drop size and the related number of deliveries combined in one vehicle roundtrip, that is, varying from full truckload (FTL) to less than full truckload (LTL). Based on the results of the experiment, Quak and de Koster (2009) propose the following three propositions:

1. Time-windows have a larger cost impact on carriers that combine many deliveries in one roundtrip than on carriers combining few deliveries in one roundtrip.
2. Vehicle restrictions have a larger cost impact on carriers whose roundtrips are limited by the capacity of the vehicle (high load factor) than on carriers whose roundtrips are constrained by factors other than capacity constraints.
3. It is more cost-efficient for carriers whose roundtrips are limited by non-capacity constraints to increase the period to supply the stores than for carriers whose roundtrips are constrained by the capacity of the vehicle.

A carrier's cost sensitivity to time-windows is lowest if it uses the time-window period as efficiently as possible. Lowering the delivery frequency would reduce costs most for carriers, as well as the environmental burden. From the experiment, we learned that the cost-efficient decisions a carrier can take in its logistical concept are also better for the environment. Time-windows and vehicle restrictions together do not seem to influence a carrier's performance more than the policy measures do individually.

The logistical implications of road pricing for carriers are limited. Vonk Noordegraaf (2007) mentions three possible reactions carriers might have:

- Continuing operations the same way as before road pricing.
- Passing on the charge to others in the supply chain.
- Trying to lower the cost increases due to the road price, for example, by avoiding expensive times, using other locations, or cooperating with others.

McKinnon (2006) describes the impact of road pricing on freight transport in general, which is to a certain extent also applicable to urban freight transport:

- The logistics system design—the impact of road pricing depends on different factors, such as:
  - The degree to which carriers are able to pass on the extra costs to their clients. McKinnon (2006) shows that most carriers are able to pass on the extra toll costs (for the German toll LKW Maut), but that these carriers usually pay the toll themselves in cases of empty running (e.g., return trip). Holguín-Veras (2009) shows that for urban freight transport it is difficult to pass on all extra costs.
  - The degree to which carriers are able to compensate a cost increase by improving efficiency.
- The vehicle utilization—possibilities to improve the vehicle utilization, for example, less empty driving or carrying more goods in a vehicle.
- Modal choice—if prices for road transport increase, it might be possible to use other modes, although the possibilities for efficient and cost-effective urban freight transport are limited (see Quak, 2008).
- Vehicle routing—avoid roads that are charged (if possible; for the London Congestion Charge it is not possible in cases where stores are located in the charging zone).
- Rescheduling of deliveries; this reaction depends on:
  - the degree to which carriers can absorb higher costs in their margins.
  - the degree to which road pricing results in faster travel times due to less congestion.

Therefore, road-pricing regulations might affect carriers, but mainly in the costs. Depending on their market power to pass on costs, the pricing is at the expense of the clients or the carriers. Since urban freight transport carriers have often limited influence on the transport requirement (e.g., time, location; see also Figure 12.1), the possibilities of changing their operations are also limited. The focus will be on reducing empty running in the charging zone (because the extra pricing costs there are for the carriers anyway).

12.4 REGULATING AND RESTRICTIONS AS PART OF AN URBAN FREIGHT TRANSPORT SOLUTION

This chapter deals with access restrictions and urban freight transport regulations in isolation. However, the regulations are not (or should not be) used in isolation, but as part of a larger urban freight transport scheme (see also Figure 12.2, a mix of solution directions is best for a more sustainable urban freight transport system). For example, regulating or restricting conventional urban freight transport can also stimulate more sustainable (or innovative) urban freight deliveries (see also Figure 12.5). Low emission zones are not restricted to "clean" transport; electric freight

	Financial	**Non-financial**
Promoting electric vehicles	• Purchase subsidy • Exemption from vehicle registration taxes • Discount on toll and parking fees	• Preferential parking spaces • Access to restricted highways or bus lanes • Facilitating charging infrastructure • Sharing practical information • Carbon footprint related recognitions
Restricting conventional vehicles	• Higher parking charges • Higher taxes	• Low emissions zones • Time windows

Figure 12.5 Examples of restrictions used in larger promoting scheme for EVs (electric vehicles) (FREVUE, 2013).

transport is stimulated by local authorities' regulations (e.g., high charges for conventional vehicles and no charge for electric freight vehicles).

In a similar way, other urban freight solutions might be stimulated by the right use of access restrictions; for example, to promote bundling and the use of city consolidation centers. However, since the scope of local authorities is often limited to the city (center), which implies logistics chains are out of their scope (and knowledge), restrictions sometimes do not stimulate innovative or sustainable solutions, but are used to minimize urban freight transport (in time or place) and restrict it as much as possible in order to restrict local nuisance. As a result, these restrictions lead to extra delivery costs and an inefficient urban logistics system. Carriers consider these restrictions then as random, which explains why carriers often mention restrictions as one of the most important irritations when doing their jobs. Therefore, the objective and wider context of using access restrictions and regulations should be communicated clearly to all stakeholders, in order to increase the basis for it. In practice, there are many regulations and restrictions to combat negative urban freight transport effects, but a wider policy scheme (Quak, 2008) to stimulate more sustainable urban freight transport is often lacking.

12.5 CONCLUDING REMARKS

The chapter provides an overview of access restrictions and regulations commonly used by local authorities in city logistics. Public-private cooperation proves to be difficult due to differences in interests and scope of local authorities and private carriers in the urban freight transport settings. Although local authorities may have several roles in improving the sustainability of urban freight operations, the regulating role has the most direct effects because resulting access restrictions force carriers to obey, which is often not the case if local authorities use another role. Access restrictions do have a negative effect on private carriers, all restrictions increase the costs for carriers and result in logistical inefficiencies. Therefore, it is important to use these regulations within a wider policy scheme and evaluate the effects carefully. In such a way, these restrictions might contribute to improving local sustainability, and increase costs only for carriers that do not show the desired behavior. Some logistics knowledge at the level of local authorities would be a requirement in order to develop such a scheme.

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13

Future Directions

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Contents

13.1 INTRODUCTION

Current trends relating to the nature of cities and their populations will present major challenges in the future. Many cities are growing in terms of population and density and this is leading to increased levels of road congestion. Aging populations and online shopping are increasing the demand for home deliveries. Natural disasters are becoming more prevalent, presenting major difficulties for ensuring high levels of reliability of urban freight systems. This chapter describes a number of trends in cities as well as suggesting some city logistics solutions for increasing the efficiency and reducing the impact of freight in urban areas.

There are enormous opportunities to adapt and implement the rapid developments in Information and Communication Technology (ICT) to create more efficient and safer urban goods movement systems. ICT is a key technology for facilitating cooperative freight systems. Emerging technologies such as 3D printing and electronic media could reduce the demand for goods movement in cities.

Developing effective partnerships between key stakeholders is considered vital for solving the growing problems in urban freight. Alternative fuel vehicles, larger capacity vehicles, as well as non-motorized transport provide good potential for lowering the negative effects of goods movement in cities.

A range of city logistics schemes offers effective solutions for addressing the challenges confronting cities in the future. Methods for improving management of the road network, including off-peak deliveries and designated lanes and parking areas, will be crucial. Public transport and waterways could provide viable alternative modes in some cities for transporting specific goods. Urban consolidation centers and intermodal transport provide opportunities for reducing the effects of logistics sprawl. Local and regional consolidation centers as well as lockers at pick-up points will be necessary to limit the impact of home deliveries.

13.2 CHANGING NATURE OF CITIES

A majority of the world's population now live in urbanized areas (UN, 2012). More than 75% of the population in more developed countries now lives in urbanized areas because of the opportunity for a better quality of life. As the sizes of cities grow, there are many challenges in achieving high levels of sustainability, mobility, and livability that are the visions of city logistics (Taniguchi et al., 2004).

There are also a growing number of megacities (cities with populations of over 10 million) throughout the world. Due to their dense populations, megacities often have high levels of traffic congestion. City logistics schemes are necessary to increase the efficiency of movement as well as reduce environmental impacts.

The world is currently in a period of rapid and unprecedented population aging. Globally the number of persons over 60 years of age is growing the fastest and this is projected to continue throughout this century. By 2050, Europe, North America, and Asia are expected to have 27%, 21%, and 18%, respectively, of their population 65 years of age or older (UN, 2010).

As the world's population ages, there will be a growing need for home delivery services for the elderly. It is now common in many societies for elderly persons to live alone without the direct support of other family members. Older persons living alone often require special outside support in terms of delivery of food and medicine as well as healthcare services.

Deliveries of food and medicine to homes present many challenges for logistics systems. City logistics solutions in the future will need to focus on how to cater to the demands of elderly persons.

There are many social and economic benefits for elderly persons remaining in their homes instead of care facilities. However, home care services including nursing, cleaning, and maintenance also generate a substantial amount of light commercial traffic in residential areas. Consequently, home health care (HHC) problems are becoming an active research area in urban logistics.

13.3 DISASTERS

Cities can experience a range of natural disasters, including earthquakes, floods, and hurricanes, which can significantly disrupt urban freight systems. Traffic systems are often disrupted because of disasters, and efficient means of continuing distribution services need to be identified for the case when the capacity of the urban traffic system is reduced.

Recent floods in major cities such as Brisbane, New York, Bangkok, New Orleans, and Kurachi caused substantial human suffering as well as economic losses. Business and Government Continuity Planning (BGCP) provides a framework for minimizing the disruption of operation in the event of a disaster (World Bank, 2012).

Since road networks are critical infrastructure vital to the well-being of the economy of cities, there is a need to increase their resilience. Implementing preventive measures is a proactive approach undertaken before extreme events occur that reduces disruption and recovery costs. Adaptive resilience methods based on preparedness are required to be developed to create more disaster-resistant road networks.

There is a need to build more resilience into urban transport systems to limit the effect of disasters. Traffic systems are often disrupted because of disasters and city logistics schemes can provide an efficient means of continuing distribution services when the capacity of the urban traffic network has been reduced.

Improved methods for reducing the substantial costs associated with the restoration of roads and bridges that have been damaged by extreme events are needed. Procedures for identifying vulnerable freight links and determining optimal strengthening measures for minimizing disruption to freight networks after disasters are required by road infrastructure managers.

Cost-effective treatments need to be identified for enhancing the post-disaster residual functionality of roads and bridges before extreme events occur. Before future disaster events occur, there is an opportunity to reduce their impact by strengthening elements of the transport network that are likely to be damaged and have a major role in the functionality of the transport system. This can involve strengthening bridges and increasing the geometric standards of roads.

Methods for identifying opportunities for increasing the redundancy, connectivity, and modal substitution of vulnerable urban road elements also need to be developed. Decision support systems that produce plans for reducing the effects of extreme events on road networks are currently not available. There is an urgent need for robust, reliable, and practical tools to assess the vulnerability of road transport systems considering both transport and structural health vulnerabilities of transport systems in one integrated platform.

Proactive resilience-based management of urban road infrastructure goes beyond traditional recovery-orientated methods and has the potential to provide substantial economic benefits. A platform for integrating a vast range of road network, traffic, geographic, economic, and meteorological data is required. This will enable plug-in components with innovative models and algorithms to be implemented in a systematic means.

13.4 ALTERNATIVE TRANSPORT MODES

There is increasing interest in utilizing public transport systems for freight transport in urban areas. Traditional (or heavy) rail can be viable to transport large consignments of freight between regions in large metropolitan areas. Tram and light rail can be used for distribution within urban regions of large cities. Rail has substantially lower emissions, but has less flexibility as well as higher costs due to transhipment compared with road transport. Longer distribution times are also common. There is also renewed interest in the use of canals and rivers in major European cities.

Recently, the concept of co-modality has been promoted in some cities, which involves the efficient use of different modes individually and in combination with each other that results in optimal and sustainable utilization of resources (Commission of the European Community, 2006). Co-modality requires comprehensive and integrated approaches for transport problems using technological and management innovations. Traditionally, transport policy was dealt with separately for each transport mode, that is, road, rail, sea, and air, and was not well coordinated. Policy measures for passenger traffic and freight transport were also treated in a different manner. However, for solving complicated transport problems, integrated approaches are needed that consider efficiency, environment, safety, and energy aspects. In that sense, the concept of co-modality provides a more holistic view of transport policy toward more mobile, sustainable, and livable societies.

City logistics is similar in concept to co-modality in terms of global optimization of urban freight transport systems. Although trucks on road networks are the dominant freight transport mode in urban areas, there is a recent trend that has been observed in some cities that involves combining the use of trucks with railways, trams, subways, inland water shipping, bicycles, and motorcycles. These examples of city logistics solutions foster the implementation of co-modality in urban freight transport and promote more efficient and sustainable use of resources. ICT and Intelligent Transport Systems (ITS) allow the combined use of different transport modes to be more efficient and environmentally friendly by reducing unnecessary waiting time in transhipment and providing information for choosing the best mix of transport modes. As well, a combination of passenger traffic and freight transport can be realized by using buses or taxis for carrying goods as well as passengers. Bus companies benefit from carrying goods by utilizing space on less crowded buses and shippers benefit by having a convenient courier service as an option. This type of service also suits small cities with decreasing populations by providing more regular bus services.

High-productivity freight vehicles (HPFV) provide additional load capacity that can reduce the number of trucks and reduce emissions for movements between terminals and distribution centers in urban areas. HPFV also have substantial benefits in safety performance as well as fuel consumption.

13.5 LAST-KILOMETER DELIVERIES

The trend to restrict motorized vehicles from streets in inner city areas is creating many challenges for last-kilometer deliveries to retailers. City planners are promoting outdoor spaces for safer walking, entertainment, and eating. Off-hours deliveries and urban consolidation centers provide efficient and practical methods of distributing goods in central city areas. Off-hours deliveries implemented in New York City are creating substantial benefits by reducing costs for operators.

Lockers at pickup points can reduce the financial and environmental costs of home deliveries. Mobile Internet services allow short message service (SMS) to be sent to persons when goods are delivered to pickup lockers.

Recent trials in London show that electric-assisted bikes and electric vans can replace diesel vans for distributing stationery and office supplies in conjunction with an urban consolidation center.

Bicycles and carts are effective modes for last-kilometer deliveries in high-density areas. Bike deliveries result in reduced environmental costs from mode substitution as well as less congestion from larger vehicles using the road for travel and parking.

13.6 PARTNERSHIPS

Due to the complexity of urban freight systems, all key stakeholders are required to contribute toward solving urban freight problems.

Based on specific geographic areas or industry sectors, partnerships need to be created with strong involvement from administrators, carriers, shippers, receivers, and residents. Regular meetings of stakeholders provide opportunities for developing relationships, discussing issues, sharing information, exchanging ideas, and identifying solutions. Administrators and academics have a major role to play in facilitating and coordinating partnerships (PIARC, 2012).

Urban goods transport involves a wide range of public and private actors, with different and often conflicting interests, who act interdependently. Agreement among all stakeholders, especially support from the private sector, is necessary in developing a feasible and practical policy vision.

The private sector has become increasingly aware of its roles and responsibilities and is active in developing sustainable urban goods transport systems. Many developments aimed at increasing efficiency and reducing negative impacts of urban goods transport systems have been initiated by the private sector.

Policy measures should be formulated to enhance and facilitate such developments. Regulations need to be sufficiently harmonized and stable to provide a clear framework to encourage the private sector to assess the effectiveness and viability of potential investments. Planning through a public-private partnership process can guarantee that the measures are practical and that the private sector is committed to such measures. Active and continuous campaigning, including promulgating best practices, is also important in order to stimulate and foster awareness within the private sector (OECD, 2003).

Governments also have an increasingly important role in disseminating information of best practices and promoting successful innovative city logistics schemes. Operators require programs that encourage and reward responsible behavior.

13.7 ALTERNATIVE FUEL VEHICLES

Alternative fuel vehicles (AFV) provide an opportunity for reducing emissions and improving air quality as well as personal health from goods movement in cities.

Since urban distribution vehicles are often not carrying heavy loads, electric and hybrid electric vehicles as well as liquefied natural gas (LNG), compressed natural gas (CNG), and liquid petroleum gas (LPG) are becoming practical. Consequently, many truck and van manufacturers are producing vehicles that operate on alternative fuels.

Although AFVs typically have lower operating costs due to the cheaper fuel costs, their purchase price is often substantially higher than vehicles running on conventional fuel such as petroleum or diesel.

The need for promoting cleaner and lower noise vehicles has been identified (OECD, 2003). Governments have major roles to play by providing information on the benefits (e.g., GHG reductions) and sponsoring pilot schemes.

Presenting a positive environmental image can be a powerful means of promotion for enterprises. Schemes that allow carriers as well as receivers to raise their images as being more ecologically sustainable will assist in achieving higher penetration rates of AFV. This would also assist in raising the profile of urban freight logistics and help attract more interest from forward-thinking young people considering careers in this area.

New schemes will be required for promoting the adoption of AFVs. Governments can provide concessions on vehicle sales tax and registration as well as fuel excise, which would provide more financial incentives for carriers to adopt. Local administrators could provide preferential parking areas for loading and unloading goods. The U.K.'s Freight Operators Recognition Scheme promotes good practice that can enhance the image of carriers.

13.8 EMERGING TECHNOLOGIES

Developments in ICT have the potential to transform urban freight networks. Enabling technologies such as the Internet of Things (IoT) and autonomous vehicles allow a range of city logistics solutions to become feasible.

The IoT is comprised of sensor networks, actuators, and decision-making tools that can be used for real-time monitoring and optimizing urban freight systems. Intelligent agents and dynamic decision support systems become practical with software procedures, which are developed to integrate data from a range of technologies such as radio frequency identification (RFID), global position systems (GPS), and remote sensing. Substantial challenges are processing and analyzing data streams. Substantial developments in data mining and artificial intelligence will be required before the IoT can reach its full potential.

There are numerous potential applications in urban freight such as dynamic road pricing (based on congestion levels, weight, and load factors), collaborative freight systems (matching vehicles with loads, sharing customers and vehicles), and route guidance (congestion avoidance).

Autonomous and near-autonomous vehicles are fast becoming a reality. Autonomous trucks will provide substantial benefits in terms of safety, emissions, and productivity. Platoons of vehicles operating at high speed with small headways on arterial roads will also reduce congestion levels and have lower energy costs.

Near-autonomous vehicles can provide warning and alert systems that have substantial safety benefits when trucks and vans operate on roads with cyclists and pedestrians. A range of other technologies such as 3D printing, electronic media, and unmanned aerial vehicles may reduce the demand for urban freight in the future.

3D printing involves the creation of objects from digital models by building layers of materials using local devices. This allows on-demand production of items at locations near or at points of consumption. 3D printing permits mass customization and has the potential to reduce inventory and distribution costs. Direct production of goods by retailers and consumers will lead to less transport of goods between locations and consequently lower environmental and social impacts.

Ongoing advancements in materials science as well as reductions in the cost of printing devices will enable 3D printing to become more prevalent in sectors such as health products and automotive spare parts in the near future. This will reduce the need for distribution of low volume specialized orders that is inherently inefficient.

The growth in e-books, e-newspapers, and other electronic media such as music downloads and computer tablets have reduced the need for a range of consumables to be transported.

Although it is becoming technically feasible to use drones or unmanned aerial vehicles (UAVs) to distribute small packages such as books from warehouses to homes within cities, there are substantial safety, privacy, and security issues to overcome before they will be permitted (BBC, 2013; The Conversation, 2013).

13.9 OTHER PROMISING SCHEMES

Increasing consolidation of goods is essential for improving the sustainability of urban freight systems (OECD, 2003). Urban consolidation centers can facilitate higher load factors. Larger trucks operating between distribution centers and intermodal terminals can reduce the number of movements as well as improve safety. HPFV or performance-based standards (PBS) vehicles can provide substantial improvements in urban freight productivity. Controlling access to inner city areas based on load factors can be used to promote cooperation.

Many cities are experiencing rising levels of congestion and increased peak spreading. This is leading to rising freight costs. There is a need to develop schemes for utilizing existing urban road infrastructure more creatively (OECD, 2003). Off-peak delivery, which has recently been introduced in New York City, is an exciting opportunity to reduce operator costs and improve reliability.

Innovative management of road space for increasing efficiencies of urban distribution are promising approaches. These include schemes such as the provision of dedicated on-street space for goods vehicle loading and unloading (i.e., loading bays), shared lanes for trucks (such as shared bus and lorry lanes in London), and booking systems for parking areas (PIARC, 2012).

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City Logistics: Mapping The Future examines the key concepts of city logistics along with the associated implementation issues, methodologies, and policy measures. Chronicling the growth of city logistics as a discipline and how planning and policy have improved practice over the last ten years, it details the technologies, policies, and plans that can reduce traffic congestion, environmental impact, and the cost of logistics activities in urban freight transportation systems.

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