City Logistics Research: A Transatlantic Perspective (2013)

DETAILS

98 pages | 8.5 x 11 | PAPERBACK
ISBN 978-0-309-29487-4 | DOI 10.17226/22456

CONTRIBUTORS

Meyer, Andrea; and Meyer, Dana

SUGGESTED CITATION

National Academies of Sciences, Engineering, and Medicine 2013. *City Logistics Research: A Transatlantic Perspective*. Washington, DC: The National Academies Press. https://doi.org/10.17226/22456.

CONFERENCE PROCEEDINGS 50

City Logistics Research
A Transatlantic Perspective

Summary of the First EU-U.S. Transportation Research Symposium

Andrea Meyer and Dana Meyer, Working Knowledge
Rapporteurs

May 30–31, 2013
The National Academy of Sciences Building
Washington, D.C.

Organized by the
European Commission
Research and Innovative Technology Administration,
U.S. Department of Transportation
Transportation Research Board

TRANSPORTATION RESEARCH BOARD
OF THE NATIONAL ACADEMIES

Washington, D.C.
2013
www.TRB.org

Transportation Research Board Conference Proceedings 50
ISSN 1073-1652
ISBN 978-0-309-29487-4

Subscriber Categories
Freight transportation; planning and forecasting

Transportation Research Board publications are available by ordering individual publications directly from the TRB Business Office, through the Internet at www.TRB.org or national-academies.org/trb, or by annual subscription through organizational or individual affiliation with TRB. Affiliates and library subscribers are eligible for substantial discounts. For further information, contact the Transportation Research Board Business Office, 500 Fifth Street, NW, Washington, DC 20001 (telephone 202-334-3213; fax 202-334-2519; or e-mail TRBsales@nas.edu).

Printed in the United States of America.

This project was organized by the European Commission; the Research and Innovative Technology Administration, U.S. Department of Transportation; and the Transportation Research Board of the National Academies.

Planning Committee for European-U.S. Transportation Research Symposium 1: Urban Freight Transport—The Last Mile
C. Michael Walton, University of Texas at Austin, USA, *Chair*
Alan C. McKinnon, Kühne Logistics University, Germany, *Vice Chair*
Christopher Caplice, Massachusetts Institute of Technology, USA
Laetitia Dablanc, Institute of Science and Technology for Transport, Development, and Networks, France
Genevieve Giuliano, University of Southern California, USA
Marcel Huschebeck, PTV AG, Germany
Lanfranco Senn, Bocconi University, Italy
Chelsea C. White III, Georgia Institute of Technology, USA

Liaisons
Alessandro Damiani, Marcel Rommerts, Frank Smit, Maria-Cristina Marolda, *European Commission*
Kevin C. Womack, Thomas G. Bolle, Alasdair Cain, *Research and Innovative Technology Administration*
Robert E. Skinner, Jr., Mark R. Norman, Thomas M. Palmerlee, Martine A. Micozzi, Jaclyn Hubersberger, *Transportation Research Board*

Transportation Research Board Staff
Martine A. Micozzi, Senior Program Officer–Management, Policy, and International Relations
Scott Babcock, Senior Program Officer, Rail and Freight
Jaclyn Hubersberger, Senior Program Associate

TRB Publications Office
Elaine Eldridge, Editor
Javy Awan, Production Editor
Kristin C. Sawyer, Proofreader
Jennifer J. Weeks, Manuscript Preparation
Juanita L. Green, Production Manager

Cover design by by Beth Schlenoff, Beth Schlenoff Design
Typesetting by Carol Siegel

THE NATIONAL ACADEMIES

Advisers to the Nation on Science, Engineering, and Medicine

The **National Academy of Sciences** is a private, nonprofit, self-perpetuating society of distinguished scholars engaged in scientific and engineering research, dedicated to the furtherance of science and technology and to their use for the general welfare. On the authority of the charter granted to it by the Congress in 1863, the Academy has a mandate that requires it to advise the federal government on scientific and technical matters. Dr. Ralph J. Cicerone is president of the National Academy of Sciences.

The **National Academy of Engineering** was established in 1964, under the charter of the National Academy of Sciences, as a parallel organization of outstanding engineers. It is autonomous in its administration and in the selection of its members, sharing with the National Academy of Sciences the responsibility for advising the federal government. The National Academy of Engineering also sponsors engineering programs aimed at meeting national needs, encourages education and research, and recognizes the superior achievements of engineers. Dr. C. D. (Dan) Mote, Jr., is president of the National Academy of Engineering.

The **Institute of Medicine** was established in 1970 by the National Academy of Sciences to secure the services of eminent members of appropriate professions in the examination of policy matters pertaining to the health of the public. The Institute acts under the responsibility given to the National Academy of Sciences by its congressional charter to be an adviser to the federal government and, on its own initiative, to identify issues of medical care, research, and education. Dr. Harvey V. Fineberg is president of the Institute of Medicine.

The **National Research Council** was organized by the National Academy of Sciences in 1916 to associate the broad community of science and technology with the Academy's purposes of furthering knowledge and advising the federal government. Functioning in accordance with general policies determined by the Academy, the Council has become the principal operating agency of both the National Academy of Sciences and the National Academy of Engineering in providing services to the government, the public, and the scientific and engineering communities. The Council is administered jointly by both Academies and the Institute of Medicine. Dr. Ralph J. Cicerone and Dr. C. D. (Dan) Mote, Jr., are chair and vice chair, respectively, of the National Research Council.

The **Transportation Research Board** is one of six major divisions of the National Research Council. The mission of the Transportation Research Board is to provide leadership in transportation innovation and progress through research and information exchange, conducted within a setting that is objective, interdisciplinary, and multimodal. The Board's varied activities annually engage about 7,000 engineers, scientists, and other transportation researchers and practitioners from the public and private sectors and academia, all of whom contribute their expertise in the public interest. The program is supported by state transportation departments, federal agencies including the component administrations of the U.S. Department of Transportation, and other organizations and individuals interested in the development of transportation. **www.TRB.org**

www.national-academies.org

Preface

In 2012, a unique international consortium consisting of the European Commission, the U.S. Department of Transportation's Research and Innovative Technology Administration, and the Transportation Research Board (TRB) was created to support and conduct a series of four symposia from 2013 through 2016, with each symposium focused on a selected transportation topic. The symposia provide forums for the exploration of opportunities for transatlantic collaboration in transportation research.

The first of these symposia, titled "City Logistics Research: A Transatlantic Perspective," was conducted May 30–31, 2013, at the National Academy of Sciences building in Washington, D.C.

A planning committee of four European and four American delegates was appointed by the National Research Council to organize and develop the symposium program, which included four plenary sessions:

- Demand Patterns and Trends;
- Schemes and Technologies for Enhancing Urban Distribution;
- Terminals and Hubs: Impacts and Strategies; and
- Logistics Efficiency in Urban Areas.

These *Proceedings* follow the symposium format and plenary sessions in chronological order. All research topics that speakers identified in the course of their presentations are included in the summary.

The symposium participants included 25 European and 25 American subject matter experts, researchers, academicians, and industry practitioners. The speakers reflected on the challenges of "last mile" cargo delivery in major metropolitan areas and the global supply chain and offered myriad examples of innovative uses of technology to increase throughput efficiency and reduce cost, traffic congestion, and vehicle emissions.

This report, prepared by the symposium rapporteurs, is a compilation of the presentations and a factual summary of the ensuing discussions at the event. The planning committee's role was limited to planning and convening the conference. The views contained in the report are those of individual symposium participants and do not necessarily represent the views of all participants, the planning committee, TRB, the European Commission, the U.S. Department of Transportation, or the National Research Council.

This symposium summary was reviewed in draft form by individuals chosen for their diverse perspectives and technical expertise, in accordance with procedures approved by the National Research Council's Report Review Committee. The purpose of this independent review was to provide candid and critical comments that will assist the institution in making the published summary as sound as possible and to ensure that it meets institutional standards for objectivity, evidence, and responsiveness to the project charge. The review comments and draft manuscript remain confidential to protect the integrity of the process.

TRB thanks the following individuals for their review of the summary: C. Michael Walton of the University of Texas at Austin, Kumares Sinha of Purdue University,

Alan C. McKinnon of Kühne Logistics University, and Theodore K. Dahlburg of the Delaware Valley Regional Planning Commission.

Although the reviewers listed above provided many constructive comments and suggestions, they did not see the final draft of the symposium summary before its release. The review of this summary was overseen by Susan Hanson of Clark University. Appointed by the National Research Council, she was responsible for making certain that an independent examination of this summary was performed in accordance with established procedures and that all review comments were carefully considered. Responsibility for the final content of this summary rests entirely with the authors and the institution.

The symposium planning committee also thanks Genevieve Giuliano, Laetitia Dablanc, Michael Browne, and Anne V. Goodchild for their contributions as white paper authors and Andrea Meyer and Dana Meyer of Working Knowledge for serving as rapporteurs and preparing this summary report. Special appreciation is extended to the TRB project implementation team—Martine Micozzi, Scott Babcock, and Jaclyn Hubersberger—and to Suzanne Schneider and Karen Febey for managing the review of the report draft. The symposium would not have been possible without the leadership and support of Alessandro Damiani and Frank Smit of the European Commission; Kevin Womack, Thomas Bolle, and Alasdair Cain of the U.S. Department of Transportation's Research and Innovative Technology Administration; and Robert E. Skinner, Jr., Mark Norman, and Thomas Palmerlee of TRB.

Contents

WELCOME AND INTRODUCTORY REMARKS **1**

PRESENTATION OF COMMISSIONED WHITE PAPERS **2**

Introduction 2
Alan C. McKinnon

Approaches to Managing Freight in Metropolitan Areas 2
Genevieve Giuliano and Laetitia Dablanc

Modeling Approaches to Address Urban Freight's Challenges: A Comparison of the United States and Europe 5
Michael Browne and Anne V. Goodchild

Discussion of the Commissioned White Papers 7

DEMAND PATTERNS AND TRENDS **9**

Introduction 9
Christopher Caplice

French Cities' Urban Freight Surveys 9
Jean-Louis Routhier

U.S. Cities' Urban Freight Surveys 11
Miguel Jaller

Questions and Answers with Jean-Louis Routhier and Miguel Jaller 12

Shifts and Trends in Urban Retailing and Buying Behavior 14
Robert Chumley

Questions and Answers with Robert Chumley 16

Synthesis and Summary 17
Laetitia Dablanc

SCHEMES AND TECHNOLOGIES FOR ENHANCING URBAN DISTRIBUTION **18**

Introduction 18
Marcel Huschebeck

Case Studies of Innovation 18
Cathy Macharis

Questions and Answers with Cathy Macharis....19

Impact Evaluation....20
Martin Ruesch

Implementation Aspects: UPS's Road to Optimization....23
Jack Levis

Implementation Aspects: Wal-Mart's Urban Small-Format Strategies....25
Chris Kozak

Session Questions and Answers....26

OPEN FORUM ON CROSS-CUTTING ISSUES....28

Introduction....28
Alan C. McKinnon

Open Forum Discussion....28

TERMINALS AND HUBS: IMPACTS AND STRATEGIES....34

Introduction....34
Lanfranco Senn

Part 1: Impacts of Terminals and Hubs on Metropolitan Areas....34
Jean-Paul Rodrigue

Part 2: Strategies for Mitigating Impacts of Terminals and Hubs....36

Consolidation Hubs and Freight Villages....36
Thierry Vanelslander

Environmental Regulation....37
Clarence Woudsma

Operational Strategies....38
Thomas O'Brien

Session Summary....41
Genevieve Giuliano

Session Questions and Answers....41

LOGISTICS EFFICIENCY IN URBAN AREAS: PART 1....44

Introduction....44
Alan C. McKinnon

Measuring Efficiency and Inefficiency in Urban Freight Transport....44
Téodor Gabriel Crainic

Opportunities for Improving Efficiency....46
José Holguín-Veras

Questions and Answers....49

LOGISTICS EFFICIENCY IN URBAN AREAS: PART 2....50

Barriers and Constraints....50
Birgit Hendriks

Opportunities for Public Policy Intervention 52
Ian Wainwright

Session Summary 54
Chelsea (Chip) White

Questions and Answers 55

REVIEW OF SESSIONS: AREAS FOR POSSIBLE RESEARCH 57
Andrea Meyer and Dana Meyer

Scope of Research 57

Understanding Performance 57

Understanding Stakeholder Behavior 58

Cross-Sectional Studies 58

Longitudinal Studies 58

Data Sources 58

Open Questions 59

OPPORTUNITIES FOR COLLABORATION: CONCLUDING OBSERVATIONS 60
Robert E. Skinner, Jr.

APPENDICES

A. COMMISSIONED WHITE PAPERS 63

Approaches to Managing Freight in Metropolitan Areas 63
Genevieve Giuliano and Laetitia Dablanc

Modeling Approaches to Address Urban Freight's Challenges: A Comparison of the United States and Europe 77
Michael Browne and Anne V. Goodchild

B. FINAL PROGRAM 93

C. SYMPOSIUM ATTENDEES 96

Welcome and Introductory Remarks

Robert E. Skinner, Jr., Executive Director of the Transportation Research Board of the National Academies in Washington, D.C., opened by noting that this symposium was the first of four planned symposia to encourage research collaboration across the Atlantic. Cultural similarities and similar states of industrialization bring common transport problems for both sides. The United States could take more advantage of innovations in other parts of the world, he said, and researchers could collaborate much more than they are. Institutional collaboration has been missing but is now being seen between the U.S. Department of Transportation (U.S. DOT) and the European Commission. He indicated that this symposium was made possible by institutional support from the U.S. DOT through the Research and Innovative Technology Administration (RITA) and the European Commission.

Skinner posed the framing questions that set the stage for the next two days:

- What are the best opportunities for collaboration and
- How should that collaboration take place?

This series of symposia will address those questions by taking researchers from both sides of the Atlantic to discuss specific topics over two days of intense information sharing, with the opportunity for follow-on collaboration at the project or institutional level.

C. Michael Walton, Professor of Civil Engineering at the University of Texas, Austin, explained that the members of the EU-U.S. planning committee focused on research opportunities that sponsoring entities could pursue in collaboration, identifying critical research objectives and promoting collaborative research.

Alessandro Damiani, Head of Unit, Horizontal Aspects of the Transportation Directorate, Directorate–General for Research and Innovation of the European Commission in Brussels, Belgium, explained that the initiative is an experiment, noting that the topic of city logistics is a difficult one. In Europe, more than 70% of the population lives in cities, and the EU has the ambitious objective of a 60% reduction of CO_2 transport emissions from 1990 levels by 2050. Achieving this goal will require a series of articulated strategies of policy, legislation, recommendations, good practices, and research efforts on technology, as well as the softer side of organizational and behavioral changes. In short, research has a key role to play, and much can be done by working together across the Atlantic.

Kevin Womack, Associate Administrator in the Office of Research, Development, and Technology of RITA in the U.S. DOT in Washington, D.C., commented that opportunities could be gained from the synergy and collaboration among researchers from the United States and Europe.

Presentation of Commissioned White Papers

Alan C. McKinnon, *Kühne Logistics University, Hamburg, Germany*
Genevieve Giuliano, *METRANS (National Center for Metropolitan Transportation Research) and University of Southern California, Los Angeles, California, USA*
Laetitia Dablanc, *French Institute of Science and Technology for Transport, Development, and Networks, Paris, France*
Michael Browne, *University of Westminster, London, United Kingdom*
Anne V. Goodchild, *University of Washington, Seattle, Washington, USA*

Introduction

Alan C. McKinnon

Alan McKinnon opened the first formal session of the symposium, which was the presentation of the two commissioned white papers. The white papers, which review the state of research on city logistics, were each authored by a pair of researchers, one American and one European, to gain a transatlantic perspective. The white paper by Laetitia Dablanc and Genevieve Giuliano identified the problems and initiatives that have been tried in the area of city logistics, analyzing them for their transferability. The second white paper, by Michael Browne and Anne V. Goodchild, focused on methods and modeling.

Approaches to Managing Freight in Metropolitan Areas

Genevieve Giuliano and Laetitia Dablanc

Genevieve Giuliano began the presentation by pointing out that cities around the world are grappling with "the urban freight problem." The basic fact is that freight works: the system is effective and flexible, but at the expense of cities. The coauthors' review of extant freight research found many strategies and experiments, but strikingly little systematic research. The purpose for this white paper was twofold: first, to consider the effectiveness of the strategies attempted and to analyze them for applicability in the United States and the EU; and second, to identify opportunities for collaborative research.

The Urban Freight Problem

Giuliano explained the nature of the urban freight problem. To begin with, the amount of freight flows in cities has been increasing as a result of a variety of factors, the first of which is population and employment growth. The second factor is globalization, which has increased freight flow because production is being distributed across multiple locations around the world rather than remaining local. Third, customers have demanded an increased variety of products while at the same time stores are stocking less inventory, which means that more frequent deliveries must be made to replenish that inventory. Fourth, logistics facilities have decentralized, with storage and distribution centers moving to the periphery of a city in response to high land costs within the city. As a result, freight must be moved into the city to reach urban consumers. Finally, increased online shopping is generating more freight movement directly to individual homes rather than in bulk to store locations.

Taken together, this increase in freight movement has led to congestion, parking, and circulation problems in cities, as well as a range of other externalities. Road capacity within cities is limited, as are the number of parking spaces and loading facilities. Each of these resources (roads, parking, and loading facilities) competes with passenger flows. As a result, the public has demanded time or route restrictions to be imposed on freight flows, and local ordinances have been issued as the problems have worsened.

Indeed, as Giuliano noted, the growing freight problem has led to larger and more concentrated impacts. Scale economies enable larger facilities, logistics clusters, and freight hubs to be more efficient. But these hubs create concentrated impacts at the periphery of metropolitan areas. A striking result is that planners who promote smart growth and sustainable city practices end up in conflict when placed in a larger urban context. If urban planning prioritizes car traffic, the movement of freight can be constrained.

Yet urban planners and local governments and authorities actually have limited control over the issues. Giuliano pointed out that freight "has no borders" in the global economy. Producers are often hundreds or thousands of miles away, which means that freight travels long distances through multiple jurisdictions. Local authorities can impose parking regulations, but they cannot regulate demand, so their ordinances ultimately are not as effective as intended.

Increased urban freight has led to increased air pollution and greater energy consumption, Giuliano added. Fuel efficiency and emissions improvements for trucks have lagged behind cars. Older, more polluting vehicles are used in urban deliveries and drayage. Ocean transport is often not under any jurisdiction, and rail is protected by the Interstate Commerce Clause of the U.S. Constitution. All of these factors negatively affect city noise levels, livability, and the safety of citizens.

Assessing the Effectiveness and Applicability of Solutions

The coauthors applied four assessment criteria to evaluate the effectiveness and applicability of solutions proposed to address urban freight problems:

1. Were intended objectives achieved?
2. What were the costs, and who paid?
3. Were there any unintended consequences?
4. Was there any evidence of net benefits?

The coauthors applied a different set of four criteria to assess the applicability of the solutions to other locations:

1. Could the solution be implemented and have an effect in the short to medium term?
2. Was the solution transferable to other metro areas?
3. Was the solution consistent with U.S. or EU regulatory policy and authority?
4. Could the solution be scaled to broad implementation?

Four Solution Categories

The coauthors next assessed possible solutions in four urban freight problem categories: metro core, environmental mitigation, metropolitan flows, and freight hubs. The first set of solutions they analyzed related to the metro core, namely the "last mile" of delivery (and "first mile" of pickup), both commercial and residential. This last mile is fraught with inefficiencies. Vendors delivering to establishments make many small deliveries and face restrictions on routes they can travel and times during which they can travel. For example, there are often prohibitions against nighttime deliveries due to the noise generated by such deliveries or pickups. Home deliveries are even worse in terms of the small size of the delivery, the dispersed locations, and the risk of failure if the consumer is not at home to accept the shipment. A final inefficiency is due to lack of parking or loading spaces, which leads to energy-wasteful cruising or congestion-causing double-parking and idling. The greatest problems are in dense city cores.

Metro Core Strategies

The coauthors identified five strategies intended to mitigate the problems of the metro core: parking and traffic regulations; local planning policy (such as building codes that require off-street parking or curb space); off-hours (out of hours) deliveries; negotiated programs between industry and the public sector, such as being able to do off-hour delivery (if the delivery does not make noise); and consolidation, in which small deliveries from many vendors could be consolidated to move all deliveries at once in full trucks and reduce overall truck vehicle miles traveled.

The most effective metro core strategies were local planning policy, off-hours deliveries, and negotiated programs. Traffic and parking regulations were of medium effectiveness (because they can only zone out goods movement), and consolidation had the lowest effectiveness.

All strategies had high applicability in both the United States and EU except off-hours deliveries (which the coauthors ranked as being of medium applicability) and consolidation, which they ranked as having low applicability in the United States and only medium applicability in the EU because of the required actions that industry must take to make this strategy effective. To date, vendors have been reluctant to consolidate their deliveries with other vendors. Of these five strategies, Giuliano believes that negotiated programs have the most potential to transform city logistics.

Environmental Mitigation Strategies

Next, Giuliano discussed assessments of strategies aimed at reducing environmental impact. Such strategies are important, she noted, because trucks account for 80% to 95% of all nitrogen oxides from freight transport in the United States and 50% to 95% (depending on the presence of ocean vessels) of all particulate matter with a diameter of 10 micrometers or less (PM10). In Europe, freight transport accounts for 25% of greenhouse gases and 50% of PM10 from urban traffic. Public health problems can occur in areas with a high concentration of logistics activities, namely urban highways, ports, intermodal facilities, and logistics clusters. These "hot spot" areas pose a disproportionate exposure to cancer risk.

The coauthors examined five strategies aimed at reducing environmental impact. Of these, truck fuel efficiency standards and emissions standards such as corporate average fuel economy standards were found to be the most effective and the most applicable on both sides of the Atlantic. These strategies were effective because they were applied on a systemwide basis and thus generated large benefits. In contrast, low-emission zones limit polluting vehicles from entering a specific area, but those areas are limited in size and thus do not have systemwide impact. Such strategies have high applicability in the EU but not in the United States, where the political structure of local governments makes it difficult to create such zones.

Strategies aimed at the use of alternative fuels or vehicles such as electric vehicles are not yet prevalent, the coauthors found, but they see broader use of such strategies as the technologies become more widely available and at lower prices, perhaps 10 to 15 years from now.

Strategies aimed at mandating alternative modes of transport, such as moving to slower but less polluting modes (e.g., from truck to rail), were found to have low effectiveness and applicability because of economic concerns: time is money. The trade-off of using slower modes includes increased handling costs to make these transfers, increased inventory levels, and reduced service quality.

The final strategy, community environmental mitigation, was found to have medium effectiveness but was highly applicable in the United States, which has pursued such environmental justice programs more than the EU, where the strategy is of medium applicability.

Metropolitan Flow Strategies

The third set of strategies the coauthors evaluated targeted metropolitan freight flows. Truck traffic affects the entire metropolitan transport system. Trucks contribute disproportionately to road congestion given their size, operating characteristics, and the delays associated with truck incidents. Freight rail also contributes to congestion by blocking traffic at rail–highway grade crossings.

Of the four strategies aimed at improving metro flows, the authors rated intelligent transportation systems of medium effectiveness and applicability because they are just starting to be applied. The second strategy, road pricing, is effective but is hard to implement; thus, it is of low applicability in the United States and of medium applicability in the EU. The third strategy, dedicated truck lanes, is of low effectiveness and applicability because these lanes have not been well implemented. The limited productivity of dedicated truck lanes makes them less effective systemwide. Finally, mitigating rail impacts by removing at-grade crossings, such as on the Alameda Corridor in southern California, is of high effectiveness but medium applicability due to the high costs and the question of funding sources.

Freight Hub Strategies

The last problem area the coauthors assessed centered on freight hubs, which are enjoying increased use because of the advantages of scale economies they offer. But freight hubs concentrate logistics activities in certain gateway areas, causing a disproportionate amount of negative impact in those areas. Freight hubs cause concern in Europe because the activity is concentrated in so few places, like Rotterdam, Frankfurt, and Paris. Freight hubs also pose difficult issues because locals do not think they should pay for mitigation efforts. If they suffer due to freight that is on its way to a different city, why should they be obligated to pay? Similarly, railroad companies don't want to share costs where they receive no benefit.

The first strategy to mitigate the impact of freight hubs is that of logistics land use, in which urban planning is applied to logistics, such as urban planners ensuring adequate transport access. These strategies are of medium effectiveness and applicability. A second strategy, port appointment systems, is of medium effectiveness in smoothing out operations at ports but is of high applicability in both the United States and the EU. Port pricing, in contrast, was found to be of high effectiveness but low applicability on both sides of the Atlantic. Accelerated truck emissions reductions, the fourth strategy, was found to be of high effectiveness and of high applicability to the EU but only medium applicability to the United States. Finally, ocean vessel emissions reductions were of high effectiveness and applicability to all.

Overall Findings

Giuliano concluded with some overall findings. First, there are many possibilities for managing urban freight better, such as through voluntary programs, local management of the last mile of freight, global emissions and fuel standards, and effective equipment. Pricing is another strategy, although it is difficult to implement. Technology solutions look more promising for the longer term. The authors also found that the real world was ahead of researchers' work.

Broad implementation of the most effective strategies is a challenge. Institutional considerations are expensive because of limited local and state regulatory abilities, fragmented governance structure, multiple stakeholders and interest groups, and the environmental review process. In the United States, interstate commerce protections impede nationwide solutions. Questions also remain about who should pay for implementing these solutions and the sources of public funding. Finally, there are a lack of data and analytical tools to help inform the decisions that need to be made.

Recommendations for Research

Giuliano recommended three research directions. The first is to document the problem to improve understanding and inform solutions. Documenting the problem requires data on truck and van flows and truck characteristics, data on pickup and delivery characteristics, and comparative EU-U.S. analyses. The second area, developing analytical tools, involves developing a full set of analytical tools and better methodologies to predict the outcomes of alternative strategies and to compare policy alternatives. The final area of research would be to systematically analyze the impacts of programs, which would include documenting program costs and outcomes, documenting industry impacts, comparing similar programs that were implemented in different contexts, and understanding the roles of institutions and leadership.

Modeling Approaches to Address Urban Freight's Challenges: A Comparison of the United States and Europe

Michael Browne and Anne V. Goodchild

Michael Browne and Anne V. Goodchild stated that the purpose of this white paper was to address the use of models to analyze urban freight problems. Specifically, the models analyzed were those applied at the urban or metropolitan scale (as opposed to the national or international scale); concerned with road freight (as opposed to other modes); applied to congestion, air pollution, and energy consumption research; and implemented to support transportation planning. The paper focused on how researchers in the United States and Europe are using tools to support decision making in addressing these problems.

The paper examined modeling to address the challenges of two urban freight impacts:

- Congestion and urban accessibility; and
- Energy use, greenhouse gas (GHG) emissions, and air pollution, which are the most pressing challenges and those most amenable to modeling.

Modeling to Address Congestion and Urban Accessibility

A significant body of research exists on the first impact, congestion and urban accessibility, but the issue remains a challenge. This work can be grouped into five main solution areas: the scope for rescheduling deliveries, ways to allocate and manage the use of curb space, pricing and charging, controlling or altering land use, and consolidation of flows.

The models being used to forecast regional travel demand and system performance are still primarily the four-step models originally developed to model passenger traffic and later modified to address truck traffic. Truck modeling is less well developed than modeling for passenger car traffic, and there is limited modeling of intermediate facilities and tours. Finally, the models often do not incorporate the second-order effects of congestion on demand.

Regional planning agencies face challenges of limited resources and training or skills in implementing the models. That is, people who could use or interpret the models are not well trained on the assumptions of the models, which limits their confidence in using the models. Political will to invest in and use the models is another challenge.

Goodchild and Browne also enumerated the challenges to current implementations, namely that carrier behaviors, as well as consumer behaviors, are insufficiently represented in the tools currently used. The heterogeneity of shippers and carriers is another challenge, as are limited data to develop knowledge and design model architecture. Finally, model complexity may work against implementation: complex models may provide a fuller picture but may be harder to implement.

Modeling to Address Energy Use, GHG Emissions, and Air Pollution

Next, the authors described modeling related to energy use, GHG emissions, and air pollution. They mentioned that transport is recognized as a significant contributor to GHG emissions and energy consumption and that a recent EU white paper called for essentially CO_2-free city logistics by 2030, a demanding goal given the limited number of vehicle replacement cycles between now and this target date.

The authors noted that much research has been done on energy use in general, including an examination of the scope to use alternative fuels and the role of new and improved operational approaches to minimize freight transport demand (e.g., improving vehicle utilization and consolidating flows). Research has also looked at the impact of vehicle design (e.g., aerodynamic improvements) and changes to driver behavior and how these could be achieved.

In particular, models have been used to explore the consequences of low-emission zones (LEZs) of varying sizes, levels of emission, categories of vehicle included, and so forth. These models led to a decision to make London's LEZ large, because modeling many permutations of zones revealed that a larger LEZ size would be more effective. Models need to estimate existing and future traffic levels (including freight) and arrive at emissions estimates based on typical operating patterns.

Estimating impacts, such as human exposure to pollution, requires detailed population information. Goodchild and Browne posed the question that although models may look pretty, are they right? A broad range of data is needed; the authors presented a table depicting requirements for data at different levels of granularity of geography, time, and network. Although there is constant frustration over a lack of data, some urban freight models can produce useful results with fewer data inputs. A model forecasting 40 years into the future has different data requirements than one forecasting hourly. The authors noted that their white paper includes examples of data sources. In some areas, there is a reasonable amount of data, but in other areas the data are lacking or were collected for a different purpose and thus present limitations. The authors called for researchers to pay attention to the quality of the data.

The authors discussed the strengths and weaknesses of models aimed at energy and emissions reductions. They noted that the models currently used to support planning have significant limitations, such as lacking information about intermediate locations and delivery–collection rounds. Another weakness is that the models in use are designed for regional-scale analysis, not microlevel analysis, making them hard to use at the microstreet level. In addition, validation of the models is often not done or is limited. The authors noted that researchers may validate for one year and then forecast 40 years, during which many underlying patterns of activity, such as retailing, change dramatically. Finally, there is limited evidence that more sophisticated models lead to better planning outcomes.

Difficulties in Modeling

The authors noted three categories that make modeling to address urban freight challenges difficult. First, the area is complex and rapidly changing. Including the supply chain in modeling is difficult, and new channels such as e-commerce are not easy to incorporate. The number and variety of stakeholders in urban freight adds to modeling complexity, as does the speed of technology development and adoption. The second category is a lack (or limitation) of data, such as on vans or small trucks (as opposed to large trucks) and on vehicle flows (as opposed to product and goods flows). Comparisons are also difficult because of variations in definitions or in national requirements for data collection. The third category of challenge is due to gaps in communication between practitioners and researchers and between researchers involved in urban freight modeling and those engaged primarily in policy and operations.

The authors also commented on U.S. and European differences that present challenges, such as infrastructure differences in urban centers. The nature of urban areas has clearly influenced European urban freight research. The idea of transferability is important in Europe, and there has been a recent strong emphasis on multinational cooperation in EU funding programs. The same cannot be said of U.S. funding mechanisms. Data collection efforts also vary significantly between the United States and Europe.

Questions for Discussion

The authors closed by noting some important questions for future discussion:

- What are the research challenges that limit our ability to solve urban freight challenges?
- How do these challenges relate to modeling tools?
- Should we build additional behavioral aspects into models?
- Do we have sufficient data and knowledge to do so?
- Will adding behavioral aspects allow the models to be more policy sensitive?
- How can we measure the effectiveness of these models at addressing urban challenges?
- To what extent do these tools address the urban freight problems that policy makers are most concerned with?
- Does academic research sufficiently capture the key features of private sector activities?
- Are academic projects not sufficiently relevant and therefore not considered by policy makers?
- Are the data requirements or modeling capabilities too onerous?

Suggestions for Research

Finally, the authors presented the following list of recommendations:

1. Conduct a more systematic review of the state of modeling and analytical work with joint support from the United States and Europe;
2. Fund joint projects, especially those that address modeling–policy gap(s);
3. Organize a showcase for examples in which the analytical and policy gap has been overcome (or narrowed);
4. Organize an annual meeting aimed at encouraging European–U.S. cooperation between researchers; and
5. Consider a journal special issue built around the workshop addressing the questions raised by the papers and presentations.

Discussion of the Commissioned White Papers

José Holguín-Veras asked Giuliano and Dablanc to explain how they defined "applicability" in their paper.

Dablanc explained that the coauthors looked at the institutional context as well as the legal context when making their ranking. The coauthors had done such an assessment earlier for a report for TRB's National Cooperative Freight Research Program, examining academic as well as technical literature of all the strategies that have been implemented. This is an ongoing process.

Holguín-Veras questioned whether road pricing strategies were effective. Based on data he and his colleagues collected, road pricing didn't seem to change behavior much.

Giuliano answered that the price needs to be high to achieve a material change in trucking behavior. In the example of PierPASS in Southern California, the price was on the beneficial cargo owner, not the trucker, and it changed behavior, shifting 40% of traffic to off-peak hours. So adjustments in behavior did happen as a result of pricing. A second example is the issue of relative pricing inelasticities of different markets, such as between trucking compared with passenger transport. Imposing one price globally across an urban area would deter more car traffic than truck traffic. A pricing scenario that prices everyone on a road would bring some road congestion improvements.

Ken Button agreed with Giuliano that pricing strategies do work. He noted that trucks will pay more than passenger cars because trucks need to enter the city. Passengers going to the gym or other leisure activity may opt to go elsewhere if the road fee is too high, because the trip is less important and they have other options. The traffic coming into Washington, D.C., is 40% commuter traffic. Reducing the number of people doing leisure activities would reduce traffic congestion.

Button added that he wrote a book in 1978 on this topic, and those models still apply. The acronyms have changed, but the models are the same. Environmental issues have become more important now than in the 1970s due to global warming, but even the 1970s had pollution. Button also felt it important to consider passenger traffic alongside urban freight traffic, not separately. Freight terminals in urban areas can generate significant employment and hence commuting trips. He also noted that some of the worst congestion is found around shopping malls. The big issue was not the specific strategy or technique, he said, but the politics; TRB research has not examined the political question much.

Browne gave the example that in London, the road charge was £5, and carriers of freight simply increased the price to ship a package by a few pence. On the nature of decision making in cities, he added that there are many solutions, but it is not clear which ones to implement or whether several strategies should be implemented together.

Téodor Crainic remarked that the difference between the 1970s and now is that now there is more knowledge about how to optimize and plan routes. In addition, people worry more about the environment now in ways they didn't in the 1970s. Crainic congratulated the authors of both white papers for creating such useful papers. He said that the papers examined many initiatives, but that they examined the initiatives separately. In his view, it was important to have a portfolio of initiatives that could be implemented together rather than separately.

Dablanc agreed about the need for a comprehensive agenda. It is difficult to manage urban freight because freight demand has increased tremendously.

Michel Savy agreed with Dablanc that urban freight flows were growing. He also pointed out that freight hubs result in more remote facilities away from city centers. As a result, the "last mile" becomes the last 20 miles, which is more costly and brings more congestion. Thus, the need to manage urban freight is stronger than before. Currently, experiments have been at the city level, but an industry-scale solution is lacking. Savy noted that Japan may offer some models for how to regulate and optimize the use of public space.

McKinnon echoed the idea of looking at examples from Japan.

Chris Kozak said that the white papers nailed the issues. He pointed out that although cities are trying to encourage overnight deliveries and off-peak activity to reduce congestion, other legislation such as the hours-of-service restrictions that will take effect in July are at cross purposes because they restrict schedules. Wal-Mart is partnering with carrier J.B. Hunt to try to counter the new hours-of-service regulation, but that partnership is coming too late and the legislation will have a large, negative impact on productivity.

Goodchild noted that the motivation for pricing schemes is different now from that in the 1970s. Regions are now looking at pricing mechanisms not because of political will, but because they need to find funding, and these charging schemes would provide funding. Thus, the funding motivations of cities provide an opportunity to implement policies related to urban freight management. She agreed that hours-of-service legislation adds a complexity that is significant for schedule planning.

Giuliano added that hours-of-service legislation is an example of what happens when systemwide effects are not considered. She urged that researchers simulate what inefficiencies might be brought about by a change like hours of service. If researchers could quantify the impacts of proposed changes, better policy discussions could take place.

Demand Patterns and Trends

Christopher Caplice, *Center for Transportation and Logistics, Massachusetts Institute of Technology, Cambridge, Massachusetts, USA*
Jean-Louis Routhier, *Laboratoire d'Economie des Transports de l'Institut des Sciences de l'Homme, Lyon, France*
Miguel Jaller, *Center for Infrastructure, Transportation, and the Environment, Rensselaer Polytechnic Institute, Troy, New York, USA*
Robert Chumley, *Retail–Business Innovation, 7-Eleven, Inc., Dallas, Texas, USA*
Laetitia Dablanc, *French Institute of Science and Technology for Transport, Development, and Networks, Paris, France*

Introduction

Christopher Caplice

Chris Caplice opened this session by explaining that "demand" means different things to different people. To shippers, demand means products; to freight transporters, demand means the demand for trucks to get the product into the store or to the final consumer. The views are correlated, but they are not the same. Policies will dictate freight demand but not product demand.

The first two presentations of this session focused on freight demand generation from a researcher perspective: that is, how to estimate and forecast demand and what drives demand. Jean-Louis Routhier presented freight survey results from Europe, and Miguel Jaller presented results from the United States. The third presentation, by Robert Chumley of 7-Eleven, provided the private-sector perspective and how urban product demand is changing. A discussion followed each of the two parts of the session, and Laetitia Dablanc concluded with a synthesis and summary of the session.

French Cities' Urban Freight Surveys

Jean-Louis Routhier

Jean-Louis Routhier described a set of full-scale urban freight surveys (UFSs) of French cities. Funding for the studies came from the French Ministry of Transport as well as from each city surveyed. The aim of these UFSs was to build a model (the FRETURB model) to simulate the existing urban freight situation in these cities. The first set of surveys was conducted from 1994 to 1996 in three cities of different sizes (Bordeaux, Marseilles, and Dijon); the second set is in progress now (2011 to 2014) in Paris and Bordeaux.

The aim of these surveys is twofold: on the one hand, they provide understanding of the behaviors and organizational aspects of urban pickups and deliveries (i.e., they simulate the existing situation). On the other hand, they feed into a tool to make diagnoses of urban logistics without the need for collecting large amounts of data, thus reducing costs. The surveys are a decision aid and can be used for short-, medium-, and long-term forecasts.

Survey Description

Routhier next described the details of how the UFS worked. The first task was to find a relevant unit of observation. Could it be the commodity being moved, the vehicle on the road, or the transport company? In fact, it was none of these. The best unit was the delivery (or pickup) operation serving an establishment, using a vehicle. At that point it is possible to observe (and survey) the formation of vehicle flows and their impact on the urban environment according to the transport system, the logistic strategy of the firms, and the establishment's environment.

A UFS consists of three complementary, nested surveys:

1. A survey of business establishments that describes the activity and size of the establishment and identifies all the freight delivery operations in relation to the characteristics of establishments and their environment;
2. A survey of truck drivers that describes the trips and the conditions of carrying out deliveries and pickups; and
3. A survey of truck companies that describes the logistics organization of for-hire trucking companies.

The three surveys worked together. The establishment survey included site visits and reviewed log books for a description of pickups and deliveries. The driver survey included driver logs and Global Positioning System (GPS) data to identify routes and stops. In the carrier survey, it was important that the drivers surveyed were the same drivers who delivered to the establishments surveyed.

The sampling frame was the comprehensive register of establishments by activity category. The establishments sample comprised 1,500 establishment questionnaires covering 6,000 deliveries and pickups over 1 week and 8,000 product types (by weight, packaging, and so forth). The trucker sample was composed of 1,000 driver questionnaires (6,000 deliveries and pickups), and the carrier sample included 100 major truck companies and large wholesalers.

Forty-five activity categories were used, such as "pharmacies," "bookshops," or "hardware stores." Each category was considered as a homogeneous group of traffic generators and logistic organizations. Some categories were more important than others. For example, "cafés, hotels, and restaurants" represented nearly 5% of total operations (five times more than large grocery stores and twice as much as warehouses).

The survey was costly (€1.2 million) and complex due to difficulties in contacting the business owners and poorly motivated respondents. As a result, getting responses required a preliminary information and promotion campaign, employing a contactor to ensure recruitment of experienced pollsters, and paying incentives for each survey completed.

The large size of the sample of establishments and the quality of the responses (thanks to face-to-face interviews) guaranteed a good estimation of the number of movements generated by each category. The stratification of the activities was sufficiently detailed to obtain an accurate estimation of freight and freight trip generation.

Survey Results

The main result of the surveys was a detailed description of the current situation: standard data and indicators. The researchers found consistent and stable relationships and used them to feed a traffic generation model. These stable relationships included the following: one delivery and pickup each week, per job; 75% of deliveries and pickups were carried out by rounds; 80% of deliveries took less than 10 minutes, but pickups lasted 30 minutes on average; and peak hours were 9:00 to 11:00 a.m., which differs from car traffic peak hours of 7:00 to 9:00 a.m.

Routhier said that by expanding the driver survey, it is possible to estimate truck traffic on the city roads and to estimate the flows of vehicles within and through the different zones of a city.

The surveys also found consistent and stable relationships between cities, such as between activity, workforce, and movement generation; between stop duration and size of delivery round; and between distance covered between stops and the overall size of the delivery round. These relationships, observed in all city surveys (small and large cities) were quite similar. All relationships were translated as equations in the FRETURB model. Because the relationships are not city specific, the model is efficient and robust even if it is implemented in cities without surveys.

FRETURB Model

Routhier explained that inputs for the FRETURB model are the database of the existing establishments in a given city and the city spatial zoning. Therefore, it is easy to feed the model with these inputs. The model consists of four modules. Module 1 estimates the number of deliveries and pickups. Module 2 calculates road occupancy due to delivery stops. Module 3 simulates road occupancy by running vehicles. Module 4 distributes the results over 24 hours.

FRETURB is a compromise between the simplifications needed to be able to model urban complexity and a comprehensive description of the reality.

Suggestions for U.S.-EU Collaborative Research

Routhier offered three suggestions for U.S.-EU collaborative research:

1. To compare urban freight objectives strategies of cities in the United States and the EU (do they really want to know freight demand?);
2. To compare the different methods of data-based modeling oriented toward helping make public policy decisions; and
3. To test the operational applicability of models like FRETURB in the United States and vice versa, which would require comparing data sources and collection processes as well as different establishments (which are

inputs of the model) and choosing a land use data area to test the implementation.

U.S. Cities' Urban Freight Surveys

Miguel Jaller

As a U.S. counterpart to Routhier's talk, Miguel Jaller's presentation focused on U.S. cities' urban freight surveys (UFSs). He began by explaining that development of freight demand models is difficult due to lack of knowledge, models, and data. Researchers are still in the process of understanding freight at different levels. There are not enough data, and there are multiple models that provide different outputs. The freight system is complex, with multiple agents (shippers, receivers, carriers, third-party logistics providers, consumers, freight forwarders), all of whom have their own requirements and impose their own constraints on the system. Each agent has only a partial view of the system, and there are multiple interactions and links between them. There are many metrics to measure freight, and a variety of functions (long haul, consolidation) can be performed using different delivery modes and vehicles (bikes, vans, truck, rail, barge). The freight system can also be viewed at many levels of geography: neighborhood, state, region, and so forth.

Because the numerous agents have only a partial view of the system, no single agent can provide a complete picture of it, which would involve knowing a host of metrics, such as amount of cargo, number of loaded vehicle trips, number of empty vehicle trips, number and frequency of deliveries, commodity type, shipment size, cargo value, and land use patterns.

Jaller displayed a diagram of the multiplicity of metrics, noting that the flow of freight of trucks (vehicle traffic) differs from the flow of the goods (commodity flow).

Data Needs and Sources

Jaller listed a dozen techniques for modeling three categories of flow units for urban freight models that focus on either trip interchanges, tour-based models, or both. The point, he said, is that there is debate about which modeling focus is best.

Jaller also described the different data required by different modeling techniques. He showed a table with seven data categories (freight generation, delivery tours, agent economic characteristics, agent spatial distribution, network characteristics, special-purpose models, and other economic data) on one axis and six modeling techniques on the other axis. From the table, researchers could see that some of the models require just a little data, while others require a lot. Therefore, if researchers lack the resources to gather a lot of data or do not have the needed level of data, the quality of the model will suffer.

As examples, Jaller discussed primary data sources (Commodity Flow Survey [CFS] data, zip code business patterns, surveys, interviews, and travel diaries), as well as secondary sources (Global Positioning System [GPS] data and experts). Jaller focused the discussion on the topic of freight demand synthesis. This technique, which can help fill gaps in the data with good estimates, can reduce data collection costs but may introduce an error.

Jaller listed the data gaps he identified. The gaps occur because some of the information is not publicly available or because it concentrates on a certain location, and it is not clear if the data translate to other locations. He concluded that most of the data needed must be collected from scratch.

Data collection methods vary widely in cost and response rates, and collection techniques depend on the sampling frame. Data collection methods can focus on origin–destination, en route intercepts, or various locations along the supply chain. GPS data are also helpful, but are limited in that they only provide speed, time, and location; they cannot provide data on trip purpose, commodity type, or shipment size. GPS data should be considered complementary to more traditional freight data collection procedures, but they do not provide the full picture that can be derived from surveys. Furthermore, commercially available GPS data can be biased and difficult to convert into a representative sample.

Generation of Demand and Generation of Traffic

Next, Jaller moved to the topic of freight demand generation and noted that there are two perspectives: generation of demand (FG) and generation of traffic (FTG). FG is an economic manifestation of the production–consumption processes, and FTG is the result of logistical decisions.

Reviewing more than 60 reports that contain FG and FTG references, Jaller found more than 150 case studies and many different models discussed. Many models were based only on a handful of observations, which shows the need to develop better models and collect freight data. The references discussed many more FTG models than FG ones.

Jaller mentioned several issues to be considered in FG-FTG modeling. First, it is important to pay attention to the classification system, whether it is economic based (e.g., North American Industry Classification System [NAICS] or Standard Industrial Classification [SIC]) or land use based (e.g., Standard Land Use Coding Manual [SLUCM] or Land Based Classification Standards [LBCS]). Other issues include the level of aggregation, aggregation procedures, and the modeling technique used.

In numerous case studies, FTG is usually constant regardless of the size of the establishment and is not proportional to the number of employees per establishment. It appears that larger establishments received larger shipments in larger trucks, but the number of deliveries tends to remain constant. Researchers must be cautious when using employment as the only independent variable because it will lead to errors.

Next, Jaller described the advantages of using CFS data. CFS has more than 4.3 million records of shipments. CFS microdata can be used to estimate FG models as a function of establishment characteristics, as well as models at different levels of geography or industry segment. Other data sets that can be used are the Census of Manufacturers (CMF), the Longitudinal Business Database (LBD), and the Standard Statistical Establishment List (SSEL). He mentioned that, for the first time, a research team at Rensselaer Polytechnic Institute was granted access to the microdata for a period of 5 years to conduct freight demand modeling.

Jaller summarized the main conclusions of his presentation, namely that freight is a complex system and researchers need to collect data from all economic agents. Data collection methodologies provide different types of information and levels of detail, and GPS data cannot provide all the information required. Freight demand modeling techniques may require different data, and a combination of data collection methods is required. Finally, freight demand models must distinguish between the total amount of freight generated and the number of freight trips required to move it.

Recommendations for Research

Jaller ended with recommendations for four research directions:

1. Develop innovative data collection methodologies and technologies,
2. Improve freight data synthesis,
3. Develop complementary models to take advantage of the CFS, and
4. Take advantage of administrative records.

Questions and Answers with Jean-Louis Routhier and Miguel Jaller

Caplice reiterated that Jaller's presentation was a survey of different studies, while Routhier's was a deep dive into one survey that led to the FRETURB model to help cities make forecasts. Caplice posed the first question of the discussion by asking Routhier how applicable the FRETURB model is to other cities, both in the EU as well as in the United States.

Routhier said that the model is applicable to other cities because cities do not need to collect as much data to implement it. They need to know the location of establishments in the city, but such data are easy to obtain; thus, implementation of the model in other cities is possible. The problem of applicability to the United States, however, arises from the fact that cities in the United States are larger and less dense, which means that logistics operations in U.S. cities are not the same as in Europe. The FRETURB model has been implemented with success in Switzerland, Belgium, Spain, and Italy. It is possible to use FRETURB effectively in European cities, but he was not sure if it would work in the United States.

Jaller noted research was needed on the hypothesis that operations in Europe are the same as in the United States. There have been more restrictions in the EU on operations in city centers, such as low-emission zones, so different establishments have adapted to these constraints. These adaptations have affected the number of deliveries that establishments get each week. In addition, in the densest city areas, establishments hold less inventory due to the higher price of land. So, if cities are more dense in the EU, they would hold less inventory; in less dense areas, establishments can have larger stock rooms. Finally, density affects the whole supply chain because of the implications for vehicle capacity. Carriers have to use small vans rather than large trucks when entering city centers, which alters FTG models because two smaller vans might go out rather than one big truck.

Anne V. Goodchild noted that Routhier's model collected a lot of data, but it is still based on using averages by classification. For a certain classification, the model uses one value to represent trip generation. Would it be possible to use a range of values rather than a single value?

Routhier answered that about 6,000 establishments were surveyed; thus, it was possible to build stratification categories of activity that are relatively homogenous by their logistics activity. To the extent that demand is the same in one city as another, it is possible to generalize. Having 45 types of activity makes the model robust. Perhaps there could be 50 or 60 types of activities, but even if there is some dissimilarity within a category, that dissimilarity is less than the difference between categories.

Caplice asked Jaller to comment on Goodchild's question, because Jaller used a single value.

Jaller replied that he used multiclassification analysis and models for the entire pool of employment and found differences in the trips generated in different levels. The number of freight trips may start increasing as employment increases, then it drops, and then it starts increasing again. The drop occurs as the carrier moves to a larger vehicle. Jaller said he did not find differences among industries in different regions.

Kazuya Kawamura asked whether, when using the FRETURB model in cities where surveys have not been conducted, such as Spain, small-scale surveys were conducted to see if freight was similar, and if validation surveys were done to adjust the model.

Routhier answered that they have not done additional surveys due to lack of funds. The FRETURB model is intended to help clients, who in this case are the public authorities who receive the FRETURB results. Clients have been happy with the results. The model is consistent with local observations. The FRETURB model is a comprehensive description of logistics in an urban area, and that is what public authorities need.

Barbara Lenz noted that urban stores have little room for storage and asked if the models take into account the storage strategies used by stores. She added that in Germany, different stores have different storage strategies and that some pharmacies have almost no storage space.

Jaller answered that although the database contains many models, forecasting for grocery stores in the city center that get deliveries is not possible because there is not enough information. In the United States, business-pattern data on a countywide level and often down to a microlevel of individual land parcels are available. One can use models from New York and collect a small sample to apply it to a different area.

Ken Button voiced concern over big, complicated models. He told the story of modeling for Bay Area Rapid Transit (BART) in San Francisco, which used the same type of data to which Jaller referred. The modelers forecasted that 15% of residents would switch from driving their cars to using BART. A different model simply surveyed 400 residents and forecasted that only 5.6% would switch. The eventual outcome was that 5.5% of residents switched to using BART once it was built. The second forecaster did not collect tons of data; he used a simple model and simple data.

Sometimes the problem is taking the view of a systems engineer. The people who run companies are humans and make decisions as humans. So perhaps instead of complicated models, researchers ought to look at how a small number of operators work, the incentives of the business, structure of the business, and how much emphasis is put on efficiency versus inventory, and use that information to build a model. Button ended with an example from the Netherlands regarding solving delivery problems to the Schiphol airport. The model Jaller proposed would not have helped the airport decide how much to deliver by truck compared with attempting a completely new solution: shifting the freight to barge.

Jaller replied that it is not possible to go to a municipal planning organization (MPO) and simply say, “trust me.” MPOs want to see numbers. True, there have been mistakes. For example, a few years ago it was common practice to ban car traffic by plate number, but now that practice is known to be ineffective. Nonetheless, modeling is useful and can drive behavior change. Before, carriers had the power to do what they wanted, but now consumers want trucks to be green, so that drives behavior. If locals do not want large trucks operating at night, that will influence behavior, as well. The question is how to identify the best objectives.

Routhier responded to the point about BART by saying that passengers have two main alternatives: car or public transport, perhaps bike. But companies have hundreds of thousands of variables like different types of vehicles, storage, and so forth. These factors were not taken into account until the French surveys. It is necessary to model only small samples of such activity, but it is necessary to have a comprehensiveness of activity and to make stable categories. Forty-five categories is not complex; it is a reduction of the complexity, and it is a compromise given the money available to carry out the surveys.

Alessandro Damiani asked Jaller whether his analysis also covered service trips, such as utilities or electric meter readings.

Jaller replied that most analyses do not consider service trips, but that the Phase 2 survey will include it. Freight delivery vehicles are a big issue in Manhattan. They are considered commercial vehicles and share the same space as service vehicles, but they have different purposes and structures. Nonetheless, they are a big proportion of the vehicles coming into the area.

Rosário Macário commented that freight traffic differs from passenger traffic: it is not a public service, so the city will not pay for data collection on it. Another challenge to data collection is that the stakeholders in this process (authorities and private entrepreneurs) want the status quo. Authorities do not want liabilities and entrepreneurs do not want regulation, so who will pay for the research? She suggested the need for a more pragmatic, business-oriented approach that lets entrepreneurs create business models. She asked what the capacity of the models was to generate data.

Jaller replied that the models have been used in different cities in the United States and validated via small samples. What is needed more than data collection is identification of the main drivers of economic activity; models could be developed from those drivers. He has used models to generate traffic flows and behavioral microsimulations that are useful, and they generate additional data. His research focuses on how to best use the data. The private sector will provide researchers with data if confidentiality is protected. Companies have incentives to improve their data, Jaller said. In New York City, many companies pay $1,000 a month per truck in parking tickets. If companies see a strategy that lets them reduce two delivery tours to one, they have incentive to do it because it will reduce costs. Given their close relationship with society, companies are also motivated to be at the forefront of being sustainable.

Routhier said that the FRETURB model is oriented to public decision making. Some freight companies use the model because they can change the initial situation and then simulate different types of behavior to see the result of those changes. Routhier is developing a policy tool on the basis of this model to test different scenarios for decision making.

Shifts and Trends in Urban Retailing and Buying Behavior

Robert Chumley

Robert Chumley offered a private-sector perspective on urban retailing and buying behavior. He remarked that he was puzzled when he was asked to present at this symposium, because he is neither an academic nor a logistician (his title is Vice President of Innovation at 7-Eleven). But then he realized that academics need inputs that are others' outputs. They need to understand the decisions being made inside private-sector organizations to use as inputs to their models.

Chumley began by describing the impact of urbanization and how it is affecting consumers, retailers, and logistics networks. He noted that, according to the United Nations, for the first time in human history, urban dwellers outnumber rural residents worldwide. By the year 2025, estimates are that there will be 4.6 billion urban dwellers. In the United States, more than 80% of the population resides in urbanized areas.

Chumley hypothesized that new consumers are moving into cities, and they behave differently and have new demands. Those demands, in turn, drive retailers to create new retail formats and products which, in turn, drive changes in logistics networks, assets, and destinations. Indeed, destinations are increasingly more dispersed and see lower volumes. Recounting the history of retail, Chumley identified the trends from producer driven (1850s to 1950s), to distributor driven (1960s to 2000), to customer driven (2000 to today). The future will be "anytime, anywhere," with the consumer firmly and irreversibly in place as the driver of retail activities.

The New Urban Consumer

Chumley next described the new urban consumer. Older empty nesters are moving into cities from the suburbs, but so are young professionals who are making their first homes in the city, attracted by jobs of the new economy and reasonable housing prices. Cities are characterized by ethnic diversity and an on-the-go culture that encourages new lifestyle choices, such as shedding cars in favor of public transport. Such change brings new mobility constraints as well as opportunities.

The shopping behavior of urban consumers differs from that of suburbanites. Consumers have cast off their suburban extra refrigerators and freezers and weekly trips to Costco. Instead, in urban environments, people shop much more frequently, choosing local shops and more fresh and organic foods. Having cast off their cars, they rely more on walking and smaller package sizes. Given the higher ethnic diversity in urban areas and the new cultural influences, urban consumers are more inclined to be curious about ethnic food items and new cooking methods.

Changes in Urban Retailing

Urban retailing is likewise going through profound changes in response to the new consumers. As retailers move into urban spaces, they often have to occupy much smaller footprints. The most significant implication of these smaller footprints is that retailers are considerably limited in terms of the inventory they are able to carry on the sales floor and in the back room. As a result, urban retail shops have increasingly complex supply or demand chains operating within restrictive local ordinances, restricted access, and cumbersome product movement environments. Moreover, most urban retail locations are leased rather than purchased, which affects productivity and profitability. In rapidly growing urban areas, the balance of power has shifted to landlords, who often set terms strongly in their own favor. Finally, urban retail locations require human capital to run. It can be challenging to find qualified talent willing to work for these relatively low-paying (often part-time) jobs in urban settings. Many businesses are adapting their business models to run on less human capital than their suburban counterparts.

As a result of new consumers and new urban locations, retailers have to find new store formats and new business models and deal with multiple end points as logistics networks become more fractured, Chumley said.

With smaller-footprint stores, restrictive ordinances, and rapidly evolving consumer purchase patterns, many retailers are developing new store formats. For example, Best Buy is moving into major transit hubs, and one

Starbucks is located in the vault of a historical bank, preserving the historical design of the building. Offering undifferentiated products in a mundane store would result in a loss of business. It is rumored that Starbucks has more than 100 designers working on hundreds of unique, one-off designs for urban spaces.

From an individual location perspective, many urban retail establishments are less productive than their counterparts in a suburban shopping mall, so innovations are needed. Indeed, the complexities of urban retail are driving innovation in all aspects of the business, including the supply chain. Logistics networks—driven by the unique challenges of traffic patterns, restricted access, local ordinances, parking requirements, and loading–unloading difficulties—are turning to a portfolio of delivery methods to ensure the right products get to the right places at the right time for the right cost.

For example, Fresh Direct uses a fleet of home-delivery vehicles in New York City. Coca-Cola uses 100% electric vehicles, and even UPS's familiar brown trucks are being reconceived into smaller vehicles.

Retail is evolving from consumers going to the store and bringing their items home to ordering on the web and having items delivered to their home. Eventually, with ubiquitous mobile capabilities, consumers will order from anywhere and want their goods to be delivered anywhere. Wal-Mart is experimenting with multichannel shopping in which they ask in-store customers if they want to help deliver an item to a neighbor in exchange for a gift card. Traditional paths of the first and last mile are changing.

Amazon, which staunchly fought application of sales tax to online purchases, is now giving up its fight in certain states, presumably because it plans to build fulfillment centers in those states so that it can offer same-day delivery. Chumley posed a question: Will these actions lead to a race to the bottom, as Wal-Mart offers same-day delivery for $10 regardless of purchase amount, and Amazon counteroffers with $8.99 delivery for same-day shipment plus 99 cents per item? Consumers are demanding same-day delivery but do not want to pay for the convenience. Who will pay for the needed data? Who will pay for the increased complexity?

Some interesting multichannel solutions are emerging, Chumley noted. For example, eBay is testing 1-hour delivery in San Francisco. A start-up called Deliv aims to help existing retailers by using crowdsourcing as a way to deliver goods to customers in the same day. TaskRabbit lets consumers offer any task (such as getting groceries) for which they are willing to pay, and individuals bid on what they think the work is worth. Instacart offers same-day grocery delivery in San Francisco, and Google Shopping Express is testing 1-hour and same-day delivery. Retailers are scrambling to get data for models, but by the time they get the data, Chumley said, it may be too late.

Chumley described another innovative retailing model, that of the "endless aisle" offered by retailer Tesco in Korea. Located in a subway station in Seoul, the aisle is a virtual aisle consisting of photos of 500 products with barcodes. Consumers can scan the barcodes on products they want and submit their order in the morning; the order is ready to pick up on their commute home in the evening. The concept is being tested in New York City, as well. These nontraditional distribution networks are adding strain to existing logistics networks.

7-Eleven's Response to New Urban Consumer Demands

Chumley shifted to describing 7-Eleven's response to these new urban consumer demands. The chain was founded in 1927 as an ice house, but with the invention of the refrigerator 2 years later, the founder pivoted to offer fresh items such as milk (items that would go into the refrigerator) and remain open 7 days a week. Founder Joe Thompson's motto was "Give them what they want, when and where they want it." 7-Eleven is now the world's largest retailer in terms of the number of outlets: 50,200 locations doing more than 14 billion customer transactions a year with total worldwide sales of more than $85 billion. Over its 86-year history, the company has moved from horse-drawn carriages for local delivery to 100% electric vehicles that can hold both hot and cold food in the same small delivery car.

7-Eleven receives 17 million deliveries a year to its stores in the United States alone. The items get to a store in one of three ways. The first way, a central distribution center (CDC), is a dedicated network that brings fresh items such as baked goods daily to a store. Second is the "wholesaler" way, which is a shared network that delivers twice a week. The third method is direct store delivery (DSD) from multiple suppliers who deliver more than 30 times a week. The typical store receives about 40 deliveries a week. All products are ordered by the store (as opposed to being pushed onto the store by headquarters), and store managers determine each store's product assortment.

Chumley next showed photographs of different 7-Eleven urban store formats, saying that the most leading-edge solutions were in Europe and Asia, not the United States. From rolling carts in Thailand to stores that do not have walls and never close in Singapore to a store in a central train station in Europe that is among the most productive in the entire 7-Eleven network, 7-Eleven is experimenting with many formats. In Japan, local franchisees offer delivery to the home within a 1- to 3-kilometer radius, delivering via electric vehicles. Another concept is a "store within a truck" that drives to neighborhoods with elderly populations. Finally, in

Taiwan, 7-Eleven offers a catalog of 600,000 items that can be ordered by phone and delivered to the store or any location of the customer's choosing.

7-Eleven is also experimenting with multichannel business models and has partnered with Amazon in a model in which customers could order items from Amazon and have them delivered to a locker in a 7-Eleven store. The customer feedback has been favorable, but the big orange locker boxes in the store are a bit cumbersome, so 7-Eleven is still testing the concept.

Chumley concluded by reiterating the central problem that urban retailers face, namely that consumers are becoming more and more demanding and are increasingly unwilling to pay for convenience. As a result, networks have become complex and their problems expensive to solve.

Chumley offered four topics for further discussion:

1. Changes in consumption patterns and buying behaviors of recently urban consumers;
2. The impact of multichannel commerce on brick and mortar stores (who is winning, and why);
3. Successful multichannel operations (how to manage a cross-channel portfolio); and
4. Understanding desirable, feasible, and viable home-delivery business models.

Questions and Answers with Robert Chumley

Chelsea (Chip) White asked whether, as 7-Eleven optimizes its flow of goods, it also looks at its flow of information.

Chumley replied that 7-Eleven can correlate sales with temperature, time of day, and humidity. The issue is to turn the data into consumable information that leads to decision support and taking a different course of action when needed. He said 7-Eleven has more data that it can use, so the company needs to decide which data are the key indicators. No two 7-Eleven stores have the same assortment. The typical store has 2,500 unique items of 9,500 choices, but the broader funnel is 95,000 items. It's difficult to drive consistent decision making given the huge assortment.

Caplice asked whether 7-Eleven works with its DSD suppliers to go to CDC.

Chumley replied that 7-Eleven is exploring pilots in Los Angeles, but that the DSD vendors believe that DSD is a true value proposition and do not want to let it go. When Chumley worked for Coca-Cola, he believed in the value of DSD, too. He believes that DSD vendors eventually need to understand that channel blurring is taking place and that the distinction does not exist in the customer's mind or the retailer's mind. In the Los Angeles pilot, the only trucks allowed on the 7-Eleven parking lots are those that came from a CDC.

Edgar Blanco asked if Chumley saw synergies from Europe or other countries.

Chumley replied that in the United States, fresh food is 10% of 7-Eleven's total business, but in Scandinavia and Asia fresh food is 30% to 50% of the total business. In the United States, CDCs have a range of 200 miles for daily delivery. In Japan, with 15,000 stores, the range is 12 miles, with deliveries of fresh and hot food arriving three times per day. Deliveries are determined by what is ordered, so there is a product mix issue. But there is also the emergence of different strategies of delivery out from the store, so the end point may no longer be just the store. The network has to adapt for both inbound delivery and outbound delivery from the store to a customer location.

Caitlin Rayman said that there had been discussions during the symposium about engaging with the private sector for data and planning. She asked Chumley how researchers could work with 7-Eleven to improve collaboration and data sharing.

Chumley replied that the best course was to contact the Vice President of Logistics for 7-Eleven. He said that in the United States, most deliveries to the stores are made at night. Trucks leave the CDC at 6 p.m., deliver to the store at 3 a.m., and are back at the CDC by 6 a.m. The DSDs come around 4:30 p.m. 7-Eleven wants trucks off its lots during peak hours to make room for customers.

Lance Grenzeback asked if 7-Eleven used urban congestion data to make changes to its routing decisions.

Chumley replied that when he worked at Coca-Cola, daily dynamic routing was done based on traffic and construction updates. The company knew from cases and aggregate delivery time on the truck that a route was, say, 8 hours and 22 minutes. If a driver was in 5% to 10% of that time, the route time was validated. So companies can and do use congestion data. 7-Eleven has static routing (trucks deliver to stores in the same order), so traffic and congestion merely increase the delivery time because the routes are static. But the company could influence route times if it looked at individual routes.

Lenz said that small shops cannot afford nighttime delivery because of the staffing required to receive it, and there are no lockers. She asked how 7-Eleven manages it.

Chumley answered that 7-Eleven stores are open 24 hours a day, so there is always someone there to take delivery. Because the routes are static, a store knows that a truck will be there between, say, 3:00 and 3:30 a.m.

Chumley added that 80% of 7-Eleven's stores in the United States are not in urban areas, so noise-level issues are not a concern now but may be in the future.

Synthesis and Summary

Laetitia Dablanc

Summarizing the Demand Patterns and Trends session, Laetitia Dablanc said that researchers may have more freight demand data than they think they have. Data collection has been done in many cities, as Routhier and Jaller described, and individual companies know about their customers' demand and the evolution of that demand, as Chumley discussed. Large parcel and express companies have a global view of hundreds of thousands of operations an hour.

But the information is partial, dispersed, and local. Barcelona and Madrid collected local data, but the data were not shared, even between those two cities. It is surprising, but data are not being collected even within a single region, Dablanc said. Also, the data are often collected for a different purpose, as Browne and Goodchild mentioned in the first session.

Another comment during the question-and-answer session that followed Jaller's presentation was that including the supply chain in engineers' models is difficult. Browne and Goodchild also made this point, Dablanc noted. As Jaller said, there is a need to overcome the "partial" view of the urban freight system. Researchers have to assemble what exists and also create data from scratch by using primary data sources.

As the French UFSs have demonstrated, comprehensive surveys that include all urban supply chains can be done. One way to do them is as two coordinated surveys: one surveying the generators of demand and the other surveying delivery operators. Such surveys are costly, as both Routhier and Jaller stated. Jaller estimated that the ideal UFS for New York City would cost $7 million. However, comprehensive surveys can lead to better modeling.

Jaller's presentation showed that there are many dimensions to urban freight generation analysis. Freight demand can be both an economic manifestation (freight generation) and a logistics one (freight trip generation). Researchers need to be aware of data gaps, and they need to understand behaviors, not just collect traditional data. Few specifically urban case studies exist, and there is a trade-off between the need for comprehensive surveys to resolve modeling issues and the cost of those comprehensive surveys.

A noteworthy point Routhier made was that in Paris, cafés, hotels, and restaurants generate five times more deliveries than big box retailers. That finding shows that freight demand is not just the product of big players, but also of these small generators of freight, such as local stores and offices.

To understand urban demand patterns, researchers need to understand retailers' internal decision-making processes as they respond to changes in consumer behavior and adapt their transportation and logistics in response to the trends they see. Urban consumers do not want to pay for deliveries, so retailers have to be smart and efficient in delivering goods at low prices. Urban environments require new small store formats in densely populated areas, so retailers' transportation and logistics must adapt to this new situation.

Another conclusion Dablanc drew from the presentations so far is that in both Europe and the United States, very few private software developers and consultants (such as PTV) are developing urban freight modeling. City authorities are not requesting these models because, in general, urban freight transportation "works" in that we all get our goods. However, the externalities of congestion and pollution are motivators for learning more about freight demand.

Dablanc ended with focusing on some of the speakers' suggested topics for collaborative research. First, she identified the topic of innovative data collection methodologies and technologies, such as GPS; the use of existing records, like those of departments of motor vehicles in the United States or light transport registers in the EU; and a better CFS for urban areas. Second, she suggested comparing establishment databases between Europe and the United States. Third, she suggested comparing urban freight behaviors between Europe and the United States. This last topic had three subparts:

1. Assessing the operational applicability of EU models (like FRETURB) in the United States, and vice versa;
2. Examining the changing urban economy in the face of e-commerce (the future for stores, new delivery business models); and
3. Examining the changing urban economy in the face of increasing urbanization.

Schemes and Technologies for Enhancing Urban Distribution

Marcel Huschebeck, *PTV AG, Karlsruhe, Germany*
Cathy Macharis, *Free University of Brussels, Brussels, Belgium*
Martin Ruesch, *Rapp Trans AG, Zürich, Switzerland*
Jack Levis, *United Parcel Service of America, Inc. (UPS), Baltimore, Maryland, USA*
Chris Kozak, *Wal-Mart Stores, Inc., Fayetteville, Arkansas, USA*

Introduction

Marcel Huschebeck

Marcel Huschebeck began by saying that after hearing about the demand side in the previous session (Demand Patterns and Trends), this session would focus on the supply side and would offer perspectives from both Europe and the United States.

When talking about urban supply, the "last mile" is considered to be the most costly. Everyone wants a good transportation system, but what is "good"? Transport must guarantee that citizens and enterprises get the goods they need. Transport is a very important function, comparable to water and energy supply, he said.

There are two dimensions to urban distribution: getting goods into the city and operating within the city. In getting to the city, companies must get goods to consumers while coping with urban congestion, emissions regulations, and routing decisions and restrictions. Operating within the city, companies must deal with speed and weight limits, parking, and loading zones, all of which make urban deliveries a very frustrating experience.

Huschebeck described several innovations in urban supply. In addition to off-hour delivery and accurate transportation planning systems, innovations include cooperation schemes that share capacity and vehicles, as well as adapted vehicle technology and driver assistance (vehicle propulsion, emissions, noise). Another set of innovations includes cooperative systems: vehicle-to-vehicle communication and vehicle-to-infrastructure communication.

Case Studies of Innovation

Cathy Macharis

Cathy Macharis presented four cases of innovation in city logistics using a "4 A's" framework for sustainable city logistics: awareness, avoidance, act and shift, and anticipation. Sustainable city logistics means balancing environmental and societal needs along with economic ones.

The first A, awareness, refers to making all actors aware of the social return of sustainable practices that lead to improved health, safety, air quality, and so forth. Actors calculate economic returns, but they do not know the social returns in monetary terms. Knowing the social returns can help actors cooperate and equitably share costs and benefits among companies and government.

To calculate the social return first means calculating the costs of externalities like poor air quality, noise, and poor health. Such calculations require good data on factors such as emissions, routes driven, and population.

Macharis described this calculation for the Port of Brussels, the purpose of which was to arrive at the social return of the port and what it would cost if the port were not there. The calculations showed that thanks to the port, there were 688,000 fewer trucks and €27.5 million less of external costs.

Another way to build awareness is through voluntary programs and certifications like the Lean and Green program in the Netherlands, which is also now in Belgium, and SmartWay in the United States. Companies participate in these programs by promising, in the case of Lean and Green, to reduce their CO_2 emissions by 20% in the next 5 years. Companies who achieve these reductions get certified and can display those certifications in communications to their customers. This sets an example for other companies and creates awareness.

The second A, avoidance, refers to avoiding unneeded traffic. Innovations in avoidance focus on avoiding empty miles driven and improving the capacity utilization of existing trucks. Straightsol, a 3-year EU-funded urban freight research effort, studied Oxfam, a British charity that recycles textiles and books. In this example, Oxfam collection bins were equipped with sensors that indicated the level of donations in the bin. The sensors allowed remote monitoring of the bins and eliminated the routing of trucks to bins that were still empty.

Another way to reduce traffic is by bundling via consolidation at city distribution centers. The DHL pilot test within Straightsol in Barcelona attempted to create an urban distribution center that would receive full truckloads directly in the city and from there use smaller vans to distribute the freight within the city. The demonstration was difficult, and in the end DHL opted for an easier scenario and continued using a distribution center outside the city and deploying small trucks from there to enter the city. A different demonstration within Straightsol, that of TNT in Brussels, showed interesting results. In this example, TNT created a mobile depot (essentially the trailer of an articulated truck) within the city. Previously, an average of 5.5 vans entered the city center daily. Now, one full truck enters the city and acts as a mobile depot from which deliveries are made by electric bikes.

The third A, act and shift, recommends shifting to more environmentally friendly modes such as barge and electric vehicles. Although this concept is not transferable to all cities, as noted in Giuliano and Dablanc's white paper, all large cities in Europe were constructed around rivers. Thus, barge transport can be used for city distribution. Amsterdam, Utrecht, and Paris all use barges as part of their distribution network. Utrecht has the "beer boat," and in Paris containers arrive via river to the center of Paris from where freight is distributed to small establishments. In Flanders, Belgium, some successes have been realized in the shipping of palletized freight on the inland waterways. Barges could carry anything from building materials to fast-moving consumer goods. Cargo trams are another example of a shift in mode. In Dresden, cars from the Volkswagen factory enter the city via tram rather than big truck. Cargo trams work in specific situations like this, but they may be harder to implement for distributed flows. Finally, off-hour deliveries are another solution demonstrated by Straightsol. Five supermarkets in Brussels will receive nighttime deliveries from PIEK-certified trucks that are less noisy than traditional delivery trucks.

The fourth A, anticipation, refers to using new technologies, such as natural gas–powered vehicles or electric vehicles, for more sustainable city logistics. DHL uses vans powered by natural gas, and numerous manufacturers (e.g., Alke, Goupil, Iveco, Renault Z.E.) are building small electric vehicles. New electric offerings are coming from well-known manufacturers such as Peugeot, Mercedes-Benz, Volkswagen, and Nissan. Companies like FedEx use these smaller vehicles, but the larger electric vehicles still have a very high battery cost, which at present makes them uncompetitive with diesel trucks.

Having discussed successful urban distribution innovations, Macharis next looked at why some implementations fail. The commonality was a lack of coordination between numerous actors involved in an implementation: shippers, receivers, logistics providers, authorities, and citizens. Each actor has his or her own objectives. For example, citizens do not want the noise of nighttime deliveries. Straightsol developed a framework for city distribution concepts. In addition to the traditional social cost–benefit analysis and business models, a method called multiactor, multicriteria analysis (MAMCA) takes each actor's objectives into account and weighs the importance of those objectives. With MAMCA, it is possible to see who is likely to support or oppose a given scheme.

Macharis concluded by saying that sustainable city distribution is possible through awareness, avoidance, act and shifting, and anticipation as long as the fifth A—actor involvement—is taken into account in the multiactor setting of a city.

Questions and Answers with Cathy Macharis

A participant had an immediate question for Macharis, asking about the situation in which a city wanted to do something that would affect many shippers and carriers. The shippers might care if competitors were doing it. Does the framework take competitor response or bargaining power into account?

Macharis answered that yes, the Straightsol framework identifies who the main actors are and might be refined to specific logistics service providers. The framework specifies the criteria of all actors, so the actors are asked what criteria they consider important and to attach weights to each criterion. Straightsol gives cities the framework so they do not have to reinvent it.

René de Koster commented that doing MAMCA at the project level must be difficult if one has many projects.

Macharis answered that each analysis looks at the current situation, the demonstration situation, and the future situation, because the demonstrations are one step in a global evolution. TNT is currently looking at three communities in Brussels, but the future situation would include all of Brussels and Paris, so Straightsol is comparing those three main scenarios (current, demonstration, and future).

Impact Evaluation

Martin Ruesch

Martin Ruesch provided an overview of BESTFACT, an ongoing European research project that deals with best practice and impact evaluation in freight logistics and freight transport, especially in urban areas. The BESTFACT project evaluates best practices developed over the last 10 years.

European cities face numerous challenges involving urban freight, including freight intensity, conflicts with other road users, and the high costs of the last mile. With the goal of achieving CO_2-free city logistics in major urban centers by 2030, the objective of the BESTFACT project is to develop, disseminate, and enhance the use of best practices and innovations in freight transport that contribute to meeting European transport policy objectives. The focus is on competitiveness and environmental impact.

The BESTFACT project provides a knowledge base and recommendations for policy tools for facilitating best practices. It also supports implementation strategies by market sectors in cooperation with private actors, trade associations, regional bodies, and technology platforms. The €3.4 million project is funded primarily by the European Commission (80%) and is in the first year of its 4-year duration. Of the 18 partners in the project, six attended this symposium.

Methods for Evaluating Best Practices and Their Impacts

Ruesch next presented a method for best practice and impact evaluation. For impact evaluation, it is important to know the strategic targets of public-sector and private-sector actors so that practices are assessed with those targets in mind. BESTFACT conducted an online survey of actors to learn how they rank different outcomes. Public-sector actors ranked environmental and social targets the highest (e.g., safety, reduced emissions), while private-sector actors ranked economy (increased efficiency and productivity of logistics process, increased company profitability) and services targets (increased quality) the highest. Private-sector actors ranked environmental targets lower than public-sector actors did.

The online survey also asked respondents to rank their top challenges so that BESTFACT could focus on the best practices related to the top-priority areas. Ruesch showed a slide (see Figure 1, page 21) of the 14 top challenges listed in five categories: infrastructure and technology; organization and cooperation; operations and services; regulations and policy; and knowledge, tools and methods. For example, some of the top challenges were access to transport networks, business-to-customer solutions like last-mile delivery, and modeling and forecasting.

Ruesch provided a definition of "best practice" as used by BESTFACT. A practice is considered a "best practice" if it has the following four attributes:

- It is an innovative and feasible approach that is beyond common practice;
- It addresses both business and policy objectives;
- It has considerable and measurable positive effects on business and policy targets; and
- It is transferable to other companies, initiatives, or contexts.

Next, Ruesch described the two-phase process of best practice identification and evaluation. The first phase included selecting cases based on minimum requirements and a preassessment using a multicriteria analysis. The second phase included in-depth surveys on the most promising potential best practice cases based on the fulfillment of strategic targets, expected effectiveness, and feasibility. The online survey results provided an important input to the whole process, identifying the key topics for case selection and strategic targets for assessment. In addition, in the second phase, a more detailed analysis of the cases was performed that assessed the fulfillment of strategic public and private targets. Expert opinion on the effectiveness and feasibility of the potential best practice cases was also used.

Within the first year, 92 urban freight projects were identified, and 15 were selected as "best" based on the criteria listed above. Reusch went on to describe four of the best practice examples in depth.

Examples of Four Best Practices

The first best practice example focused on loading–unloading zones and lanes. Several European cities implemented loading–unloading zones, partly in combination with parking and partly with time restrictions for the loading and unloading process. Another option to improving street space management is to use street lanes during off-peak hours for loading and unloading. The use

Field	Infrastructure and Technology	Organisation and Cooperation	Operations and Services	Regulations and Policy	Knowledge, Tools, and Methods
Topics	Access to transport networks, infrastructure and nodes ★	Business to business (B2B) solutions, cooperation	Business to customer (B2C) solutions (e.g., e-commerce, last-mile delivery) ★	Access rules and restrictions of urban areas ★	Modelling and forecasting ★
	Freight consolidation and transhipment ★	Competitive aspects: collaboration (cooperation with competitors), prioritisation (priorities on infrastructure and in nodes) ★	Innovative operational solutions	Land use and spatial planning: assessment and siting of transport facilities and infrastructure ★	Data collection and statistics ★
	Implementation of low emission technologies ★	Communication between authorities: cooperation, procedures, legal frameworks ★	Value added services, development (or extension) of services	Infrastructure financing: taxation, user charges, PPP ★	Education and training
	IT-technologies and solutions (for management and administration)	Communication between businesses and authorities: coordination, consultation ★	Service quality and sustainability agreements / certification	Environmental standards and policy	Working and implementation guidelines
	Innovative vehicles, vessels and equipment	Business models: new form of ownership, risk management	Transport management, fleet management ★	Interoperability and standardisation: vehicles, equipment, loading units, infrastructure	Monitoring and benchmarking of processes ★
	ICT (e.g. routing, guidance), transport optimisation			Safety and security: measures, regulations, insurance	

© BESTFACT

FIGURE 1 BESTFACT online survey results revealed 14 top challenges (starred entries) in five categories. (ICT = information and communication technology; PPP = public–private partnership.)

of the loading zone and loading lane has to be indicated, either in a static way or dynamically by using variable message signs. Such solutions, which have been implemented in Munich, Barcelona, Bilbao, and Ghent, have achieved positive impacts in improving freight access to city centers, making better use of the existing infrastructure, reducing loading–unloading times, and reducing conflicts with pedestrians and other road users. Overall, this best practice showed a good benefit–cost ratio and has good transferability to cities that have streets with more than one lane in each direction. To implement this practice successfully, cities must provide proper signage of the zones and enforcement of the regulations.

The second best practice example was of an urban microconsolidation center and use of electric vans and tricycles in London. This practice was motivated by the need to reduce the environmental impact of diesel vans. The solution established a new urban consolidation center close to the Tower of London. The consolidation center is served by trucks from a suburban depot and is used as a transfer point for parcels to electric vans and tricycles, so that the last mile is delivered by environmentally friendly vehicles. The microconsolidation center and end delivery is provided by a third party. The solution was implemented about 3 years ago, and the results show a 54% reduction of CO_2 emissions and profitability after 3 months of operation. A 20% reduction of mileage was also observed, primarily outside the city. Within the city, mileage increased but was handled by environmentally friendly vehicles. Overall, this approach is very promising, Ruesch said, and there are comparable approaches in French, Spanish, and German cities. Important success factors are acceptance of these vehicles for road use, a high density of delivery points, and support by authorities and retailers.

The third best practice example was about delivery management for a big trade fair in Basel, Switzerland. Basel is surrounded by residential areas, and some bigger fairs were expected to induce up to 8,000 trips before and after the fair. Given the high freight volume and limited space, as well as environmental concerns, the trade fair operator decided to implement a demand management system for the deliveries. Exhibitors, stand builders, and other suppliers had to register online in advance for all deliveries and pickups related to the fair. The demand management was supported by a logistics tool that let transport companies book time slots for access and loading–unloading. The system was implemented in 2012; results have not yet been quantified, but a better use of existing loading and unloading facilities and a more efficient loading and unloading were observed. The approach showed very positive impact at limited cost and seems transferable to other freight transport–intensive facilities like terminals and distribution centers. Important success factors were the communication and cooperation between the trade fair operator, the logistics companies, and the city authorities.

The final best practice Ruesch described was also shared by Macharis, namely the zero-emission "beer boat" in Utrecht. An electric boat using green energy was used for the delivery from four breweries and one wholesaler to 65 clients along the canals of Utrecht in the Netherlands. The implementation took place in 2009, although a nonelectric beer boat had already been in use since the 1990s. Results showed a reduction of CO_2, particulate matter with a diameter ≤10 micrometers (PM10), and nitrogen oxides (NOx), as well as a reduction in road freight transport in the city center and operational cost savings. The solution seems to be transferable to cities with canals or rivers, and there are plans to implement it in other cities, Ruesch said.

Conclusions

Ruesch noted several conclusions. First, regarding methodology, it is clear that a comprehensive and standardized approach of best practice identification and impact assessment is needed. It is important to carry out monitoring and evaluation of the cases to provide support for future decision making. Ruesch noted that in the first year there was a dominance of consolidation and clean-vehicle projects, but modal shift is also an option. Few large-scale transfers exist so far, although some solutions have been transferred to another city or company. Overall, the best practices examined show high to very high benefits, but quantification of the impact is not always available, which hampers dissemination and uptake by others.

More schemes and technologies will be analyzed in 2013 through 2015; additional information can be found at www.bestfact.net.

Recommendations for Research

Ruesch's recommendations for research in urban freight encompassed methods as well as urban freight–specific topics. In terms of methods, data collection, and instruments, Ruesch suggested innovative urban freight data collection (e.g., GPS tracking, handheld devices, Internet, enquiries, and use of company data). Urban freight topics for research include the following:

- Changes in logistics strategies and requirements for transport infrastructure and land use planning;
- The impact of increasing e-commerce on transport systems, society, the environment, and economy (freight and passenger transport);
- Functions and design of different types of nodes in urban areas (e.g., urban consolidation centers, terminals); and
- Management of urban freight transport (including the use of information and communication technology [ICT] in urban freight and integration of short- and long-distance freight).

Questions and Answers with Martin Ruesch

Alberto Preti shared some data from Italy that he thought were similar to the European scale in general. He said the pressure on urban areas from freight transport can be measured in terms of percentage. About 55% of the tonnage has an origin–destination within 50 kilometers, at least in Italy, which puts a huge pressure on local and metro contexts. Of this 55%, approximately 50% concerns own-account transport, which means shopkeepers, small retailers, and crafts. He suggested that future research and experimentation in the field of city logistics be focused on the topic of logistics outsourcing. In many instances, the case for outsourcing is clear: certainly it is evident for parcels. There is a win–win situation between the public and the private sector because the higher load factors mean fewer pollutants from the vehicles and more gains for the companies. Small shopkeepers and retailers probably do not have a clue about the cost of their logistics activities, therefore they do not have a clue about the environmental footprint of their activities, he said. Preti suggested that the idea of promoting logistics outsourcing as a public policy, perhaps with incentives or even direct actions on these generators of freight traffic, may be a topic of future research.

Ruesch agreed that lack of outsourcing was a problem. A survey in Switzerland showed that only 10% of the vans are used by logistics service providers, and the rest were used by shippers to transport their own accounts and also by service-related transport. He agreed that outsourcing would improve the situation, but there were also other solutions, such as electric vehicles.

Macharis commented that an urban consolidation center can be very helpful, and that this concept should target shopkeepers. There is the example of Citydepot in Belgium and Binnenstadservice in the Netherlands. To make these solutions work requires targeting the shopkeepers, who have to tell their suppliers to deliver to the city depot rather than to the individual establishment. These are solutions that are oriented toward stakeholders. The point is to look at the stakeholders within the city distribution and figure out how to make it a win-win for everyone, as Citydepot and Binnenstadservice did.

Anne V. Goodchild asked how the microconsolidation center was implemented in London. She could see how it reduces CO_2 or vehicle kilometers traveled, but is it a requirement that a business near the Tower of London use it? Are they incentivized to use the services? Incentivization is an important point for transferability to an American city.

Ruesch replied that it was a service for retailers in the city.

Goodchild asked whether the retailer gets to choose who provides their goods to them.

Michael Browne, who undertook research on the microconsolidation center, explained that it was designed to serve the office sector in London's financial center. It reduced vehicle kilometers in London as a whole because of a change in the system. But in the city itself, because the vehicles are smaller, the number of kilometers driven has risen slightly. The program started with just one company, Office Depot, which was already working with many offices. Office Depot probably has 25% to 30% of the office supply market in the center of London. Office Depot decided at the corporate level to do something different, and it focused on the last mile of the supply chain. This niche solution worked well because Office Depot gained publicity benefits (its name is on the vehicles), and the solution does not cost them additional money.

Michel Savy said that while outsourcing is a way to get efficiency, shippers who ship their own loads can also be efficient. He cautioned against assuming that all shippers were inefficient compared with outsourcing. He cited France's Shippers Inquiry, which was a survey sent to shippers rather than carriers. The survey asked about the logistics organization of the shipper, which traditional surveys had not done.

Ruesch agreed that big shippers could be very efficient, too.

Edgar Blanco asked about the depth of the business cases, not just from the financial standpoint but whether the cases included a robust description of the layout of the city, the density of the city, and so forth, so that a city manager could look at the case and say, "This looks like my city."

Ruesch replied that yes, BESTFACTS always describes the framework conditions of the city, such as its density and conditions. Those conditions are very relevant for a case's transferability, he said, so that city managers can assess whether a solution is a potential solution for their city.

Blanco asked whether BESTFACTS was being used in planning.

Ruesch replied that they were not developing planning concepts in this project, but they did look at the constraints from the land use side.

Implementation Aspects: UPS's Road to Optimization

Jack Levis

Jack Levis described how UPS has optimized its route planning for efficiency and reduced the company's overall environmental impact. The road to optimization begins with collecting data to analyze existing routes, volumes, and service commitments and forecast future patterns for its drivers. UPS uses robust tools to make a plan from that forecast, optimize the plan, simplify the plan so that it can be executed, and then monitor it in real time and make any adjustments. Historical analysis tools validate and inform future plans.

From Descriptive Analytics to Predictive Analytics

Levis cited research by Gartner, which found that 70% of companies use descriptive analytics (what happened?) and 30% use diagnostic analytics (why did it happen?), but only 16% use predictive analytics (what will happen?) and 3% use prescriptive analytics (what should we do?). Fewer companies move beyond descriptive data because it means using increasingly unstructured data and greater volumes of data.

Levis described how UPS was implementing these increasingly difficult analytics applications. He began by explaining UPS's handheld tool for drivers, the delivery information acquisition device (DIAD). The first DIAD was introduced in 1991 and has gone through four evolutions. The DIAD continues to be improved and is now more of an information assistant for drivers, and not just a data acquisition device. Currently, 85,000 DIADs are being used by drivers.

In the descriptive analytics phase, UPS merges data from numerous sources, including DIADs and vehicles, and analyzes the data to get a picture of the current situation (see Figure 2, page 24). For example, the analysis can show when an engine is idling, or when the driver's seat belt is not fastened when the vehicle is in motion. This analysis, which used to take 1 day, can now be completed in 45 minutes, resulting in faster improvements to reduce idling and improve seat belt usage.

Because descriptive analytics only provide historical views, UPS needed to take the next step and move to predictive analytics (see Figure 3, page 24). The company built planning tools to forecast when a package will arrive at a destination. If one truck looks as if it will have too many stops, the route is rebalanced. Levis made the analogy that UPS currently plans with a scalpel, but in the future, it will plan with a laser.

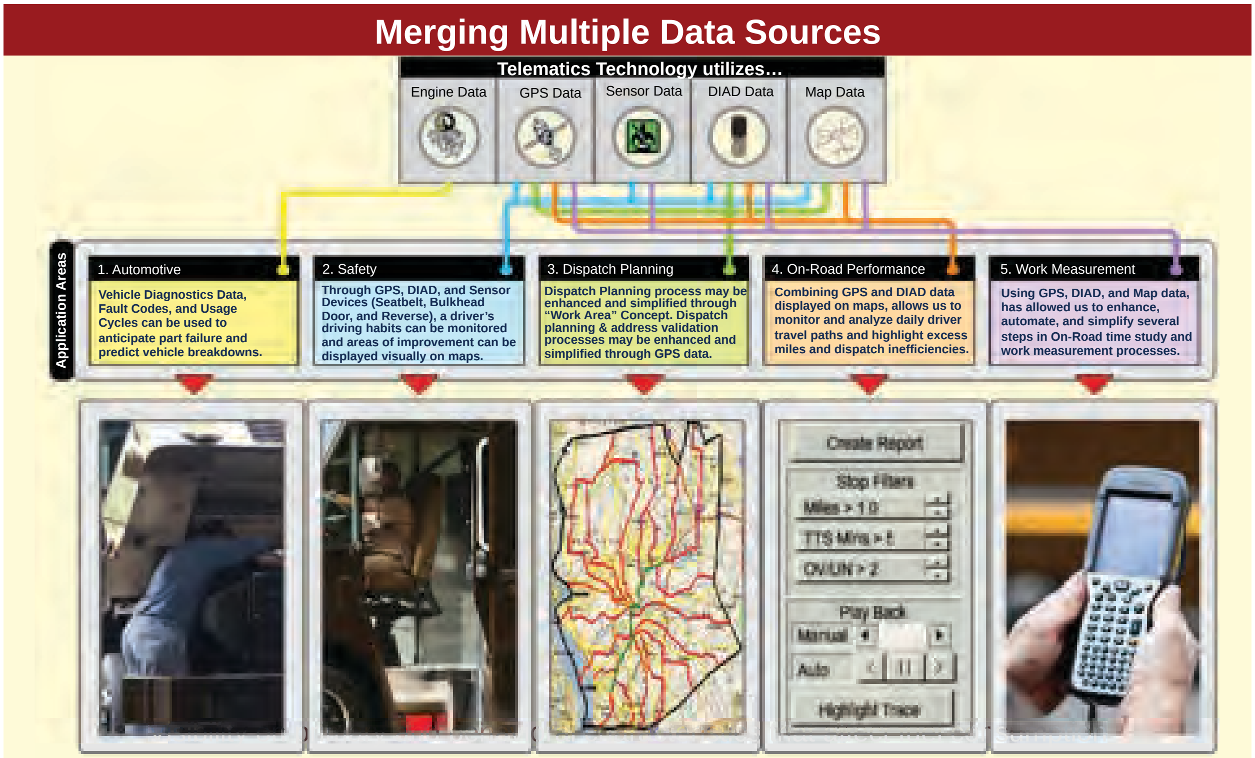

FIGURE 2 UPS analyses merged data from numerous sources in its descriptive analytics phase to obtain a comprehensive overview of factors such as safety and road performance.

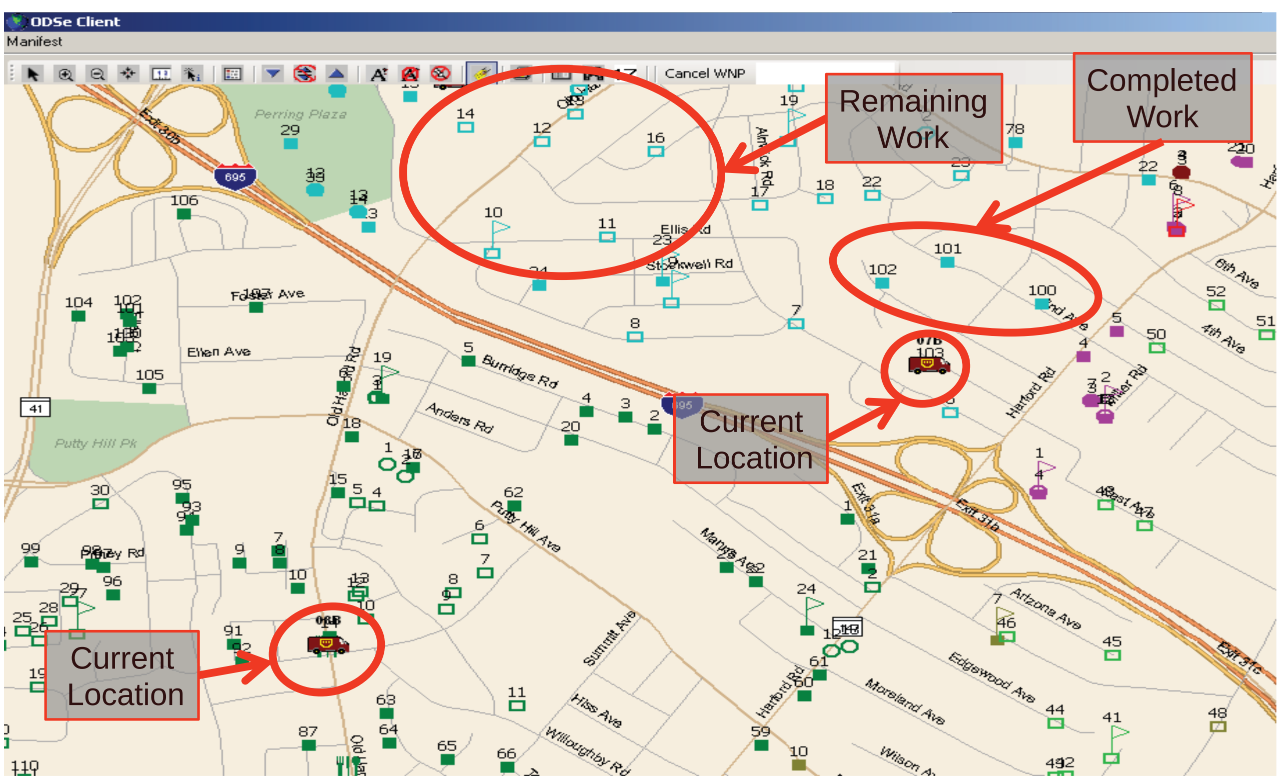

FIGURE 3 Predictive analytics tools developed by UPS forecast when a package will arrive, so that routes can be rebalanced as needed.

DIADs simplify drivers' jobs by providing daily package delivery plans with addresses, delivery orders, and time commitments. The DIAD alerts the driver if a signature is required, as well as specific customer instructions for package placement. DIADs are also equipped with GPS, a decision made several years ago, before GPS navigation systems were prevalent. The GPS feature will sound an alert if a driver is at the wrong delivery location. At any point in time, UPS knows where any package is in the UPS system, how many packages have been delivered at any point in the day, and how many need to be delivered. If an on-demand customer call is received, UPS can quickly react and accommodate the customer by communicating with a driver who is closest to that customer.

UPS Route Optimization

Results from UPS optimization efforts have been dramatic. The company has reduced its truck travel by 85 million miles annually, resulting in a savings of more than 8 million gallons of fuel and an 85,000-metric-ton reduction in CO_2 emissions. At the same time, UPS has achieved the highest levels of service in its history and has reduced training time by 95%. Faster training time lets UPS provide consistent service during peak times. Safety has also improved, with 99.9% seat belt usage.

Driver acceptance of route optimization efforts came as drivers experienced improved route times with a reduction of miles driven per day. Driver performance metrics are aligned with such savings, encouraging efficiencies. Even 1 mile saved per driver per day amounts to approximately $50 million a year of savings, Levis said.

In the future, prescriptive analytics will make possible more personalized services, with delivery alerts, delivery planners, and the ability to reschedule delivery time or delivery location. Called "My Choice," these services will include a confirmed 2-hour delivery window to the home.

Levis ended with a list of challenges, including having standardized, accurate data and avoiding increasing miles to redeliver packages when a customer is not available.

Implementation Aspects: Wal-Mart's Urban Small-Format Strategies

Chris Kozak

Chris Kozak began with some key statistics about Wal-Mart that indicate its size and global presence. The company operates 3,146 Supercenters, 561 stores, and 620 Sam's Clubs. In addition, it has 256 smaller-format Neighborhood Markets and 12 Express Stores, its smallest-format store, which are currently being tested. Overall, Wal-Mart has more than 6,025 stores in 27 countries and 2.2 million employees (called associates) worldwide. Mexico has the most smaller-format Wal-Mart stores.

Within the United States, Wal-Mart has 172 distribution centers, which provide 99.55% on-time delivery to 75 to 100 stores within a 250-mile radius. These distribution centers result in vastly fewer miles driven than previously. Nonetheless, Wal-Mart is aware that its tractors, which drive 700 million miles per year, have an environmental impact. The company implemented a sustainability program in 2005 with a goal of improving efficiency by 100% by 2015. As of 2013, the company achieved an 80% increase in fleet efficiency and was named a superior environmental performer by the U.S. Environmental Protection Agency in 2012. Route optimization plays a role in this efficiency by telling drivers where to go and where to turn. The company operates 12 unique logistics networks and outsources 425 million miles to third parties, such as Schneider National, Inc.

How Wal-Mart Measures Efficiency

Wal-Mart defines fleet efficiency in terms of the ratio of cases shipped to gallons of fuel burned. Productivity initiatives (number of cases per trailer, routing improvements, reducing empty miles and packaging) have improved efficiency over the past 5 years. For FY 2008 to FY 2013, Wal-Mart shipped 614 million more cases but drove 300 million fewer miles (a 47% increase in cartons shipped per mile). These improvements saved 50 million gallons of fuel, the equivalent of taking 85,000 cars off the road.

Wal-Mart's Smaller-Format Urban Stores

Wal-Mart recently began experimenting with smaller-format stores in urban areas. Its plans for Chicago called for opening six urban stores between 2011 and 2013: four Neighborhood Markets and two Express Stores. Wal-Mart estimated 10 to 15 deliveries a week to each of these stores and knew that time restrictions and ordinances might apply. None of these small-format locations have access for the 53-foot trailers Wal-Mart typically uses, so Wal-Mart explored three options for delivering to these stores. The first option was to deliver from its grocery distribution centers and regional distribution centers by using 28-foot straight trucks, which would travel an average distance of 105 to 115 miles, depending on the distribution center. The second option was to deliver from each of these distribution centers via 53-foot trailers to a metro cross dock located 95 to 100 miles from each distribution center, and then delivering via a 28-foot truck to each store. The final option was to combine routes, delivering from the grocery distribution center to the regional distribution center and then to the metro cross dock.

Kozak next described Wal-Mart's experience with locating a store at the base of the Presidential Towers in Chicago, home to 20,000 people but with practically no parking. In contrast to its superstores, which sell 20-pound bags of dog food, this Neighborhood Market sells fresh, ready-to-eat foods and the ethnic foods that its urban customers want. One of the challenges Wal-Mart faced at this location was a curb with two parking spaces. Wal-Mart wanted the curb removed so that it could use larger trucks to deliver to the store, but locals did not want to lose those two parking spots. Ultimately, Wal-Mart prevailed, but if it had not, deliveries would have cost the company an extra $600,000 a year due to more frequent deliveries via a smaller truck.

At its Lakeview store, Wal-Mart faced noise ordinance issues when wanting to deliver at 3 a.m. rather than during the busy daytime hours. Wal-Mart needs quiet trucks, but the trucks emit a "beep" warning when they back up, which they have to do to back into the building's delivery area. In other urban locations, Wal-Mart faces the issue of having to deliver in an alley that has fire escapes that limit the height of the truck. The limited storage space of urban stores also means that there is no room for pallets, so Wal-Mart has to use small carts instead.

Another new concept that Wal-Mart is testing is called "tethering." The goal is to "tether" a small store supply chain to a larger store. That is, large trucks from regional distribution centers and grocery distribution centers deliver to a Supercenter that is within 15 miles of the small store. Because the cost to serve stores via small trucks is very high, tethering saves money. Tethering leverages the Superstore for order fulfillment, shortens lead time, and increases the assortment available to small stores.

Wal-Mart also offers a multichannel option, in which customers can order online from Walmart.com and have their item delivered to a local store. The smaller urban stores outperform Supercenters for online delivery.

Kozak concluded with some challenges to consider for urban small-format stores, such as the use of truck-only corridors to decrease transit times and how to mix different products on the same trailer. Other issues are the frequency of deliveries to small stores, which is related to receiving deliveries from the company and direct store delivery from vendors. There could be opportunities for consolidated urban delivery. City ordinances pose another challenge and place restrictions on delivery providers. Locals want the store there but then fine drivers when they deliver to the store, Kozak said.

Session Questions and Answers

Tom Cherrett asked about alternative delivery points for UPS and whether UPS could deliver to a person, not a zip code. For example, could an individual intercept UPS at a point of the individual's choosing to, say, pick up a package on the drive home from work?

Jack Levis answered that such a service had been discussed at UPS but was not a priority. Europe would need this service more than the United States, and in the United States it would be more needed in cities than suburban areas. UPS can see where individual drivers are, but an interception would not be easy to do.

Caitlin Rayman commented that if fleets were changing to straight (single rigid frame) trucks, she would like to hear examples of that, as well as examples of the effects of intermodal shifting. She also asked about optimization: were companies using their own private fleet data to identify congestion times, or were they using someone else's data? She commented on the large amount of data that private fleets have on urban situations that the Federal Highway Administration (FHWA) does not have but that would be helpful for planning. She asked if it would be possible to improve data sharing, or if there was incentive for companies to share some level of data (omitting confidential data, of course) to enable metropolitan planning organizations (MPOs) and other planners to use such data.

David Logsdon said that Waste Management was using its own data for optimization and was also calibrating drivers' driving times and their average customer time to create a baseline to evaluate whether the tools are grounded in reality. He commented that the idea of sharing data was interesting, but data are proprietary, so there would have to be some incentive to make sharing worthwhile.

Levis said that UPS uses its own data and shares data with others, except for data on its customers or cost to serve. UPS is willing to share its data and does that with universities. Of course, UPS has spent 15 years collecting the data, he said, and if everyone gets it identically, UPS would lose its competitive advantage, which makes sharing a more difficult proposition.

Kozak said that Wal-Mart uses open source data from the American Transport Research Institute (ATRI).

Rayman also asked if the companies were using real-time information about weather events or traffic congestion to make real-time change to their routes.

Kozak replied that Wal-Mart has satellite communication with trucks and is close to using weather data and traffic data to update routes in the cab.

Levis added that at present UPS does not react to weather problems or traffic congestion in real time. It would be helpful to know the traffic flow, but UPS would need to know that flow hours beforehand in order to create the route plan. It is not possible to know exact traffic congestion in the future. Navigation systems in cars that try to reroute drivers in response to heavy traffic often result in other delays, because those alternate routes get congested by the time the driver reaches them. The driver ends up driving longer routes with no time savings because traffic is everywhere. Levis added that UPS talks with each driver at three different times during the day.

José Holguín-Veras asked the presenters to imagine that they could do anything to improve efficiencies. What would they do?

Levis joked that it would be great to be able to ask a customer to take a later delivery than they wanted in order to improve the overall greater good.

Open Forum on Cross-Cutting Issues

Alan C. McKinnon, *Kühne Logistics University, Hamburg, Germany*

Introduction

Alan C. McKinnon

Moderator **Alan C. McKinnon** of Kühne Logistics University began the open forum by reiterating that the symposium goal was to promote collaborative research between the United States and the EU on city logistics. He recounted that when he was asked to join the symposium planning committee, he looked at several hundred papers on city logistics to see how many were coauthored by a researcher from the United States and a researcher from the EU. He said few such coauthored papers existed, which presented an opportunity to begin such collaboration now. He posed the question, "How can we catalyze better research interaction?"

He also mentioned another topic based on the presentations heard thus far in the symposium: "Where do you draw the boundary around city logistics?" He noted that as yet there is no clear definition on city logistics, particularly on the interface of the movement of freight and the movement of people. In addition, online retailing is replacing cars with vans on the last mile, making freight movements that were previously latent in passenger vehicles more statistically visible.

A second interface is that of intraurban and interurban freight, and a third interface is the disciplinary interface between engineers, economists, and planners. McKinnon mentioned that some disciplines are not well represented in urban logistics, the discipline of behavioral science in particular. Behavioral science would provide insights into better understanding the decision-making process. He suggested that enlarging the number of disciplines involved in the field, to gain insights from these perspectives, may be of benefit.

A final theme that struck McKinnon from the first day of the symposium was the issue of data sharing raised by Caitlin Rayman of the Federal Highway Administration (FHWA), namely, the extent to which companies would be willing to share their data with researchers. Related to that question, he asked how much interest companies take in the fruits of academic research. For example, the academic community has generated many vehicle routing research papers, McKinnon noted, but is there much uptake? Is the lack of uptake due to academics not communicating about the papers, or companies not taking an interest?

Open Forum Discussion

Chris Kozak of Wal-Mart said that some areas of data and proprietary items are certainly sensitive, but he gave an example of how Wal-Mart has shared data with MIT, which has resulted in significant benefits. Wal-Mart calls this the "MIT model"; it was developed in partnership with MIT to determine the best workload for Wal-Mart's trucks. Wal-Mart had worked on the problem internally, but then it partnered with MIT to develop this model for workload allocation. The model is being used today to manage Wal-Mart's $2 billion spending on transportation. There are definitely opportunities like this, Kozak said, for mutual benefit. He stated his interest in Wal-Mart's further participation in such research projects, as shown by his attendance at this symposium. He added that Wal-Mart will likely not be a leading-edge company but will be testing and learning and would be open to being a participant in further research.

Genevieve Giuliano commented that the Schemes and Technologies for Enhancing Urban Distribution session fascinated her because Part 1 and Part 2 were so different. Part 1 was about an external agency trying to invoke change, and Part 2 was about internal change. Giuliano noted that when innovations are discovered, they are not widely implemented by industry. She saw four reasons for this. First was a lack of information: a company may not know that there is a better way to route trucks. Second, some innovations require cooperation: if X, Y, and Z worked together, the solution would work, but X, Y, and Z do not cooperate. Third, cost advantages may not be internalized. Fourth, perhaps there is a lack of competitive pressure for companies to take action. Giuliano suggested that one of these four reasons—or perhaps one not yet articulated—could help researchers understand why strategies such as consolidation or alternative fuel strategies have not been more widely adopted. For example, an additional reason may be that costs and benefits have not been properly enumerated. Understanding adoption is part of the needed research: to determine, in a systematic way, which strategies meet the test of adoption.

McKinnon echoed the need to understand why there has not been more uptake of innovations if they offer a genuine benefit. In situations such as those that Cathy Macharis described, in which academics worked with companies and demonstrated real benefits, why were the innovations not more widely adopted? He asked Macharis if she had thoughts on this.

Cathy Macharis, drawing on her example of green vehicle adoption, explained that lack of uptake could be attributable to a combination of reasons. One reason may be that green vehicles are simply more costly right now than traditional vehicles. Another reason could be a lack of competitive pressure, but she saw that situation changing given goals such as CO_2-free cities by 2030, which will challenge companies to find solutions. Those solutions will bring them a competitive advantage, because if they do not find solutions, they may find themselves out of business. She urged researchers to show the impact of innovations, both to the environment and to profitability, to provide decision makers information to make good choices. In examples like the TNT mobile depot, five main stakeholders were involved, but implementation took even more actors. For example, because the location was in a historic place, the Institute of Historical Places had to grant permission. In addition, the Commune of Brussels had to grant permission for parking. The police department was yet another actor. All of these actors have to move in the right direction. Collaboration is needed to make innovation work.

Rosário Macário saw several problems in city logistics. The most important problem was the significant differences between the actors. On the one hand is the private sector, which is very sophisticated and well developed, already using leading-edge technologies. On the other hand is the public sector, which should be taking on the role of a facilitator but is unprepared to do so. This leads to a huge imbalance between the actors and results in communication problems. The two sides do not understand each other. Academics are in the middle, but due to their obligations, they tend to dedicate their resources to research. They do innovative and brilliant things, but ultimately those things enlarge the communication gap that already exists. Macário suggested that academics reconsider their role in innovation. When they work in the field, they understand the situation and see the lack of trust between actors, which is the factor that makes it so difficult to bring the actors together. She suggested bringing academia, industry, and the public sector together, and urged academics to reflect on whether they should reorient part of their resources to bridge this gap in order to produce more innovative, but more balanced, communication between the actors. She saw this reorientation affecting research and interventions, and that academics should research not only technology and physical objects but also institutional processes and communication.

Carlo Vaghi, who is from Europe, thanked participants for the U.S. perspectives they offered. From Giuliano and Laetitia Dablanc's presentation (Approaches to Managing Freight in Metropolitan Areas), he saw the comparisons of city logistics measures applicable to the EU and the United States. He noticed that the measures applicable to Europe and the United States were the technology-driven ones, such as truck efficiency, cleaner vehicles, and more Internet and communications technology. Could that mean we are surrendering to the congestion factor of urban distribution? Another interesting point Vaghi saw was that consolidation centers were described as a stand-alone measure, but in the EU almost all consolidation centers seem based on a regulatory scheme. In Europe, implementing consolidation centers is a complicated and articulated measure requiring many stakeholders. In contrast, consolidation centers in the United States are considered to be only a measure taken by private industry. The EU has public–private centers that are run with the hope of reaching a break-even point so that they require no more subsidy. If a city issues a tender to select an operator to run a consolidation center, then the center becomes a partially public center.

Vaghi also asked whether it was valid to assume that consolidation centers can be viable without strong regulatory schemes and incentives. He asked what participants thought of the assumption taken by third-party logistics providers that dropping goods off at a consolidation center shifts the least profitable deliveries to the public, making the public shoulder the cost, which would not be true if consolidation centers operated without subsidies.

Birgit Hendriks responded to Vaghi's questions by saying she would present a case about the Binnenstadservice on the second day of the symposium that addresses these points. She added that, having worked in several fields in addition to logistics, she saw logistics research as being less market driven; that is, less funded by companies. In medical research, 95% of the proposals were market driven and funded by the market. She stated that logistics research should be more market driven: if companies are paying for the research, they are interested in it.

José Holguín-Veras challenged the assumption that the private sector is inefficient. He thinks it is efficient, but from a private-sector point of view, not from a social point of view. From a social point of view, the private sector generates externalities. So the issue is how to help move the private sector toward overall efficiency without hampering economic activity. Sometimes an intervention can have a counterproductive effect and actually create a market failure.

In order to move the market toward better social performance, Holguín-Veras continued, researchers need knowledge about the behaviors of the agents, particularly about their interactions. The question is how to help the chain of decision makers move toward the appropriate decision. Researchers need to understand the economic interaction between these agents, and they need to understand behavior. Once researchers understand behavior, the question is what policy levers should be pulled. That is the essence of a research program: understand the interactions, the behaviors, and what to do from a public policy point of view. If an idea is good for society but is not in the basic interest of the company, the company will not implement the idea. That is the fundamental dilemma researchers need to address, Holguín-Veras said.

McKinnon suggested that Michael Browne comment on the question, because he chairs the Central London Freight Quality Partnership, which brings together various stakeholders. He asked Browne whether it was easy to introduce new initiatives in central London and whether there was an understanding of stakeholder behavior and how it could be influenced.

Michael Browne said that people like to have a simple solution. The Central London Freight Quality Partnership started off with a problem that had been causing a lot of tension between the private sector and the local authorities in the center of London: the penalty charges for parking. Delivery drivers were parking in the wrong place in order make deliveries, and they were being fined for doing so. But they needed to do their jobs, so they continued parking in these places and paying fines. The problem was so extensive that London had a so-called "Millionaires' Club" of businesses who were paying more than £1 million in fines per year. It was a significant problem and led to animosity between the public and private sectors. However, by working together in public–private partnerships like the Central London Freight Quality Partnership, in which some neutrality is involved, solutions can be found. Indeed, over the last 4 years of the partnership, many solutions have been found, and the fines have been significantly reduced. Today, the discussion is much more positive about what they could work on together. Browne returned to his initial point, however, that everyone would like a nice, simple solution, but in reality there is no single simple solution. What is needed instead is a blend of complicated solutions. Perhaps the role of academics could be to better package and explain the solutions, detailing their advantages and disadvantages.

Ian Wainwright said that trying to explain logistics to people in public policy often results in blank stares. One of the issues is to make sure everyone speaks the same language, as Macário mentioned, and understands the efficiencies and what is driving behaviors, as Holguín-Veras said. Customers drive logistics behavior based on what they will pay for the goods in the shop or for the contract (e.g., for a construction site). The customer drives behavior through the supply chain, but everyone is making their own individual decisions on an economic basis throughout the supply chain. Moreover, urban freight involves more than retailers. Consider Regent Street in London, Wainwright said. It is one of the three premier shopping streets in London, but only 29% of the deliveries on that street are for the retailers: the rest is for offices, restaurants, and so forth. So, city logistics is not just about retailers, but also about all the other functions that happen in cities.

McKinnon noted certain biases in city logistics, such as a bias toward retailing. Of all the economic activities in the urban sector, the retail sector has been most heavy researched. Within retailers, do we include cafés and restaurants? Jean-Louis Routhier made the point that most of the freight trips in Paris were related to these quasi-retail activities. But what about the other economic activities in urban areas that generate freight? They have probably been underresearched over the years.

Ken Button noted that the symposium's private-sector presentations had an international perspective, not just the United States or EU. This is a product of globalization, he said, and information in the private sector travels faster than it does in the public sector. Speed is a necessity; businesses that are behind the curve in the private sector are out. The private sector has to move quickly. The public sector, in contrast, is mandated to talk with everyone, which slows it down.

Button disagreed with Browne's point on the need for complexity. He cited the tremendous benefits the United States achieved with legislation like the Motor Carriers Act. This act freed the market and resulted in huge economic benefit as well as huge environmental benefit. In the 1970s, before the act, the same proportion of freight was carried by rail in the United States as in Europe: about 4% to 5%. In Europe, it remains at 4% to 5%, with the rest of freight moving by road and some by coastal shipping. In the United States, in contrast, 45% of the freight goes by rail. This increased use of rail has brought tremendous economic and environmental benefit, and it was done not with complicated models, but with a simple institutional change. Finally, given the symposium goal of more interaction among academics and the professions and government, Button suggested reexamining earlier initiatives and learning from them.

McKinnon mentioned a paradigm shift, and posed the question of whether 5, 10, or 15 years from now there would be a transformational shift in city logistics. Perhaps three-dimensional printers or other transformation technology would change the way products are moved or not moved in urban areas. Another point, based on Macário's comments, was whether academic research in city logistics leads or lags behind the trends and developments. McKinnon's suspicion was that it lags. Perhaps academics have not been as creative as they might have been. Perhaps they have remained in a more supportive role, looking at the implementation and evaluation of new developments rather than taking the lead.

Alessandro Damiani lauded the contribution of the practitioners in the symposium, saying that they brought substantial value to the discussion. He noted that there was an assumption that practitioners neither pursue nor use research. However, what else has UPS been doing the last 15 years but collecting and analyzing data for the best way to optimize its operations? Shouldn't that be called research? He believed that a lot of in-house research was being done. He posed the question of what academia could do—either in terms of content selection when setting research priorities or in terms of consortia formation—that would encourage greater relevance and bring about more collaboration.

McKinnon asked whether companies could handle research for themselves, and if so, whether the role of academic research should be more at the macro level than the micro level.

Edgar Blanco mentioned the importance of defining "city scale" when talking about logistics. A city over 60,000 inhabitants is called a city, but it does not really have the logistics problems that New York City or Tokyo, with their huge populations, do. The scale of the city matters in terms of the strategies, approaches, and data relevant to it. Another issue is the market, that is, the demand for research. Cities in emerging markets face huge pressure to do something about logistics. In Europe, the market demand is for historic preservation and the environment, so the market is there and has shaped the kind of research going on in Europe. In the United States, there has been little on the policy side. So the question is, where can city logistics research have the most contribution? In the developing world and in big cities with lots of regulations, companies like Wal-Mart are interested in what is going on. They know how to do business in the United States, but they are interested in Bangkok and India and China, and they know much less about what to do in those countries. Finally, teaching and education are an important component. Blanco is teaching a logistics class to urban planners. They had never heard of logistics. So the education component is another point to discuss, he suggested.

McKinnon thanked Blanco for bringing in the global perspective and emerging markets. As emerging markets think of green freight, they are looking to the developed world to give them ideas as to how they could reform city logistics. So research has a role to play there, as well.

Hervé Levifve commended Routhier for his contributions to policy for the city of Paris. Without Routhier's data, new policies would not have been adopted in Paris.

Maria Boile summarized what she heard today: private companies optimizing their businesses, but only focusing on their operations. Holguín-Veras mentioned making companies aware of social benefit and how companies could do better in supporting social benefit. Huge amounts of data are needed to build a complex picture, and very complex models are used. Boile believes that from an academic point of view complexity is needed, because researchers need to see how systems interact. Even if the models do not make the very accurate predictions that would be ideal, those models are still needed. Perhaps the solution—to help communicate the complexity—is to have an index that would make it easier to comprehend. She mentioned the logistics performance index (LPI) that the World Bank uses to assess how well a country or region does. The LPI is composed of five to six elements. The elements are not simple, but they are comprehensible. One of the elements is customs, which both the private sector and the public sector can understand. Urban logistics needs this kind of index, something like an urban LPI, with feeds from the models or from the complex data, something that would make it easier to compare regions and identify where there is room for improvement.

McKinnon said the key thing to note about the LPI is that it is a perceptual index. The LPI asks for the opinions of freight forwarders. So it raises the question, who would be on the panel that would judge the quality of logistics in different cities?

Téodor Crainic echoed the need for more education about what city logistics is to people outside the field. He preaches city logistics to operations research people and continually people ask, "What's that?" He noted that little behavioral modeling is being done on freight and even less on city logistics. The field needs to be publishing more papers and more applied research to get more uptake and notice from industry. He also suggested that if there were more academics in the field, some could focus on pushing the envelope of how big a problem they could solve and how many attributes could be put in.

Regarding the U.S.-EU disparity in the use of rail for freight, Crainic pointed out the continental differences. The United States has vast expanses of land and needs to move imports from China thousands of miles to cities like Chicago. The United States also ships millions of tons of coal by rail, as well as exports of grain and minerals. He also pointed out that the United States lacks a carrot and a stick, like the EU goal of CO_2-free cities by 2030. In the United States, the general public's knowledge about carbon or particulate matter is limited. Education, private initiatives, and an exchange of students among academic institutions are needed.

Rolf Schmitt offered some statistics about goods movement in the United States. First, he said that despite what is said about all the goods from China moving across the United States, the amount of material related to export and import only accounts for 10% of the total amount of goods that move in the United States. That figure may be low due to the way the measurement is done, but it is nonetheless much less than 25%.

Second, he said that coal, gravel, and other bulk products represent two-thirds of the tonnage moved in the United States, although only 20% of its value. So a lot of the transport system is involved in moving bulk, and it is not all long-distance bulk: half of the tonnage moved in the United States travels less than 100 miles.

Third, within urban areas, he agreed the problem was not just retail; much of the freight is construction materials. A study done on freight needs in Baltimore, Maryland, revealed that the number two need was high-quality refrigeration, because the biggest economic activity there was Johns Hopkins Hospital. Transport requirements for hospitals are very different and have special needs.

Fourth, Schmitt echoed the point that the U.S. experience is different from the European one because of geographic differences. The continental United States is 3,000 miles across; consider how many cities and countries in Europe you would cross in 3,000 miles. He was curious how the EU measures moves between cities now that it is one entity and no longer has customs data.

The United States spends $25 million every 5 years on the Commodity Flow Survey to benchmark what moves in the United States. It then spends a few million more dollars to build on the data and provide estimates for the things the survey misses. It is a big, expensive proposition, he said, and yet it still does not get down to the neighborhood level, so it does not capture the urban scene. A big challenge in the United States is that the government provides the national picture, but states and localities must measure what is going on at the local level.

McKinnon asked Schmitt what improvements he anticipated in data collection and analysis for urban areas in the United States in the next 5 to 10 years.

Schmitt replied that FHWA tracks half a million trucks via GPS to measure the speeds on the Interstate systems. It pings the trucks, gets the locations, calculates the distance, and calculates the speed. The problem with technologically based monitoring such as this, compared with traditional surveys, is that the data are on much smaller slices of the world. FHWA can tell you that a vehicle was traveling X miles an hour at spot Y, but it does not know what was in the truck. In fact, the driver may not know what was in the truck. Even the carrier may not know, if the container came from someone that was loaded by a third-party logistics firm. In short, much better data exist on much smaller slices of the world, and the challenge for the future is how to link all of these narrow slices to get a full picture.

Robert Skinner commented that research oriented to helping the public sector is not as sharply defined as research in the private sector. In the private sector, the objectives seem crystal clear: efficiency, cost cutting, and changing logistics to support a new strategy, as Wal-Mart is doing to introduce services to areas they were not serving before. In contrast, what are the goals of research to solve broader societal problems? Is research simply making smaller incremental changes to reduce the number of vehicle miles traveled and thereby reduce the consequent CO_2 emissions, or is there a broader strategy to make urban areas more livable by bringing in goods and services more efficiently? It would be helpful, in these broader strategies, to define the objective of the research more sharply.

McKinnon commented that in the EU there is an objective to "achieve essentially CO_2-free city logistics by 2030," which has been declared as an EU Commission policy objective. Perhaps the United States does not create targets such as this.

Stane Božicnik noted that one of the main contributors to congestion in city logistics is the length of time the delivery vehicle needs to stop when it is delivering goods. He suggested including technical development in the research to focus on speeding up all the elements necessary for the delivery process in city centers. That could be an aim for practical research. Second, he suggested using BESTFACT as a model to develop a database of European and U.S. best practices. It would be useful, and the implementation lag would be short, so it could be very efficient. Third, he suggested that city logistics include the transport of passengers, not just freight, in its analysis. Enlarging the scope to include both freight and passengers would result in more optimal solutions. Finally, Božicnik voiced support for two items mentioned earlier, those of education and of integration of urban planning into city logistics theory and practice.

Michel Savy commented on the need for public–private sector cooperation. Both parties need each other, he said. Access to a public space depends on traffic management and parking management. The private sector also needs support from the public sector so that real estate prices do not expel logistics farther and farther from the city. Academics could be useful in the interactions between the public and private sector, acting as translators and intermediaries to facilitate the dialogue, particularly between such entities that have very different horizons and views but must learn to work together.

Heike Fläemig called for identifying the system boundaries of city logistics and clarifying what the targets of improvement are. She noted that lower transport costs may actually increase traffic and result in more externalities that then cannot be put back on the companies. Researchers should help solve this gap. Second, she said that just as private companies have different strategies for delivering different types of goods, cities need different strategies for solving different urban problems. Given all the different functions that take place in the city, a single solution does not work for everyone. The task for researchers is to create structure and clarity so that politicians can understand when researchers come up with a solution to a specific problem.

McKinnon ended the session with the issue of semantics: in the discussions today, urban freight has been equated with city logistics, but transport is merely one part of city logistics. City logistics also involves materials handling, storage, and limited space for parking near shops. As Fläemig said, optimizing city logistics does not necessarily reduce freight transport or result in fewer externalities. It is a boundary issue: Is it logistics or urban freight? McKinnon felt that public authorities think of it as freight, but companies think of it as logistics. There is a mismatch of views, so defining the respective terms is important.

Terminals and Hubs

Impacts and Strategies

Lanfranco Senn, *Bocconi University, Milan, Italy*
Jean-Paul Rodrigue, *Hofstra University, Hempstead, New York, USA*
Thierry Vanelslander, *University of Antwerp, Belgium*
Clarence Woudsma, *University of Waterloo, Ontario, Canada*
Thomas O'Brien, *California State University, Long Beach, California, USA*
Genevieve Giuliano, *University of Southern California, Los Angeles, California, USA*

Introduction

Lanfranco Senn

Lanfranco Senn opened this session by saying that hubs have both a positive and a negative effect. Given global supply chains, freight has no well-defined borders, which results in "glocalism" (the practice of conducting business according to both local and global considerations). Global supply chains create local impacts. This session will focus on terminals and hubs that have arisen around nodes, particularly ports and airports, he said. These hubs create more concentrated environmental impacts around their immediate area, even though the freight they transport may go to locations worldwide. The purpose of the session, Senn said, was to discuss the impact of hubs and how to mitigate their negative impacts.

Part 1: Impacts of Terminals and Hubs on Metropolitan Areas

Intermodalism and Urban Logistics: Impacts of Terminals on Metropolitan Areas

Jean-Paul Rodrigue

Jean-Paul Rodrigue spoke about intermodalism and urban logistics, focusing on the impacts of terminals on metropolitan areas. Across the board, he said, material intensiveness has increased. This term refers to the fact that the number of containers moving across the world has increased by a factor much higher than the levels of export value, economic activity, or population. One interesting change that has taken place is the dislocation of manufacturing, while its operations have become highly integrated. That is, there is a higher level of functional integration even though operations are spatially dislocated. The outsourcing and offshoring of manufacturing has had a large impact on global supply chains (see Figure 1, page 35).

Rodrigue attempted to cross-reference United Nations data on cities with the logistics performance index (LPI), an indicator published by the World Bank. The scale mismatch (city versus country) does not allow a strong association, so the concordance between urban areas and the national LPI is tenuous at best. He noted that 75% of cities are located in areas considered to be logistically deficient.

Using Ports for City Logistics

Next, Rodrigue moved to the topic of ports as an element of city logistics. When the performance of a port or terminal is evaluated, city logistics is not part of the evaluation. Ports and terminals only report on metrics inside the port. The fact that drivers may occasionally wait for hours on urban roads before they can access a terminal is not part of the performance evaluation of the terminal. This creates a conflict in which the city has to bear the externalities of port operations. Instead,

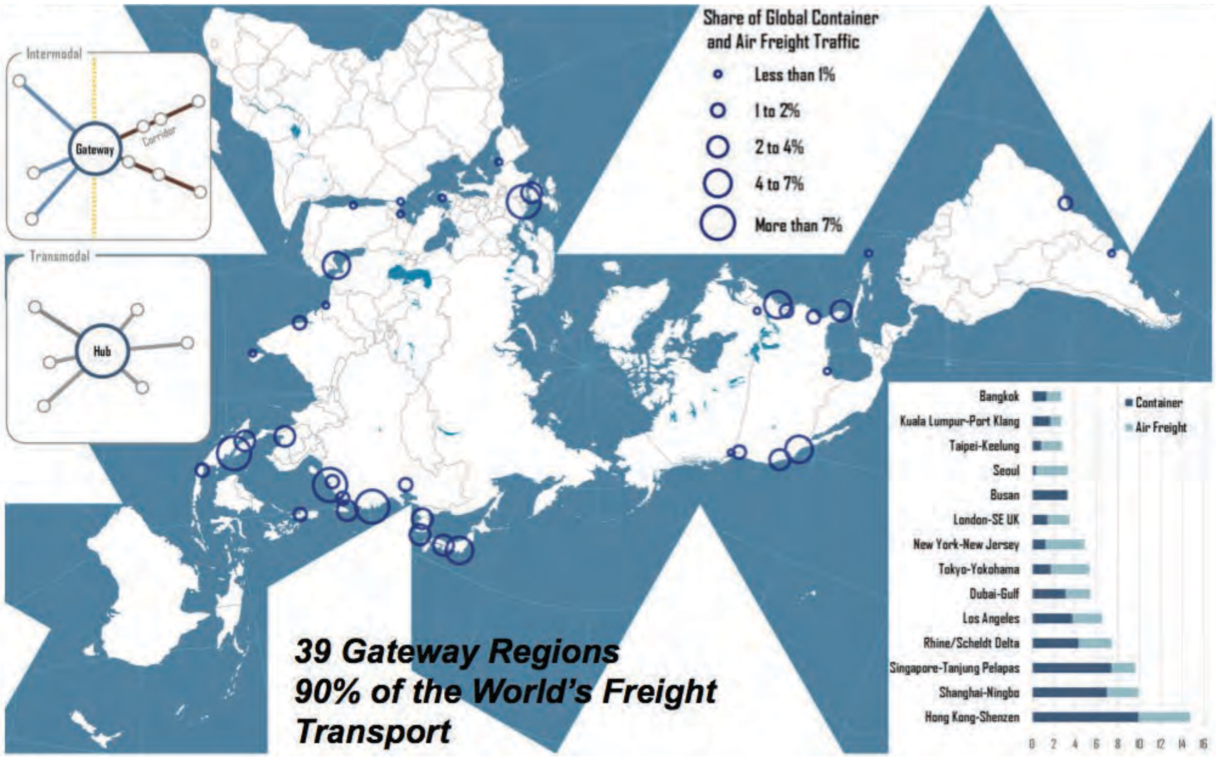

FIGURE 1 Outsourcing and offshoring of manufacturing has significantly affected global supply chain.

Rodrigue proposed the idea of using ports for city logistics. Port-centric logistics zones would offer advantages such as the availability of land and labor. Containers could be transloaded within the port and empties could be quickly repositioned, which would decrease supply chain lead times.

Rodrigue cited the Savannah Logistics Cluster as an example of such a port-centric cluster. This cluster, based around the seaport in Savannah, Georgia, has numerous industrial parks and is home to the distribution centers of large firms such as Ikea, Target, and Home Depot. The Savannah Logistics Cluster is a new gateway and is the outcome of private firms' decisions to use a new port of entry to the East Coast. One factor for planning such port-centric clusters, however, is that many ports experience a yearly cycle in which monthly container traffic builds for the holiday season and then drops dramatically in January before slowly picking up again. A question for urban planners is whether to build for the peak operations or for the less-intense daily operations. Locating a logistics center in an area that has both a seaport and an airport, or that has a seaport and rail connections, makes it easier to shift between modes, Rodrigue said.

Companies build and choose to locate in large terminals or freight handling facilities due to economies of scale that make these facilities efficient. However, a problem occurs because this concentration of flows triggers major conflicts concerning functional, spatial, and environmental goals.

City Logistics Performance Index

Rodrigue suggested research was needed to develop a global city logistics performance index and to understand the interaction between city logistics and ports' commercial cycle impact. Rodrigue was immediately asked what kinds of performance measures would go into this index. He answered that there would be different metrics, but the analysis would begin with perception: How do you perceive parking or opening hours in terms of ranking the city?

In the short discussion that followed, **Heike Fläemig** pointed out that it was important to distinguish between logistics and freight. The city of Hamburg is located near a port, but very few of the goods coming into the port actually go to the city of Hamburg itself. Some ports are gateways to a whole region. Another example is that a city may look high performing in terms of having large fleets of commercial trucks, but those trucks may be running half empty, which is not good for the environment.

Part 2: Strategies for Mitigating Impacts of Terminals and Hubs

Consolidation Hubs and Freight Villages

Thierry Vanelslander

Thierry Vanelslander presented two strategies for mitigating the impact of consolidation hubs or freight villages: making a time shift and making a mode shift.

Specifically, the first strategy for mitigating the impact of consolidation hubs or freight villages is to make better use of the existing network, which can be accomplished by shifting operations in time. That is, opening hours in seaports or in the hinterland, or both, could be extended in order to spread operations over more hours during the day and night. Alternatively, within the existing open hours, traffic could be shifted to less-congested periods during those hours.

Making a Time Shift

Vanelslander researched these two strategies to identify bottlenecks and assess the impact of making such shifts. He found that shifting within existing terminal opening hours is more efficient than extending terminal opening hours. The method he used to arrive at this conclusion included creating a hinterland flow typology, using port flow statistics, opening hours, and capacity use data. He also used real-life cases and found that in current practice, most deliveries and pickups take place at 8:00 a.m. This timing is the result of habit more than anything else, he said, and it occurs because 8:00 a.m. is typically the start of the day. Furthermore, just-in-time strategies dictate frequent deliveries of small batches of freight. Finally, the opening hours of Customs facilities constrain when the movement of freight can take place.

Vanelslander measured the cost of making time-shift changes, considering three alternative scenarios: a 3:00 a.m. start, a 10:00 a.m. start, and a 7:00 p.m. start. His assumptions included peak hours being 7:00 to 9:00 a.m. and 4:00 to 7:00 p.m., and he assumed average travel and waiting times and time and distance costs. He did not take external effects into account, or the cost of extra trips. His first case was the export of containers by a medium-sized shipper via the Port of Antwerp. The two systems involved were container lift and chassis (or skeletal trailer), and the timing of these was 7:00 a.m. to 5:00 p.m. for the container lift and 24-hour per day operations for the chassis.

Vanelslander's analysis showed that the cost impacts were highest for operating during the off-peak hours of 8:00 p.m. to 5:00 a.m. Moving to off-peak hours would require finding ways to compensate receivers for off-hours delivery. Similarly, adding extra labor for the Customs office to operate outside of the hours of 8:00 a.m. to 5:00 p.m. would be an added cost that would need to be borne by the public. On the basis of this analysis, he concluded that shifting within existing terminal opening hours is more efficient than extending terminal opening hours.

Making a Mode Shift

Next, Vanelslander considered a shift in mode, namely using rail rather than truck to reach a city center. He analyzed the case of French retailer Monoprix, which uses rail to deliver goods into Paris. The freight begins at a large production facility and is then moved by rail (using existing rail lines) to the city center. The transfer point in Paris is an old railway station that Monoprix transformed into a hub. The results, after 1 year of using rail rather than truck, include a savings of 70,000 liters of fuel and a reduction in vehicle kilometers. In particular, 12,000 trucks do not have to enter the center of Paris, which reduces traffic congestion. In addition, the mode shift significantly lowered greenhouse gas (GHG) emissions (a decline of 340,000 tons of CO_2 and 25 tons of nitrogen oxides [NOx]). Using rail in Europe is more expensive than using trucks, so that shift was more expensive for Monoprix.

Vanelslander also discussed another case of mode shift: urban distribution using barges. He examined the case of the Utrecht beer boat, in which the barge delivers to the city center, and bikes deliver the last mile. Using the barge rather than vans results in significant environmental benefits, namely reductions of 74% of particulate matter with a diameter ≤10 micrometers (PM10), 27% of CO_2, and 85% of NOx (all percentage reductions are kilograms per year). Another example of a shift to barge is the DHL Floating Center Concept. The advantages of the shift to barge are that it is a sustainable alternative that lowers external costs, reduces congestion, avoids road transport limitations, decreases traffic fines, and offers a reliable service. The disadvantages include adapting logistics habits to the change and extra transfer cost. If there is a large last mile, then there are higher costs of using cycling messengers. However, delivering by bike is not always more expensive; if enough volume is generated, the cost per stop is comparable with van transport cost. In addition, if road congestion increases, bikes are less susceptible to the resulting traffic congestion delays. In contrast, under increasingly congested conditions, fuel consumption increases and more vans and drivers may be needed to make on-time deliveries, which further increases costs of that mode. Finally, Vanelslander observed, less equipment cost is more important than extra needed bike drivers for the same volumes.

Recommendations for Research

Vanelslander concluded by offering some recommendations for collaborative research. First, he suggested that much more urban logistics research is needed into the areas of urbanization, congestion concentration, and pollution concentration. Second, supply chain thinking and analysis are needed, because to date urban logistics research has considered these topics separately. Collaboration and chain thinking are needed because chain actors will need to work together and, in terms of financing, the public and private sectors will need to work together.

Environmental Regulation

Clarence Woudsma

Clarence Woudsma briefly defined environmental regulation and offered some examples of regulation that affect the freight system. Environmental regulations are explicit requirements aimed at reducing noise levels, improving air quality, reducing GHG emissions, and so forth, he said. They are sustainability driven and are focused more on mitigating negative effects on the environment rather than on productivity or economic concerns. Regulations in North America are set at the federal, state, and regional or local levels. At the federal level, examples of environmental policies that may affect the freight system include policies that set emissions or fuel standards, air quality standards, water pollutant discharge rules for vessels, and oil spill prevention rules, such as requiring double hulls. At the state level, policies affecting the freight system include drayage truck rules at ports and rules on locomotive idling. At the regional or local level, environmental policies such as airport noise restrictions, restrictions on visual impacts (e.g., lighting), and vessel shore power requirements affect the freight system.

Similarly, regulations regarding energy and climate change issues are set at all three governmental levels. Examples that affect the freight system include requirements or subsidies for renewable fuels, GHG cap and trade, and programs or incentives to improve fuel efficiency, such as the SmartWay program.

The key consideration with all of these policies is that there is an interplay among policies and regulations and the local terminal or hub. Woudsma focused his presentation on the city level and impacts of terminals on cities. At this level, the question arises of what to regulate (air quality? noise?) and how to regulate (and subsequently mitigate), such as via land use measures.

U.S.-EU Examples of City-Level Environmental Regulation

Woudsma next presented examples of regulations currently in effect at the city level in the United States as well as in Europe. He explained the regulation and listed the location where that regulation is currently enacted. He listed regulations that penalize poor performers (such as restricted access or fees), as well as promote good performance (such as exemptions from charges). Woudsma's examples included truck fleet emission standards that specify diesel particulate filter standards (California); low-emission zones (LEZs) that restrict access by older and more polluting trucks (London); alternative fuels and electric delivery vehicles exempted from paying a congestion charge (Milan, London); promotion of alternative modes or cargo diversion, such as CargoTram (Paris, Dresden); restrictions on truck idling, such as a 5-minute limit on diesel truck idling (California); delivery noise reduction (such as the Netherlands' PIEK program to research noise reduction equipment for vehicles, and Atlanta's ASTROMAP); and environmental justice or community mitigation measures, such as Baltimore's Maritime Industrial Zone Overlay District. In the area of environmental justice, public health concerns may push the agenda more than anything else.

London's LEZ and Los Angeles's Clean Truck Program

Woudsma then examined the results of London's LEZ 5 years after of its implementation. The LEZ covers the greater London area, not just its core. The larger area extends the environmental benefits. The LEZ set minimum emissions standards for heavy goods vehicles of Euro III class, using a phased approach that began in 2008. This measure led to a higher rate of vehicle replacement, decreasing the proportion of pre-Euro III class vehicles.

After 5 years, air quality measurements in the LEZ show that PM10 has dropped by 2.46% to 3.07%, compared with an increase of 1% just outside the LEZ. No differences were found for NOx. National Cooperative Freight Research Program Report 23 (2013) rated LEZs high for effectiveness but low for applicability in the United States due to local jurisdictional complexity.

In the United States, results of mandatory clean truck programs (in the Los Angeles–Long Beach ports) have been dramatically more effective than voluntary programs, such as those at the ports of Houston or Charleston. Results include an 80% reduction in PM10 and NOx from the baseline for the mandatory programs, compared with a 1% to 4% reduction in the areas covered by voluntary programs.

Canadian Examples

Woudsma next offered some examples from Canada, particularly the greater Toronto area, which is subject to federal emissions standards, trade corridors, and the SmartWay program, as well as provincial regulations that limit trucks to speeds of 105 kilometers per hour. Regulations do permit one tractor pulling two 53-foot trailers, which improves fuel efficiency, although motorists are not happy with these long vehicles on the highway. Locally, Toronto has issued anti-idling regulations that limit idling to 1 minute in the city of Toronto. Toronto often looks to London as an example for environmental regulations and policies.

At the provincial level, Ontario has developed Freight-Supportive Land Use Guidelines to provide consistent direction for local land use planning, site design practices, and operational procedures to facilitate goods movement in diverse communities. There is legislated protection of economic highway corridor lands and consideration of truck-specific usage of highway capacity to enhance system performance. Unfortunately, Woudsma said, the planning community knows little about urban freight. A business-led initiative that includes major logistics firms seeks to create a recognized "eco-business zone" around Toronto's Pearson International Airport. In addition, Metrolinx, a provincial agency, was created to integrate transit systems across jurisdictions in the greater Toronto area. Metrolinx initiated an urban freight study in which freight is the focus of the study, doing so in conjunction with their major emphasis, which is passenger transit.

Innovative ideas are welcomed in Canada, but there is lack of pressure for action, Woudsma said, because Canada does not have the core congestion and land development challenges that, for example, Paris has. In Canada, there is still room to build 1,000,000-square-foot facilities on the periphery of major cities, and the pressures in the urban core—air quality, congestion, or noise pollution—are not as acute.

Challenges of Environmental Regulations

Woudsma next discussed the challenges of environmental regulations. First, there are interdependencies, such as air quality and noise being linked to public health outcomes. Second are unanticipated consequences and multijurisdictional influences. Another challenge is that of enforcement and compliance. Often, large firms comply but small firms are less compliant, yet the combined actions of many small firms can have a disproportionately high impact. Finally, it would be good to internalize the externalities, Woudsma suggested, such as utilizing user-pay or polluter-pay schemes. Such pay schemes are often difficult to implement during an economic downturn, however, when there is less appetite for more stringent measures. One way to motivate change or political pressure could be to visually show externalities that may otherwise be hidden. Woudsma showed an example of fine-grain emissions data graphed by the Hestia Project. The graph displayed on-site fuel CO_2 emissions across the city of Indianapolis, Indiana, showing not just green and red zones but also the three-dimensional height of the red zones, which highlighted the worst areas and presented a more effective communication of the issue (see Figure 2, page 39).

Recommendations for Research

Woudsma concluded his session with suggestions for research. One research area is how to move on the spectrum of "command and control" regulation to "negotiated" policy (regulation) through partnerships. Here, policy makers could act as "deal brokers" rather than rule makers, taking into account the competing interests of multiple actors. A second research thrust could look at the most effective types and combinations of policies to achieve environmental objectives, examining how they interact with other policies. A third possible research area is that of public health and equity implications of environmental regulations. Overall, there is a need for both qualitative research (to better understand the motivations, response, and process of the policy lifecycle) as well as quantitative research (i.e., data on activity and outcomes) to better understand the impacts, interactions, and trade-offs among regulations. Finally, Woudsma mentioned the need for a databank with information about approaches, implementation, and impacts.

Operational Strategies

Thomas O'Brien

Thomas O'Brien began by explaining the context of the hub and terminal problem. Growth in merchandise trade and services has brought an increasing need for scale economies on the part of ocean shipping, and that scale has impacts on cities and regions. Decentralization has resulted in the development of distribution centers on the urban periphery from which goods must be moved into the urban core. Urban freight comprises not just goods for consumption in the city, but also the export activity within the city. This activity can have a large impact, such as in Los Angeles County, which is the largest manufacturing county in the United States.

The increasing size and capacity of container ships lets them move a large amount of goods, but the ves-

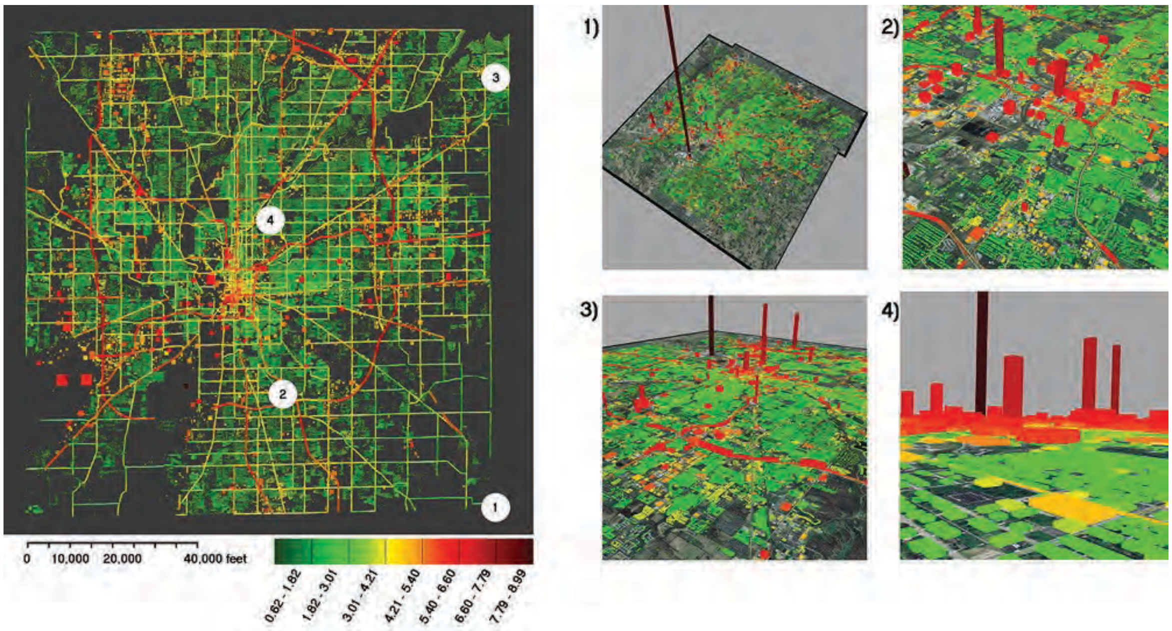

FIGURE 2 Three-dimensional graphs effectively communicate high levels of urban CO_2 emissions. (Example of fine-grain emissions data, from the Hestia Project, Arizona State University: on-site fossil fuel CO_2 emissions across the city of Indianapolis, Indiana, for the year 2002; from Gurney, K. R., I. Razlivanov, Y. Song, Y. Zhou, B. Benes, and M. Abdul-Massih, Quantification of Fossil Fuel CO_2 Emissions at the Building/Street Scale for a Large U.S. City, Figure 5, 2012. www.epa.gov/ttnchie1/conference/ei20/session3/hestia_gurney.pdf.)

sels' size limits the number of ports they can enter. The largest container ships, as of 2013, have a capacity of 18,270 20-foot equivalent units (TEUs), compared with 4,538 TEUs of the largest ships in 1988. These "triple E" (economy of scale, energy efficient, environmentally improved) ships of 2013 are 400 meters (1,312 feet) long by 59 meters (194 feet) wide with a draft of 16 meters (52.5 feet). Because not all ports can accommodate these huge vessels, a smaller number of ports must handle a larger amount of cargo.

O'Brien next discussed some of the solutions to address the problem of freight at trade hubs and gateways, focusing first on the issues of bottlenecks at these hubs. Specifically, these solutions encompass gate pricing at the port and the use of an appointment system for truckers to pick up cargo. The goals of these solutions are to spread out the flow of truck traffic and to reduce noise, air pollution, and engine idling.

Congestion Pricing at Ports

One such program, the PierPASS program instituted at the Los Angeles–Long Beach ports, was a program to encourage off-peak traffic. PierPASS charged a surcharge to companies who moved goods during the peak 8 a.m. to 5 p.m. hours. The program had a dramatic impact immediately from its inception in 2004: it rapidly shifted 40% of eligible cargo to evening and weekend hours.

The PierPASS program was managed cooperatively by the terminal operators themselves, who created a third-party company to collect the fee. The fees were used to pay for off-peak labor. The PierPASS program worked because it was terminal focused, O'Brien said. An earlier appointment scheme at the Los Angeles–Long Beach ports failed. Appointment schemes often fail because they focus on just one actor, ignoring the effects on the rest of the supply chain.

The Port of Busan in South Korea implemented congestion pricing, but in reverse of southern California's scheme. In Busan, the greater demand was for off-peak operations because of the desire to pick up shipments in the evening in order to make early-morning delivery in Seoul. Thus, Busan assessed a surcharge on off-peak operations to encourage a spread of operations to daytime hours.

Clean Truck Program

Next, O'Brien described the Los Angeles–Long Beach Clean Truck Program, which is an example of gate pricing. The Clean Truck Program was a mandatory program whose aim was to transition the truck fleet to cleaner vehicle standards. The program was the centerpiece of a voluntary agreement to develop an environmental program that would encourage cleaner vehicles by offering subsidies and grants to truckers to retrofit or replace vehicles to accelerate truck replacement. A fee was attached to using older, dirtier trucks. There was a progressive ban of trucks in the port: a ban on pre-1989 trucks by October 1, 2008; a ban on 1989 to 1993 trucks by January 1, 2010; a ban on unretrofitted 1994 to 2003 trucks by January 1, 2011; and a ban on pre-2007 trucks by January 1, 2012. No fees were needed as of 2012, because the entire fleet was now operating with newer or retrofitted trucks. This sunset clause was added to appeal to industry.

Results of the Clean Truck Program included a 90% reduction of air pollution from harbor trucks in 3 years. O'Brien offered the Clean Truck Program as an example of an industry-driven approach that bought aggressive implementation. It established a fee structure to pay for environmental mitigation efforts. Getting ahead of environmental mandates was good for regional competitiveness, O'Brien said.

In the realm of environmental policy and processes, the Clean Truck Program set a precedent for extraregulatory pricing. The risk of such programs, however, is that they might create multiple, competing standards. Some regions may also be hesitant to implement such programs for fear that the uncertainty might be bad for regional competitiveness. Nonetheless, O'Brien said, the Clean Truck Program serves as a model for adoption and adaptation.

Road Pricing and Separate Truck Lanes

O'Brien next moved to the topic of road pricing and separated truck lanes, whose aim is to reschedule truck traffic to off-peak hours or to separate truck traffic from automobile traffic. He mentioned that weight distance fees are being used in Switzerland, Austria, and Germany, and noted that economic conditions and budget limitations affect the scale and feasibility of pricing schemes and separated lanes. For example, there may be a scarcity of land to create truck-only lanes, as in the Netherlands, or a lack of political will. Dedicated truck lanes were proposed in Atlanta, Georgia, and Los Angeles, California, but were never implemented. Truck bypass lanes or auto-only inner roads separated from general-purpose outer roads may be more feasible to implement.

In London, it took 2 years for stakeholders to agree on a congestion-pricing fee for commercial vehicles. A proposed New York bridge toll plan assumed a $21 daily fee for trucks and may require a subsidy to receivers. A key question arises from such pricing schemes: Do they divert discretionary cargo?

Rail Strategies for Hub Regions

Next, O'Brien turned his attention to rail strategies for hub regions. Examples of strategies are the elimination of bottlenecks through double tracking, double stacking, integration of legacy rail systems, and better switching technology. The problem with double tracking is that it is capital intensive. O'Brien cited the Chicago Region Environmental and Transportation Efficiency Program (CREATE). The program is a first-of-its-kind partnership between the U.S. Department of Transportation, the State of Illinois, the City of Chicago, Metra, Amtrak, and Chicago area freight railroads. One of the ways the project aims to improve efficiency is by building flyovers to separate rail freight traffic from passenger traffic on congested rail lines.

Freight rail traffic becomes an issue in cities when it interferes with passenger traffic, particularly at rail–highway grade crossings. Attempts to minimize such freight impacts include eliminating grade crossings, shifting truck and rail traffic to barge (marine highways), optimizing rail schedules, and using commuter rail for local freight, as in the Monoprix example in Paris cited earlier. San Francisco attempted this type of solution as well by using the BART passenger rail system to move packages for UPS, DHL, and FedEx, but it proved too difficult to integrate those operations.

One of the main challenges of rail strategies, such as removing grade crossings, is the high cost of the projects and the question of funding. U.S. infrastructure projects are often a combination of public- and private-sector funding, with contributions from the federal government, states, and private companies who stand to benefit. For example, the $300 million Heartland Corridor Project funding is approximately 46% federal, 20% state (Ohio and Virginia), and 33% Norfolk Southern. The corridor is designed to help the East Coast rail networks handle more traffic from the expanded Panama Canal, which will be completed in 2015. The corridor improves direct transit time to Chicago by providing a high-speed, double-stack corridor and helps East Coast ports compete with those on the West Coast by allowing them to serve Chicago faster. The corridor will shave 225 route miles off each container moved to Chicago and will reduce transit time between East Coast ports and Chicago by 1 day.

The Alameda Corridor Project stands as an example of innovative financing, with 48% of the $2.43 billion project funding coming from revenue bonds, 17% from a federal loan (repaid in 2004), 16% of funding coming from ports, and 14% coming from local transportation agency grants. The 20-mile corridor replaced four rail branch lines and built 40 grade crossing separations and a 10-mile dedicated trench that improves the connections and speeds up traffic to make the region more competitive. This showcase project has not, unfortunately, been replicated elsewhere due to the high costs and protracted negotiations involved.

Recommendations for Research

O'Brien concluded his presentation with an identification of research needs in three areas. First, in intrametropolitan freight moves in hub regions, researchers need to define what "local freight" means. Shippers may not even know, so researchers need to spend time defining the concept. Second, a better exploration of case studies of existing policies and experiences is needed, in particular an examination of pricing strategies. The PierPASS program has been evaluated, but looking at other pricing programs would be beneficial. Finally, O'Brien suggested conducting an inventory of municipal-level regulations that affect freight flows in trade hubs and gateway regions.

Session Summary

Genevieve Giuliano

Genevieve Giuliano identified three themes in Rodrigue's presentation. The dominant theme was that of the importance of taking a comprehensive approach to city logistics and the broader context in which it takes place. All the types of flows, the modes on which they move, and all the metro locations in which those activities take place come under this purview. Rodrigue provided the audience with many examples, she said.

The second theme was that of the concept of city logistics terminals and the important function they play. Terminals affect the larger network and the whole supply chain. Third, Giuliano pointed out, Rodrigue mentioned creating a global city logistics performance index, which instantly initiated questions on what types of metrics would be used.

Finally, Giuliano said, Rodrigue made a point about the importance of decision makers who are typically supply chain managers. Giuliano described these decision makers as key global players. For example, Wal-Mart managers and Target managers are key global players who have tremendous impacts all around the world and significantly affect cities through their supply chain designs.

Vanelslander, Giuliano said, walked the audience through the types of strategies that could improve efficiency in freight hubs, namely time shifts and modal shifts. The weakest link limited what could be done. In Vanelslander's example, the opening hours of Customs facilities was a limiting factor that raised costs for companies who tried to operate outside of opening hours. Another point that was clear throughout Vanelslander's presentation, Giuliano said, was the conflict between technical ability to generate efficiencies (e.g., by using appointment systems or pricing strategies) and institutional habits that may block these strategies. Researchers have the technical knowledge and can simulate the benefits of strategies, Giuliano said, but they cannot change the opening hours of Customs facilities. She recommended identifying which conditions were binding and which were not.

Woudsma's presentation illustrated the often-conflicting objectives of environmental regulation and economic efficiency. In Canada, the government aims to get more of the trade market in North America; thus, it allows the use of higher-capacity equipment, such as double and triple trailers, which increase efficiency and therefore support an economic development strategy.

Giuliano also mentioned the value of careful empirical studies, such as the one done by London Transport, to show exactly what happens when a policy like an LEZ is implemented. London has documented the environmental benefits of the LEZ, and such documentation is rare. Giuliano said it was important to have such measures—in this case, to know if air quality improved—so that policy makers and decision makers can see if the social benefits outweigh the costs.

O'Brien's presentation detailed the implementations undertaken by Southern California ports and how to make changes in a complex world of trade-offs. In the Southern California case, the ports took a risk that they could impose these costs given the uncertainty and yet still maintain market share, Giuliano said.

Session Questions and Answers

Barbara Lenz commented that with supply chain nodes and various functions, we have to ensure that we have the right function in the right location.

Edoardo Marcucci questioned the value of a city logistics performance index, because 39 gateway regions have 90% of the worldwide concentration of freight. He praised Vanelslander's point that cooperation is needed along the whole supply chain, especially given that not all agents in the supply chain have equal power. From a methodological perspective, analytical tools are needed to estimate the interaction among agents, he said. Within supply chains, there is not just one reaction but many. Marcucci also praised Woudsma's presentation for its clear conception of how environmental regulations influence the flow of goods. Multilevel governance is at play, from cities where flows are local on up to regional, national, and international: different regulatory policies have different impacts. It would be nice to see if regulations could be coordinated, Marcucci said.

Finally, from O'Brien's presentation, Marcucci appreciated seeing the effects of pricing policies and what could be done. He suggested that, methodologically, researchers could develop instruments to test the effects of policy interventions.

Vanelslander agreed with Marcucci about the need for tools to look at cooperation among supply chain actors.

Woudsma added to Marcucci's point that not only are multilevel jurisdictions a challenge, but sometimes even within a given jurisdiction, multiple players have competing models and may be unaware of others' models. This was the case when Woudsma worked with the Federal Ministry of Canada and saw that the Environmental Ministry and Natural Resources Canada each had their own models but did not talk with one another. Therefore, even within a jurisdiction there may be lack of communication or interplay.

O'Brien agreed with Marcucci's call for case studies and evaluating the effects of strategies implemented. He urged that not only success stories but also failures be included in order to understand why some strategies failed to be implemented.

René de Koster asked about the impact of warehouses that are located at the edge of cities. He said such warehouses generate problems that must be mitigated, but no one had yet spoken about that topic. Goods flow from these warehouses, but labor also must get to them. Often, warehouses are located where people do not want to work. Warehouses often get automated when people do not want to work there.

Vanelslander replied to de Koster, saying that these warehouse issues are similar to the issues that seaports have, namely the problem of getting people there and the cost of land. He agreed that such centers could be important centers of jobs and value added, and thus merit research.

Rodrigue added that, over time, terminals and warehouses could create neighboring services and activities, generating a critical mass of people to bring in service industries like restaurants and shops.

Carlo Vaghi asked Vanelslander whether, in his survey of hubs, he took into account the neutrality of the location (i.e., a hub that does not favor any particular carrier) as a success factor.

Vanelslander answered that yes, neutrality and confidentiality are important success factors, which is why collaboration is important between operators who specialize in providing special types of contracts that guarantee neutrality.

Vaghi asked Woudsma about the congestion charge, which has had successful results in reducing traffic by 23% and accidents by 22% and improving environmental standards in the Milan city center through bundling freight and better truck utilization.

Woudsma responded to Vaghi's point about reducing the number of accidents, saying that in many countries road space is shared by vehicles and bicycles, increasing bicyclists' exposure to potential crashes. In some cities, environmental considerations may be less of a motivator for regulations than public health and reducing accidents.

Anne V. Goodchild asked a question of O'Brien, saying he seemed to imply that PierPASS was industry driven, but she thought it was driven by air quality regulation.

O'Brien answered that Goodchild's was a fair point, but PierPASS happened because of significant buy-in from the terminal operators because it was in their best interests. It is true that state-level legislation was in the works to mandate something similar to PierPASS, but with that legislation, proceeds of the fee charged would have gone back to the state, not the terminal operators. With PierPASS, the proceeds of the fee go back to the terminal operators. Thus, PierPASS was terminal-operator driven, and that was a key reason for its success. O'Brien added that it has not been possible to audit the program, but it was not losing money. A combination of heavy trade volumes and political pressure drove the terminal operators to act.

Rosário Macário commented that researchers needed to think clearly to distinguish between what is "urban" and what is not. She posed several questions: Where are the locations of hubs? Are they in metro areas, and how is it reflected in the supply chain? Where are the elements of value added of urban logistics, and what elements of the supply chain can provide value?

Vanelslander replied that different kinds of cities play different roles in the supply chain and have different needs. He noted that there has been an evolution in thinking about "urban": an area like the region of Flanders is considered a metro area because of its dense population. But although Flanders is considered to be a metropolitan area, it is not a classic city and has very different needs.

Woudsma turned the question back on Macário, asking her what she meant by "urban." To planners, "urban" means a dense built-up core area with a dense population. To them, the core is urban and the rest is suburb.

Macário replied that she considered a location "urban" if it was administratively defined as such.

Woudsma added that downtown Chicago is different from the suburbs of Chicago. Some see urban areas as parcels of land, he said, while others see them as markets.

Rodrigue added that other typologies of cities that can be looked at are as a jurisdiction, as a commuting range, as a market, or as a government region; there is variation in levels of density. He suggested research be done in the area of added value and value chain to find which cities are adding value. Globalization has decreased the costs of manufacturing. For example, Apple captures 50% added value. There are logistics inequalities in terms of where value gets captured.

Kazuya Kawamura commented that more research was needed about rail terminals. In France, an older terminal was converted for Monoprix's use to haul freight into the Paris city center by rail. Having logistics centers at the outskirts of a city means that goods have to be delivered into the city, but they also offer an opportunity for rail freight to bypass the city, as happened in Chicago. Building outside the city can provide benefits, as well.

Edgar Blanco commented that the Port of Los Angeles in 1988 was taken to court, lost the lawsuit, and was forced to improve air quality, which led to initiatives like PierPASS. He asked whether O'Brien saw nongovernmental organization pressure as a factor that motivates mitigation measures. Entities are committed, even if their commitment is not quite market driven.

O'Brien answered that the court case was against a China shipping terminal, which did result in specific environmental measures, but PierPASS was based on rising trade volumes and involved all the terminals, not just one terminal, which made it work. He noted that many others have looked to Southern California as a leader and have emulated measures such as the Clean Truck Program by calling theirs a "Clean Truck" program, but they do not have the pressures of compliance. Participation is voluntary, and other ports like to advertise that they are "congestion-fee free" in contrast to Los Angeles, using this as a marketing tool to attract vessels to their ports.

Logistics Efficiency in Urban Areas

Part 1

Alan C. McKinnon, *Kühne Logistics University, Hamburg, Germany*
Téodor Gabriel Crainic, *Université du Québec à Montréal, Québec, Canada*
José Holguín-Veras, *Center for Infrastructure, Transportation, and the Environment, Rensselaer Polytechnic Institute, Troy, New York, USA*

Introduction

Alan C. McKinnon

Alan McKinnon began the session by saying that many would say that there is a lot of inefficiency in city logistics, but companies do not like to divulge that their vehicles are underutilized, even though that underutilization may not be their fault. He reiterated the theme of boundaries, saying that if we want to measure efficiency, we have to define the boundary. The boundary could be the trip, the collection–drop point, the delivery network, the logistics system, the supply chain, the urban economy, the national market, or the world as a whole. Drawing the boundary will be critical. If the boundary is just the drop-off point, then efficiency rests with truck driver behavior. But if logistics is the boundary, then efficiency measurement must consider storage space utilization, management of inventory, materials handling, land use, and so forth. A supply chain boundary, in turn, means adding a multiple-company perspective. What metrics, then, should we use? McKinnon named several ratios. The numerator might include terms such as costs (of transportation, logistics, supply chain), time utilization, or ecoefficiency (energy and emissions). The denominator might include terms such as number of delivered cases, consignments, vehicle kilometers, tonne-kilometers, or case kilometers. What are the key performance indicators? The bigger the boundary, the more trade-offs and conflicts among actors. There are many stakeholders, and efficiency must take into account both the public and private perspectives.

McKinnon set forth the four issues that would be discussed in this session:

- Measuring efficiency and inefficiency,
- What can be done to enhance efficiency,
- The barriers and constraints to improving efficiency, and
- The role of the public sector in giving companies incentives or using policy interventions to improve efficiency.

Measuring Efficiency and Inefficiency in Urban Freight Transport

Téodor Gabriel Crainic

Teodor Crainic opened by noting how essential transportation and logistics are to cities. Without transportation, society as we know it would not exist; without logistics, the modern economy would not exist. In short, transportation and logistics are essential to most economic and social activities. Cities cannot survive without freight transportation. People would die of hunger or die in their own garbage. Urban freight transport is a necessity, even though it has negative effects on the quality of life and future generations as a result of emissions, noise, and energy consumption.

Crainic further observed that people want the benefits of transport, but they do not want to tolerate the activities and inconveniences associated with it. Freight does not vote, but passengers do. Freight is a private-sector activity.

Government does not worry about freight because freight movement is primarily handled by the private sector. The result is that government takes a rule-heavy approach to mitigate the impact of freight transport on citizens. Crainic discussed zoning access regulations. These regulations forbid heavy trucks from entering a city and regulate parking. The closer to the city center, the more restrictive the rules are against the size of vehicle that can enter, and the less parking is permitted. These zoning access regulations are necessary, but they are not sufficient, and sometimes they are detrimental.

Crainic continued by saying that urban freight is part of the larger global logistics picture, and it involves more than the last mile. The literature on urban freight focuses on inbound traffic and largely tends to ignore the other significant flows that take place in a city, namely outbound traffic by producers, through traffic en route on major corridors, and traffic flows within the city that result from the city's being a major activity center.

Measuring Efficiency

Freight is both efficient and inefficient at the same time. Freight is efficient in that it flows around the globe, supplying people, industry, and institutions. UPS and Wal-Mart say they are efficient: they deliver on time, at low cost. They make a profit while keeping prices low. However, the system as a whole is inefficient from a systems perspective and cost to society. Resource utilization is low. For example, the average load factor of trucks in cities is 25%. There are other inefficiencies, too, such as duplication of warehouses, which results in underutilization of warehouse space. This inefficiency makes the system unsustainable in the long term, possibly even in the medium term.

In terms of measuring efficiency, there are many measures, but the measures depend on what is being measured and who is doing the measuring. Companies measure costs, profits, and reliability of on-time delivery and pickup services, but there are other measures of efficiency, such as congestion, emissions, overall pollution, and noise levels. Carriers use measures such as time lost in traffic and the cost of this time. City governments have yet other measures, such as safety (e.g., fatalities and injuries). All these measures must be integrated into city (and state and national) planning committees and advisory commissions as well as into data collection and planning activities. How much is freight integrated into the DNA of city planning? Not much, Crainic said, joking that it was "0.something."

Crainic referred back to the idea of a global city logistics performance index, which Jean-Paul Rodrigue suggested would be based on perceptions. But, Crainic asked, perceptions by whom? The corporate world sees that cities are not organized for their businesses to be as profitable as they could be, and this sector has little interest in the needs of passengers and bicycles. City planners have different perceptions. Citizens, especially pressure groups, have their own perceptions, as well.

Efficiency is in the eye of the stakeholder, Crainic said. It depends on who is being measured, what is being measured, and what the goals are. The range of stakeholders includes producers and shippers; logistics-service providers and warehousing facilities; carriers, intermodal facilities, and distribution centers' consignees (industry, retail, institutions, people); authorities (city and borough, state or province, and so forth); and people (as consumers, as citizens, and as special interest groups). People can be both consumers and citizens, but their behavior varies according to their roles. For example, people as consumers want to have goods close to them, at a good price, arriving on time. But people as citizens do not want the trucks that deliver the goods and cause congestion or noise. Citizens start pressure groups and become "NIMBYs" who say, "not in my back yard."

Challenges to Efficiency

Crainic then discussed challenges. The main challenge is reconciling the efficiency requirements of the various stakeholders. Business models that foster efficiency for individual stakeholders and for the city system as a whole are needed. To create these new business models, Crainic recommended going beyond "urban freight transport" to "city logistics." This change involves moving beyond a logistics system (shippers, shipments, carriers, service providers, vehicles, and consignees) to include a "public system" view operated as best fits the local culture, laws, and regulations.

Another challenge is how to make the city a better place to live, work, visit, move within, and move through without penalizing its economic activities. We have to foster an efficient transportation system and make transportation become a mainstream part of urban design and planning.

Crainic's list of challenges included education, leadership, governance, legal and financial incentives, collaboration, innovation, data, evaluation and optimization and, finally, integration. He called for more research both within the discipline and in collaboration with other disciplines.

The Physical Internet

Crainic offered a quick illustration based on the physical internet metaphor. The digital internet has moved from numerous unconnected computers to an internet and worldwide web that consist of independent networks interconnected in a transparent way for the user. The digital internet involves transmission of standard formatted information flows (data packets) in seamless transit through heterogeneous equipment, respecting standard protocols (TCP/IP). In the same way, the physical internet consists of independent networks interconnected in a transparent way for users. The physical internet involves transmission of standard formatted physical flows (modular containers) in seamless transit through heterogeneous intermodal facilities and transportation networks. More information on the physical internet concept can be found at http://www.physicalinternetinitiative.org/.

The physical internet framework is scalable from intracity logistics to intercity, interstate, and eventually intercontinental networks. A simulation of the mobility web for the consumer industry in France (using retailers Carrefour and Casino, their top 100 suppliers, and road and rail integrated into a physical internet network) showed promising preliminary results based on existing infrastructures, facilities, demand patterns, and service levels. Specifically, the simulation showed an overall cost savings of up to 26% and a reduction of greenhouse gas emissions of about 60% as a result of consolidation and mutualization of facilities and flows. Modular, standard containers are a key factor in the savings and efficient flow of goods.

Research Recommendations and Challenges

Crainic concluded with a discussion of research challenges and opportunities. The first research challenge is to create socially aware organizations and business models that have solutions tailored to the culture and business. This solution involves understanding and modeling stakeholder behavior, governance, demand identification, partnerships and collaborations (supply models), and public policy.

Data collection is another research opportunity, as is research to create evaluation models and tools. Currently, the overall number of models and tools is limited in scope and size. Most models take limited (or no) account of planning and advanced intelligent transportation system (ITS) technology. Yet another research area is comprehensive urban transportation planning that integrates freight with people (private, public, alternative) transportation, ITS, and land use.

A research opportunity also exists in the combination of system, service, and operational planning. New problems require new models, algorithms, and instruments. In particular, strategic planning needs a system design perspective that takes into account multilevel location routing, freight corridors, and fleet (resource) dimensioning. Tactical planning needs service network design encompassing schedules, time issues, and routing. Finally, operational planning, control, and management should allow adjustment of plans to accommodate variations in demand and modify vehicle routing. Overall, Crainic said, the whole system needs to be able to deal with uncertainty and be resilient to shocks and changes.

Finally, research into the physical internet and interconnected logistics is needed because little has been done from an operations research perspective, and practically nothing has been done from a transportation point of view. The physical internet offers a perspective for better, more efficient, and more profitable transportation and logistics systems that will lead to better cities. The containers and automatic transfer equipment required for efficient operations are coming, Crainic believes, and the physical internet and smart city logistics offer great opportunities for synergistic research and development.

Opportunities for Improving Efficiency

José Holguín-Veras

José Holguín-Veras began by defining the "freight system" as the conglomerate of all the economic entities involved in the generation, transportation, consumption, and transformation of cargo. Five key agents play a role in the freight system:

1. Producers, who manufacture or produce the goods;
2. Shippers, who send the goods;
3. Receivers, who use the goods transported;
4. Carriers, who transport the goods; and
5. Ancillary entities such as warehouses and distribution centers.

The first three agents listed are key to behavioral change, Holguín-Veras said.

The freight system currently has low efficiency as a result of competitive market forces. For example, carriers are very efficient from a private point of view, but not necessarily efficient from a social point of view. The solution, Holguín-Veras suggested, is to modify the markets through policy interventions. Surveys show that about 25% of the truck trips are empty and that average load factors in urban areas are 20% to 30%. Increasing this efficiency would translate into more livable cities and a more productive economy.

Holguín-Veras next offered a case from the New York City metro area, in particular Manhattan, which has about 200,000 daily shipments that are delivered or shipped out. Many of these deliveries go to large establishments like the Empire State Building, which has 1,000 offices. Grand Central Terminal has 100 stores served by 300 to 400 trucks daily. What can be done to improve efficiency? Holguín-Veras listed eight interventions, which can be grouped into four areas: supply interventions, operations, demand, and policy interventions. Specifically, infrastructure-related interventions focus on supply. The next five interventions are traffic management, logistics management, vehicle-related interventions and pricing, and taxation, all of which are operations focused. Sixth and seventh are demand management and land use management (and pricing and taxation again), which are demand focused. Finally, proper governance is important because it enables policy intervention.

Traffic Management Interventions

Holguín-Veras zeroed in on traffic management interventions, which he identified as a key area in which more could be done. Traffic management interventions include the following:

- Access time restrictions;
- Vehicle size restrictions;
- Truck and traffic route regulations (advisory, statutory, and freight routes);
- Lane management (multiuse lanes and exclusive truck lanes);
- Traffic signals and signs; and
- General infrastructure investments.

When using one of the first three interventions, it is important to consider it carefully, because many have failed and some of the implementations could make things worse if poorly applied.

Pricing and taxation interventions also need to be carefully applied. For example, freight road pricing is of limited effectiveness to reduce congestion, but it could produce significant revenues to finance improvements. It is important to ensure that vehicle license fees reflect the externalities produced by vehicles based on their age and condition. The PierPASS program worked because the fees were charged to the receivers of the cargo, who decide on delivery times. The Muni Meters scheme in New York City, which changed the location of parking spaces, also worked and showed tremendous improvement. Before Muni Meters were implemented, trucks were paying from $500 to $1,000 per month in fines.

Demand and land use management interventions include the following:

1. Promoting off-hour deliveries (OHDs) using incentives;
2. Fostering a mode shift whenever possible;
3. Promoting staggered work hours;
4. Fostering clustering of warehouses, terminals, and distribution centers;
5. Fostering the location of terminals at the fringe of urban areas; and
6. Relocating large generators of freight to locations where they can grow and create less impact.

The last of these is the area with the greatest potential and, ironically, is the least-studied group. Convincing receivers to change behavior could transform entire supply chains and put them on the path of increasing sustainability.

Off-Hours Delivery in New York City

Holguín-Veras offered a detailed example of an OHD project, a demand management intervention in New York City. The background of the project was that both theory and empirical evidence agree that cordon time-of-day pricing interventions are of limited effectiveness in moving urban delivery traffic to the off-hours. The results of the 2001 Port Authority of New York and New Jersey time-of-day pricing initiative showed that 20.2% of carriers changed behavior, mostly by increasing productivity (not by reducing facility usage). Only 9.0% of the sample increased rates, and increases were relatively small (about 15%), which meant that most of the truckers absorbed the extra costs. Of the carriers who did not change behavior, 69.8% indicated that their lack of change was due to "customer requirements"; that is, customers did not want to receive deliveries during off hours. There was almost no change in facility use. These results show that truckers are the weakest players in that they cannot change customer demands and they cannot pass on the costs to the customers. Holguín-Veras noted that London experienced similar results for its time-of-day pricing initiative. He concluded that such pricing schemes would have to charge exorbitant fees to bring about a change in behavior.

Holguín-Veras explained that there is a market failure. Markets typically find the most efficient outcome, but when they do not, public sector intervention is needed. OHDs are beneficial to society on numerous fronts. They have huge environmental benefits because they result in less pollution, and carriers as well as regular-hour travelers (cars, buses, and trucks) all benefit by spreading deliveries to off hours. Although noise of delivery can be problematic, new research and development (such as the PIEK program in the Netherlands) have resulted in quieter vehicles and handling equipment. The main disadvantage of OHD, however, is that receivers accrue additional costs if they do not already have nighttime staff or cannot support unassisted nighttime delivery. The market failure in this case is that the savings that carriers gain through OHD is not large enough to compensate for the receivers' costs. The solution, therefore, is either to compensate receivers for their additional costs or to develop technologies or systems that allow receivers to accept OHD at lower costs.

With funding from the U.S. Department of Transportation (U.S. DOT), a pilot test was conducted to assess OHD performance. The project had five interlocking components. First, it required demand modeling, behavioral, and economic components, which included analyses of the most promising industry segments to target in the pilot and to analyze freight trip generation data. Second, the technology component included using Global Positioning System data to assess performance. Third, the network modeling component included a mesoscale traffic model to assess local impacts and a regional model to assess networkwide impacts. Fourth, industry and agency outreach was needed to get feedback from all involved. Finally, Holguín-Veras conducted a small pilot test, which turned out to be very cumbersome.

Results from satisfaction surveys after the pilot test showed very favorable results. Vendors were happy, and participating drivers felt less stress and experienced fewer problems with congestion, parking, or travel speeds. The time needed to deliver goods and complete the route was reduced, and their feeling of safety improved. Indeed, average travel speeds more than doubled and service was more than three times as fast. At the end of the pilot, however, all of the receivers doing staffed OHD reverted back to regular hours, while almost all of the receivers doing unassisted OHD remained in the off hours. The receivers who stayed with OHD said their main reason for staying with the program was the reliability of OHD.

The economic impacts of the project revealed that implementing OHD policies in Manhattan leads to

- Travel time savings to all highway users of approximately 3 to 5 minutes per trip,
- Travel time savings to carriers that switch to off-hours of about 48 minutes per delivery tour, and
- Potential savings in service times (per tour) in a range of 1 to 3 hours.

Depending on the extent of the policies, economic savings are between $100 and $200 million per year in travel time savings and pollution reduction.

In short, the pilot was a big success and was reported widely in the press. *Time* magazine listed the OHD project as a "Top 10 Ideas" project on March 25, 2013, and New York City adopted OHD as part of its sustainability strategy. Furthermore, in June 2012, the Federal Highway Administration and the U.S. Environmental Protection Agency (EPA) issued $450,000 in grants for small- to medium-sized cities to implement off-hours goods movement and delivery programs based on the New York City pilot. Numerous cities such as Boston, Massachusetts; Washington, D.C.; and Atlanta, Georgia, are considering OHD programs.

Ongoing work after the pilot includes funding provided by the U.S. DOT and its Research and Innovative Technology Administration for a larger implementation project that focuses on enabling unassisted deliveries, namely technologies and systems that enable OHD without the need for staff at the receiving business and that address the liability concerns of receivers. The funding also targets large traffic generators: those large buildings that generate hundreds of truck trips a day. There are about 56 such buildings in New York City, and they generate 4% of truck traffic in the city. Adding in large establishments increases that number to 8% of truck traffic. These large establishments could implement OHD very cost effectively without inconveniencing receivers. One technique to enable unassisted OHD is that of "virtual cages" in which electronic sensors identify the delivery driver, record the times of access, and limit access to those areas where the driver needs to be.

The chief conclusions of the project were that removing the constraints imposed by receivers (either by providing financial incentives or by using unassisted OHDs) works because it is more effective than freight road pricing and because it benefits all parties: regular-hour travelers, the environment, the business community, and the participants in OHD. Noise impacts can be mitigated by electric trucks and low-noise truck technologies and practices. OHD also has political appeal because it is implementable as a voluntary program.

Recommendations for Research

Holguín-Veras ended his session by listing areas of research needed. These research areas, which mirrored the eight intervention areas mentioned earlier in his presentation, are as follows:

1. Infrastructure related,
2. Traffic management,
3. Logistics management,
4. Vehicle related,
5. Pricing and taxation,
6. Demand management,
7. Land use management, and
8. Governance.

Infrastructure-related research could include freight demand modeling, behavior, economics, and game theory. Research Areas 2 through 5 above could include traffic models, consideration of tour behavior, economics, and policy. Research Areas 5 through 7 could include freight demand modeling, behavior, consideration of tour behavior, economics, and policy. Finally, governance-related research could include studying governance structures and multistakeholder decision making.

Questions and Answers

Cathy Macharis liked the different perspectives of stakeholders, which is exactly like the multiactor, multicriteria analysis (MAMCA) method. The global city logistics performance index could include the point of view of different stakeholders in assessing city efficiency.

Crainic agreed the MAMCA tool would be a great tool to use. As an operations research person, he would add people to the equation and play with the number of stakeholders and their objectives to build in flows and feed the model.

Birgit Hendriks said she was a big fan of Holguín-Veras's OHD solution and asked who "sold" the solution to the establishments.

Holguín-Veras replied that effecting changes in behavior is difficult, and there is much inertia. New York City was fortunate to have a commissioner who has been supportive. In his own opinion, Holguín-Veras said, incentives are needed. New York City has existing incentives to encourage economic development, as well as to reduce energy use. About $200 million in incentives is available, so nighttime deliveries or other sustainable activities could be part of these efforts. Similarly, the EPA has the SmartWay program to incentivize replacing truck engines with more efficient, less polluting ones. Nighttime deliveries would solve a host of problems, reducing traffic during daytime hours and all the externalities that come from them. Environmental benefits would accrue to the whole network, not just Manhattan.

Edoardo Marcucci said he liked Holguín-Veras's approach and the need to understand behavior. He asked which analytical tools and methodologies Holguín-Veras used in the study to understand behavior.

Holguín-Veras replied that he conducted a lot of basic research and modeled interactions of carriers and receivers and the economic conditions to allow OHD to work. He conducted in-depth interviews and focus groups and used game theory to gauge which industry segments would be most inclined to participate. Incentives help effect behavior change. Participating companies gained public relations goodwill. He is now consulting with hotel properties in Manhattan and said that companies need to be rewarded for their good behavior. Companies who have a trusted vendor were the most likely to participate in OHD, he said.

Ken Button followed up on the comment about behavior change, asking why the private sector did not participate more in these seemingly win-win solutions.

Holguín-Veras replied that it took some years for him to understand this issue. Markets want the most efficient outcome. Analysis of OHD shows that it is more efficient than daytime delivery. So why don't companies do more OHD? Holguín-Veras concluded that it has to do with the market fee that receivers have to pay. In OHD, they need staff in the off hours to receive the delivery. Because receivers are in a position to dictate when deliveries will come, they do not choose OHD because they do not want the added expense of nighttime labor. Carriers save money through OHD, but these savings are too low to compensate for the cost increases to receivers. OHD benefits society, so there would be an overall benefit if receivers did not have to pay the increased costs.

Logistics Efficiency in Urban Areas

Part 2

Birgit Hendriks, *Binnenstadservice, Nijmegen, Netherlands*
Ian Wainwright, *Transport for London, United Kingdom*
Chelsea (Chip) White, *Georgia Institute of Technology, Atlanta, Georgia, USA*

Barriers and Constraints

Birgit Hendriks

Birgit Hendriks began by showing slides in Dutch from Henk Diepenmaat because she wanted to pique attendees' interest about his work. His slides showed freight movements from medieval times.

In modern times, she said, we need to solve the collateral damage issues of freight movement and need a multiactor process for management. Actors cannot only make decisions within their own systems, because that is only one level. Researchers and companies need to talk to each other and build a new system together. Freight transportation needs to satisfy three needs: to be both effective and efficient but also to take societal needs into account. Thus, Hendriks urged, political actors need to be involved, too, and not just U.S.-EU actors, but other stakeholders as well.

Case Study: Binnenstadservice

Hendriks described the Binnenstadservice concept, which is a collective warehouse used by small-end receivers, namely small retailers, offices, and cafés and restaurants. These receivers send a change of address to their suppliers, asking that the goods be delivered to the collective warehouse rather than to their individual establishments. Carriers deliver goods to the Binnenstadservice warehouse, regardless of who the individual end receiver is. Binnenstadservice receives the goods, signs the papers, and bundles the goods to deliver them efficiently to the individual receivers. The concept is end receiver–driven and was organized bottom up. Reverse logistics are included in the Binnenstadservice service. The service uses clean trucks to make deliveries to the end receivers. The focus is on small volumes that go to many receivers, not full truckloads that would go to one end receiver. Consolidation of multiple end receivers reduces the number of trucks that have to make deliveries, and it also reduces the number of trucks that would be associated with reverse logistics.

Binnenstadservice began with one city, but the organizers realized that to survive after the subsidy ended, they would need to expand to other locations. Binnenstadservice is organized as a franchise operation now and receives no subsidies. The next step is to expand to every city in Europe to build a Europe-wide network.

The system currently has 1,000 suppliers, 60% to 70% of whom are from somewhere in the EU, so Binnenstadservice needs one EU phone number for simplicity. For Binnenstadservice to work effectively, all cities have to be accessible in the same way and during the same hours so that trucks can make deliveries anytime. The system would not work if one truck could enter one city but not another. There has to be a spot in every city where a truck can unload.

The Binnenstadservice concept operates at three levels, with "tree-level coordination" warehouses. At the local level are inner-city service centers that city entrepreneurs use as their delivery address. The consolidation work is done at this level, as small deliveries from different chains come together. Thus, the inner-city service center coordinates the last mile. At the national level is BS Netherlands. All local service centers use the same information technology (IT) system, particularly for invoices, administration, and financial flows. BS Netherlands services the national shippers in their wish to supply their inner-city customers in a sustainable way. Finally, at the European supply chain level, is Eco2City Europe. The goal of Eco2City is to connect every city in Europe through one European platform. BS Netherlands is now working with Citydepot Belgium and Citylogistik Denmark to form Service2City, which will grow in the coming years as other European countries follow. The current focus is on coordinating freight and information flows. The financial flow will follow later.

Eco2City partners are expected to operate collective warehouses and act in the interest of all stakeholders, with a focus on the end receiver. There is a uniform IT system for booking and invoicing, and operations conform to European "general conditions." The focus is on socially responsible and sustainable delivery, such as clean transport.

For research on the impacts of Binnenstadservice on shippers and carriers, Hendriks called on Hans Quak, who presented results of a study by TNO, an independent research organization in the Netherlands that analyzed whether the Binnenstadservice could be expanded to other cities. The results showed that it could be expanded because the service solved stakeholders' problems. The Binnenstadservice solves problems for carriers as well as shippers by giving them just one drop-off point.

The TNO study ran four scenarios, calculating the effects of the Binnenstadservice service for two shipper–carriers. In the first scenario, no Binnenstadservice was used. In the second scenario, six cities used Binnenstadservice; in the third scenario, 20 cities were used; and in the fourth scenario, 41 cities used Binnenstadservice. The subjects of the study were TWI, a network of travel agencies that receives small-volume deliveries; and Lekkerland, a convenience store chain. The results of the four scenarios for TWI and Lekkerland showed significant cost and time reductions compared with no Binnenstadservice for these shipper–carriers. Reductions of distance, time, costs, and CO_2 emissions of approximately 5% were achieved by both TWI and Lekkerland in the six-city scenario, 15% in the 20-city scenario, and up to 25% for TWI in the 41-city scenario. Rather than using one roundtrip that takes 2 hours to get to the next city, the goods for three roundtrips could be consolidated into one vehicle.

Explaining the wider effects, Quak said considerable savings were achieved per delivery when a Binnenstadservice branch was used. In particular, 48% to 72% fewer kilometers were driven, saving 60% to 70% of time and reducing costs by 58% to 71% and CO_2 emissions by 47% to 71%. The variation in these savings was due to the types of deliveries, round-trip length, the number of kilometers between the city and the carrier's distribution center, and the number of deliveries in each city.

TNO concluded from the study that Binnenstadservice differs from other initiatives because of its focus on a value proposition for all stakeholders. All actors profit from Binnenstadservice. In particular, local authorities benefit through improved quality of the public space and cost savings due to bundled deliveries. Receivers benefit from reverse logistics and value-added logistics. Shippers benefit from the convenience of a consolidated transport order (called a "green order"). Carriers benefit because of a single drop-off point. Finally, inhabitants benefit because of improved quality of the public space. Growth of the Binnenstadservice network into Europe creates opportunities for shippers and carriers to reduce costs, time, and emissions. Binnenstadservice is one of the solutions that organizes city logistics to be more sustainable, TNO concluded.

Barriers and Constraints

Hendriks thanked Quak and continued the presentation by explaining the barriers and constraints encountered when implementing Binnenstadservice. She noted that when she first proposed the Binnenstadservice solution, she was not aware of the full picture of city logistics. She saw the local problems that needed to be addressed and worked with stakeholders in just one city, with everyone sitting around the table working on the solution together. As Binnenstadservice began to scale up to multiple cities in the Netherlands, it received negative press because the concept was perceived as local governments subsidizing a transport competitor. In fact, however, Binnenstadservice only does the warehousing, not the transport. The transport is outsourced to a carrier who delivers from the local warehouse to the shelves or to the end consumer. However, there was resistance. Indeed, transition always brings resistance, Hendriks said. The trick is to find out where, when, how, and who is resisting. Carriers may be resisting because of an unwillingness to change their logistical "ways of doing business" or because they think they earn more money by doing it the old way. Another barrier that Hendriks found was the "macho man culture" in logistics, in which actors believe "I can do it myself." Instead, Hendriks believes that actors should be concerned with sharing, respecting, serving, trust, and social responsibility.

Another constraint Hendriks identified was an eagerness for "quick wins" and the attitude that "we've tried them all and they didn't succeed." There was reluctance to be patient and go for the "slow food" (i.e., a longer-term process). An additional constraint was a disbelief, both in the market and among researchers, about the financial sustainability of the Binnenstadservice solution. Indeed, 106 other initiatives had all failed, but Binnenstadservice recently celebrated its 5-year anniversary and operates without subsidies. Finally, Hendriks saw consultants as a barrier if they did not want solutions but wanted the inefficient status quo so that they could keep earning money from their advisory services.

Remarkably, Hendriks said, there were no barriers or constraints from local governments, establishments, inhabitants, or end consumers. Most of the cities were great ambassadors of the program. Local shopkeepers and restaurants did not offer barriers other than simply wanting to only pay their fair share. Local inhabitants supported the idea because of improved traffic safety and reduced noise. Finally, end consumers loved the idea of more sustainable distribution, Hendriks said, and they wanted it to be used more widely.

Recommendations for Research

Hendriks offered four areas for further research. The first area is organizational and behavioral change around new logistics systems: How can carriers and shippers be motivated? The second area is to research the impacts of a European cooperative network of urban freight service points on European shippers. The third research area would look at these impacts on American shippers. Finally, further research could be done on the transferability of the Binnenstadservice solution. The solution worked because it was in the interests of all the stakeholders. Could this process work in the United States?

Opportunities for Public Policy Intervention

Ian Wainwright

Ian Wainwright spoke about the London approach to public policy intervention, focusing on the example of the London Olympic Games in 2012 and building on that legacy. He began by saying that Transport for London was not just double-decker buses and the underground subway system. London Transport includes these, of course, but it also includes rail, overhead cable cars, bikes, light rail, river service, and traffic lights.

The London Context

Wainwright described the political landscape of London, which is complicated by the existence of 33 boroughs, including the Corporation of London. Boroughs have wide-ranging powers and responsibilities over planning, waste, traffic, and environmental health issues such as noise levels. There is potential for some harmonization and standardization across these boroughs, Wainwright said.

In London, 88% of all freight by weight comes by road, 5% by rail, 5.8% by water (river and canals), and 1.2% by air. On a typical weekday in London, 281,000 journeys are made delivering to 290,000 businesses and 8.2 million residents. In total, 13 million kilometers are traveled per day, and 80% of this traffic takes place between 6 a.m. and 6 p.m. Freight comprises 16% of London's road traffic (compared with 1.7% for buses) and employs 5% of London's workforce. Road transport produces 24% of CO_2 emissions in London. Wainwright added that London's population is once again growing, which will only add to the problems, and he questioned why 80% of deliveries had to take place from 6 a.m. to 6 p.m.

The traditional approach to policy intervention is complicated by the borough structure, in which each borough can set its own policies on parking restrictions, loading times, and so forth. Given the 33 boroughs, one street could be subject to different controls as it moves through different boroughs, which causes confusion for operators. On one street in London, nine sets of regulations apply. Furthermore, some streets allow off-hour delivery (OHD), and some do not. In addition, the single yellow line and double yellow lines indicating parking and the markings indicating loading and unloading restrictions differ widely among jurisdictions; these differences have resulted in five million parking violations issued in 2011 and 2012.

Interventions: Congestion Pricing and the Low-Emission Zone

Wainwright discussed two policy intervention schemes implemented in London: congestion charging and the low-emission zone (LEZ). The congestion-charging program was introduced in 2003. Initially a £5 daily fee was charged for all traffic moving into Central London between 7 a.m. and 6 p.m. This fee is currently £10 according to Transport for London's website. The penalty for violation was £130, and the overall goal of the scheme was to improve the environment and safety. The results of the scheme showed a reduction in general traffic, but freight still needed to move, so the scheme reduced general traffic more than freight traffic. Also, congestion overall did not improve much because some road space was reallocated to make more room for cyclists and pedestrians in the downtown area.

The LEZ was introduced in 2008 and increased in scope in 2012. The scheme was not intended to be a big financial success, but it has eliminated 28 tons of particulate matter. The Mayor of London is considering designating an ultra-low-emission zone to get even lower emissions.

London Freight Plan

In contrast to the traditional approach to policy intervention, which focused just on engineering and enforcement, the London approach has added a third tool, behavior change, to the traditional "engineer and enforce" duo. The approach involves research and data gathering to create a draft plan that, after consultation, becomes a London Freight Plan that identifies a program of work for Transport for London in conjunction with the local boroughs.

The London Freight Plan for sustainable freight distribution includes a fleet operator recognition scheme (FORS), delivery and servicing plans, and construction logistics plans (see www.tfl.gov.uk/freight). Fleet operators are recognized for emissions reductions, safety, compliance, and best practices, all with the goal of improving fleet standards. To date, 2,000 operators are involved in the recognition scheme, from small single-vehicle operators to DHL and TNT, who want to have their depots accredited. Transport for London itself is a procurer of goods and services, particularly for large construction projects, and it ensures that anyone delivering to Transport for London is demonstrating good practice. Other cities have adopted some of the freight plan proposals. For example, Newcastle (UK) is implementing FORS, and Brussels is currently considering implementation of delivery and servicing plans.

Freight Plan for the London Olympics

Wainwright moved to a discussion of the 2012 Olympic Games, which was the world's largest peacetime logistical event, comprising representatives from 203 countries and an Olympic Family of 55,000 people that included athletes, officials, and media. Over 8.5 million tickets were sold. Clearly, such large scale creates huge road and passenger transport challenges, and London officials evaluated the logistical implications of hosting the Games and knew they would have to make sure all the shops, restaurants, hotels, and so forth were kept supplied during the 2 weeks of the Games. In conducting this evaluation, London realized there was no single source of information, and little available second-hand information from previous Olympic host cities like Sydney and Vancouver, about how to manage the challenge. They worked out a plan for controlling the impact that the Games would have on transport for 6 weeks in 2012.

Transport for London created a Road Freight Program for industry describing the issues, solutions, and actions of how deliveries would be made during the Games. The program included discussions with industry in "freight forums," which included large carriers like UPS and DHL, big construction and waste removal firms, and regulators and representatives from the local boroughs and national Department for Transport.

The Road Freight Program included an advice program to reduce, retime, reroute, or revise delivery modes. An awareness campaign comprising leaflets, posters, radio advertisements, one-on-one meetings, workshops, and e-mails was also part of the process.

The Road Freight Program worked well, as shown by data from the Transport for London's network of traffic cameras, which showed retiming of freight traffic, particularly large (over 3.5 tons) vehicles, entering and leaving London. The proportion of truck traffic in daytime hours during the Games was 31% during the Olympics and 35% during the Paralympics, compared with 39% in the summer of 2011. The biggest increases of freight traffic were between 8 p.m. and 6 a.m.

Lessons from the Games show the value of political and industry engagement, especially with the construction sector and across Transport for London, the London boroughs, and London councils through the freight forums to understand needs, identify specific points of contact, investigate best practices, remove barriers, and sell the culture of behavior change. Direct engagement between regulators and freight operators above the transport manager level, to real decision makers, was of great value. Talking industry language (i.e., cost and service rather than less direct terms about air quality) also helped get industry attention and buy-in to the concept of retiming deliveries, reconfiguring routes, and collaboration. OHD, consolidation, and revised delivery modes were all used. Finally, explaining freight and logistics in the media helped customers to understand the nature of their own supply chains and led to more "conscious procurement," such as bulk ordering or preordering. One of the lessons learned was that 35% of goods delivered to a building might come from individuals ordering online for personal use but asking for office delivery rather than home delivery.

The Games provided a burning platform (i.e., a "do or die" situation) for business and local authorities alike. Businesses could see impacts on costs, service, reputation, and delivery reliability, while authorities could see negative impacts on air quality, congestion, cyclist and pedestrian safety, and journey time reliability. Although the Games were a one-time event, the reality of London's growing population (1.25 million more people by 2031) and economic development (750,00 more jobs and a 15% rise in demand for goods and services coupled with a 10% decrease in road space availability) show that the need for planning for freight will continue in the future.

Going forward, Wainwright said, the three key elements to address in a revised freight program are to

- Reduce the traffic impact of freight on the road network, reducing peak activity and minimizing the congestion resulting from deliveries and freight traffic flows, in balance with other road users;
- Reduce the impact of freight on the environment, improving overall air quality and reducing noise attributable to freight; and
- Increase the levels of compliance and safety, specifically reducing the potential for impacts or collisions involving freight vehicles.

These three elements are things with which everyone can agree, along with the use of key performance indicators to measure performance.

The work topics to achieve the outcome of safer and more efficient deliveries involve logistics efficiency, as well as doing the right things for safety and the environment. Lessons from the changes made during the Games show that it is possible to reduce the impact of road traffic through a variety of measures, such as consolidation, conscious procurement, or by changing the mode from truck to rail, water, bike, or walking. Two other lessons from the Games show that it is possible to retime freight activity, particularly away from the peak times, and to make more use of the transportation network 24/7 and to switch to OHD. Third, it is possible to maximize efficient journey planning, ensuring practical routing of freight activity (both heavy goods vehicles and vans) and dealing with issues around the loading location to increase compliance and minimize parking tickets (penalty charge notices) for operators.

A new team in Transport for London is looking for logistics efficiency and is planning interventions in certain areas or events such as during the London Bridge redevelopment. These interventions require consistent messaging to shippers and carriers, as well as joint conversations to share information. This information will be supplemented by the work focusing on increasing the safety of the industry, particularly for vulnerable road users such as cyclists.

Future Policy Interventions

Current policy direction includes a roads task force, a cycling vision to increase the numbers of cyclists and offer greater levels of safety, and an ultra-low-emission zone. The cycling lobby is powerful in London and is a political issue because bicycle fatalities and even mere accidents become major news stories. There were 16 cyclist fatalities in 2011, nine of which involved heavy goods vehicles, mainly construction vehicles. Politicians do not want to deal with these kinds of accidents and fatalities. The questions around the ultra-low-emission zone include defining its boundaries and defining what "ultra low" means.

Transport for London's tasks include data gathering and modeling, reviewing existing regulations and restrictions, cyclist safety, off-hour activity, electric vehicles, logistics, and land use. In particular, Transport for London will look at how much freight is moving, what the regulations are, and what the perceptions of players are in a number of key locations. They want to deliver for industry so that industry players remain involved.

Opportunities for Research

Wainwright concluded by identifying research gaps and opportunities for research. The first opportunity is for quantification:

- Which policy lever should be pulled? What will happen?
- If a city bans trucks, what effect does it have on safety?
- What happens to the bottom line—the costs of goods and services—as a result?
- If a new policy is implemented, what are the consequences?

Other gaps in research include not knowing what is moving where and when, and who is controlling the activity (shipper, receiver, regulators, or residents' fears). More research also needs to be done on light-goods vehicles and vans, as well as on home-delivery models that residents will support. Finally, the policy impacts (general traffic versus freight) on safety, emissions, and costs are another area for research.

Session Summary

Chelsea (Chip) White

Chip White wrapped up the session with a recap of the talks and offered general comments from the session overall.

First, White said, Téodor Crainic talked about measuring efficiency and inefficiency in urban freight transport and discussed what is measured and what should be measured. He discussed costs and profits and performance measures, such as on-time and same-day delivery, as well as service reliability. Crainic also presented the negatives of inefficiencies, namely congestion, which affects mobility; emissions and overall pollution and noise levels that compromise city livability; and safety issues such as fatalities and injuries, which are both personal and community costs. Crainic called for integrating planning and advisory activities with research activities and data collection.

Crainic further identified many needs for efficiencies. In cities, there is simply not a lot of extra space for products and waste, and there is a high cost of "building out" of congestion. Although Crainic did not talk much about the high cost of building out, White said, it is one of the differences in urban logistics that sets it apart from nonurban logistics.

Despite all the inefficiencies of urban logistics, however, there are many opportunities to move from inefficient to efficient operations. One such opportunity is using real-time congestion information, but there is a challenge in balancing the competing needs of reducing the number of vehicles and miles traveled while maintaining the ideal of just-in-time delivery due to high inventory costs. Coordination and consolidation are required. Crainic also talked briefly about the physical internet, using the virtual internet as a metaphor that illustrates the high value of universal standards.

Next, White summarized José Holguín-Veras's presentation about opportunities for improving efficiency. Holguín-Veras offered examples of public-sector interventions to improve urban freight and identified research needs in this area. Holguín-Veras provided an in-depth example of the OHD project in New York City, which was both very successful and very challenging to implement. Could this example be replicated elsewhere?

Holguín-Veras also made the point, White continued, that current trucking practices are efficient from the private company perspective but are inefficient from a systems perspective. For example, surveys show that 25% of truck trips are empty and only 20% to 30% of truck capacity is utilized. There is a need for more systemic efficiency, and increasing this efficiency would translate into more livable cities and a more productive economy. Much of the freight moved in urban areas is low density, requiring higher cubic capacity, which appears inefficient when a weight-based efficiency metric is used. Just-in-time inventory policies in city logistics tend to drive down load factors and therefore decrease transport efficiency, but inventory efficiency and overall supply chain efficiency may offset these decreases. Public policy needs to be aligned with societal and private sector goals. Logistics costs as a percentage of the U.S. gross domestic product (GDP) have declined since 1980, from 15% to 8% of the GDP, but the decline has come as a result of reduced inventory costs, not transportation costs, White said.

White then summarized the highlights of Birgit Hendriks's presentation about barriers and constraints to efficiency. She described the Binnenstadservice concept. Does this service satisfy customer service levels, which may vary from customer to customer? Binnenstadservice is socially responsible and ecologically sustainable, but it may conflict with a firm's business plan or competitive advantage. Again, such conflicts call for better alignment of societal and private sector interests, which forms the basis for suggestions for research.

In the final presentation of this session, White said, Ian Wainwright discussed opportunities for public policy intervention, sharing the very interesting lessons learned from the London approach to the 2012 Olympic Games. The presentation raised questions regarding quantification, such as which policy levers to pull and who controls the activity. Policy affects safety, emissions, and costs.

White offered three areas of general comments on the session. First, the competitive landscape for retailers is rapidly changing, as are consumer demands. Hence, corporate strategies must change and be better aligned with supply chain strategies. Moreover, retail is not the only industry in need of city logistics innovation.

Second, White identified two research gaps. The first gap calls for a better understanding of the impact of regulatory and policy intentions on the private sector (e.g., on supply chain and fleet efficiency). Case studies of innovations that have been implemented, along with the multiactor discussion that Cathy Macharis mentioned, help to inform this gap.

The second gap in research relates to IT applications, which are central to much of the discussion (e.g., the rapidly increasing reliance on fleet and enterprise value contained in real-time big data as mentioned by 7-Eleven, UPS, Waste Management, and Wal-Mart). Big data calls for new analytic tools to determine the value of information of new IT products and services at the planning and operational levels. Information flows are important, and in some cases information can substitute for inventory; if a shipper reliably knows the location of inventory at any given point in the system, less inventory overall needs to be held. Vendors know the cost of a service, but they rarely know the implications of the return on investment (ROI). Understanding ROI is vital to understanding the value of new ideas, White said.

Questions and Answers

Alison Conway asked whether decisions such as bike lanes were made at the whim of politicians, or whether freight had a seat at the table.

Wainwright replied that freight is more at the table than ever before. There is a greater recognition of freight. Politically, because of the work of cycling campaigners and bloggers, cycling has an influential voice.

Holguín-Veras remarked on the good idea of the Binnenstadservice and that receivers had the power to force change. He asked if there were other examples or ways to use the power of receivers to force change.

Hendriks answered that it was far more efficient to sell the idea to shippers than to individual receivers. By making the service delivery area larger (expanding it to all of the Netherlands) every single small retailer could be approached, but it wouldn't have to be a cold call. It is easier to sell the idea at the top level, because if Binnenstadservice has a national contract with the shipper, it just needs to see the shipper's customer list in the cities, which Binnenstadservice then gives to its local franchisees. The franchises can then contact the shopkeepers, retailers, and other establishments, and it is not cold-call selling.

McKinnon asked a question of Wainwright about planning for transport during the Olympics.

Wainwright answered that London Transport couldn't influence every development because individual boroughs had jurisdiction to a certain level, but London Transport did talk with trade associations, mineral production associations, and even the British Association of Funeral Directors. It was important to work together, both top down and bottom up.

Edgar Blanco asked Hendriks about how Binnenstadservice handled the issue of liability for packaging or returns.

Hendriks replied that they began by working with 20 establishments, telling them, "Let's try this for 2 months." It was about trust. Binnenstadservice had contracts and was authorized to sign the transport papers. The shipment was in Binnenstadservice hands but owned by the retailer: retailers had to trust Binnenstadservice. Will stakeholders trust? "We had to just do it," Hendriks said. By doing the 2-month trial, Binnenstadservice proved that the concept works.

Clarence Woudsma posed the question of committee structures and the influential behavior of certain actors, citing an example in which the most influential voice was that of the fire chief, because he had to have fire truck access.

Wainwright replied that London Transport talked with industry. The conversation was at first limited to the time during the Olympic Games. After the Games, London Transport started freight forums to continue the conversation, and these were more open-ended discussions. London Transport's goal was to stay one step ahead, thinking about questions before asking them. The London Transport team knew key players in the room from the Olympics discussions, such as DHL, and another player who delivered 70% of the food in London. The London Transport team prepared for the freight forums by identifying issues that would be important to stakeholders. People have to stay in the room, Wainwright urged, and keep talking.

Hendriks added that she knows the problem of the fire chief from her days as a city manager, and that the fire chief is right: he must take care of the city's citizens and be able to enter anytime, anywhere.

Another question posed to Hendriks centered on who pays for the last mile of delivery under the Binnenstadservice business model. Shippers who outsource transport have to pay the service provider anyway, so do they pay Binnenstadservice?

Hendriks answered that yes, shippers who own or outsource have to pay, because it is the same box in both cases. Shippers have to hire a logistics service provider, but what differs is whether the shipper hires a third-party logistics provider to deliver 10 boxes to the inner city or to deliver just one box to a warehouse that does not have the time limits of inner cities. The benefit is that shippers can tender very simple orders rather than shipping to the inner city. Binnenstadservice sends an invoice at the national level to the national shippers. Shippers pay for the bundled delivery and the store pays for the reverse logistics. That is the business model.

Alan McKinnon closed the question-and-answer session with a comment that city logistics has a certain amount of inertia, so sometimes it needs a shock to the system. The shock can be positive (like a sporting event such as the Olympic Games) or negative (like bad weather), but it can be used to motivate behavioral change.

Review of Sessions

Areas for Possible Research

Andrea Meyer, *Working Knowledge, Boulder, Colorado, USA, Rapporteur*
Dana Meyer, *Working Knowledge, Boulder, Colorado, USA, Rapporteur*

The presentations and discussions during the symposium revealed a wide range of possible avenues for research. These diverse research interests and potential priorities can be grouped in several overlapping thematic dimensions such as scope, performance metrics, stakeholder behavior, cross-sectional studies, and longitudinal studies. For example, research could target specific performance measures along various social, transportation, or business dimensions. Research could also target stakeholder behavior to better model freight demand and stakeholder response to proposed policies or urban logistics services. In addition, research could be cross-sectional in order to understand the diversity of urban logistics contexts and myriad strategies for providing dense populations with the goods they need. Conversely, the research might be longitudinal in monitoring intentional as opposed to unintended changes in urban freight patterns. The presentations highlighted a wealth of potential data sources, and the discussions uncovered some open issues about potential research.

Scope of Research

Research could cover a wide range of scopes defined by either geographic dimensions or categorical dimensions. Three dimensions for the geographic scope were mentioned during the event. The first dimension was the natural question of whether the research would focus solely on the United States and EU, or whether it might be broader. For example, Japan might provide useful examples for high-density city logistics; emerging market megacities could be a key area for seeing evolving new practices or applying urban freight logistics concepts. Second, some participants asked about the scope of the research in terms of the threshold city size or density: Should the research concentrate only on the largest cities, or should it also include smaller cities that face urban logistics issues as a result of having compact, historical cores? The third geographic scope dimension concerned the unit of analysis of the freight system; that is, whether the freight system is considered on a shipment, route, network, city, national, or global scale.

The participants also mentioned three categorical types of scoping dimensions. First, many of the talks implicitly focused on freight entering cities intended for consumption by the city's population. However, some cities might face three other categories of freight movements: production within the city, gateway movements at major ports, and transshipment flows. A second categorical scope dimension concerned the distinction between the transport function of urban freight and city logistics, which encompasses a broader array of functions such as storage, distribution services, goods handling, and delivery processes. The third categorical scope dimension was the scope of commercial sectors, which might be retail but could also include food service, office supplies, construction, service vans, and other nonpassenger, commerce-related vehicle movements.

Understanding Performance

Many implicit and explicit performance measures were discussed during the course of the symposium. One category of performance measures was the environmental and social metrics associated with the negative externalities of urban freight. These included measures such as congestion, CO_2 emissions, particulates, noise, and safety. A second set of measures focused on the performance of the transportation activities with measures such as vehicle miles, ton-miles, capacity utilization, empty miles, and so forth. A third set focused on business performance measures such as cost, level of service, and the extent to which the city logistics system enabled (or stymied) new strategies or business models. Some of these discussions led to the question of whether a global city logistics performance index could be created as an analog to the country-level logistics performance index. The as-yet undefined index would attempt to provide an aggregate insight into the overall performance of logistics within selected cities.

Research could assess different performance measures cross-sectionally, longitudinally, or in the context of an experiment in urban freight. Performance has a time and experimental dimension with the potential to measure or estimate the performance before a change, the expected level of performance, the actual achieved level, and a goal level. The choice of performance measure affects the relevancy of the research; public stakeholders might care most about environmental performance, and private stakeholders might care most about business performance measures. The choice of measures affects the data collection and models.

Understanding Stakeholder Behavior

To the extent that stakeholder behavior influences the adoption and success of city logistics schemes, some participants thought that research on stakeholder behavior might provide insights. Participants noted the high cost of implementing urban freight schemes and the lackluster rate of success. One person explicitly asked how research could change decisions and actions. Some participants noted that the diversity of stakeholders on the playing field, both on the government side (multiple jurisdictional levels and different departments of government) and on the private-sector side (e.g., the competing needs of shippers, carriers, and shipment recipients), creates complex interactions and outcomes.

The talks and discussions cited many elements of stakeholder behavior that could be studied. First was the willingness of members of the private and public sectors to invest in new schemes. Second was the tendency of stakeholders to block proposed schemes and any measures that overcame those objections. Third were compliance issues, either with the law (e.g., double-parking) or with company policies and decisions (e.g., driving the company-optimized route). Issues of incentives, preferences, needs, constraints, and flexibility might help elucidate why each party acts as it does.

Cross-Sectional Studies

Research could measure a wide range of independent or codependent variables that affect the performance of city logistics systems or the behavior of stakeholders. The performance of the system or behavior of stakeholders might be a function of a large number of variables. Cross-sectional studies could help elucidate possible explanations for what has worked and what has failed. The choice of variables affects data collection, modeling, and the applicability of the research across cities, businesses, and countries.

These cross-sectional variables can be grouped into four categories. The first category is the attributes of the city itself (e.g., scale, population, demographics, economic intensity). The second category is infrastructure attributes (e.g., road and parking capacity of the network), and the third category concerns business attributes (e.g., business classification, delivery frequency, delivery density, volume of deliveries, business strategy). The fourth category is vehicle attributes (e.g., capacity, speed, size, fuel consumption, noise), which might change as a result of technology, regulations, or business imperatives.

Longitudinal Studies

Longitudinal studies could focus on trends affecting city logistics, the effects of specific interventions, or the natural daily, weekly, and annual cycles. Participants mentioned at least four types of longitudinal issues. One category of studies might look at the changing consumer habits of recent decades (e.g., the shift toward fresh foods, smaller package sizes, and home delivery). A second category of longitudinal studies might consider changes in company strategies (e.g., just in time, multichannel, smaller-format stores, new markets). A third category could be changing public-sector priorities (e.g., urban planning priorities, CO_2 goals, or revenue requirements), and a fourth might be changing land use patterns (e.g., distances trucks travel due to high city costs, parking, clustering or dispersal of retail outlets, or road use designations).

Data Sources

Many talks described data sources that have been used or could be used for research in this area. Research could use qualitative data such as case studies (of successes and postmortems), literature reviews, and stakeholder interviews. Research could also use quantitative data such as survey values, business data, and sensor data. Private-sector representatives at the event said businesses may be willing to share their data under appropriate terms. Such data could provide fine-grain data on orders and shipments for selected companies. Automated sensors could provide a wealth of data that might come from vehicle GPS data, road sensor data, and road-monitoring camera data.

Open Questions

Over the two days, some deeper questions arose that could affect research priorities and methods. For example, lively discussions highlighted a potential core challenge in researching urban freight; namely, picking the appropriate level of model complexity. Some participants argued for simpler models as being good enough, easier to communicate, and having comparatively straightforward data needs. Others felt that more complex models may be required to understand the complex feedback loops of actions, reactions, and counterreactions among the private and public players in the space. Aggregated models may miss too many of the details that contribute to pollution, congestion, high logistics costs, and poor delivery service.

A second open question concerned the required depth of sampling. On the one extreme were comprehensive, but relatively expensive studies such as the French urban studies. Such studies can play a role in building sophisticated models, but the cost of the research limits the number of cities where the study might be replicated and limits the frequency of replication for assessing changes in patterns of city logistics. At the other end of the spectrum were smaller-scale studies that might not have the statistical power to create conclusive evidence but might be sufficient to show that the results of a larger study apply in a new city or urban freight transportation scenario. Simpler studies might be more widely or more frequently conducted.

Finally, some of the discussions touched on the philosophical issues of the multifaceted roles of the researcher. Although researchers' primary role might be to create new knowledge through basic and applied research, some researchers felt that this is not their only role. As educators and communicators, researchers can act as a bridge between the private and public sectors. These additional roles might influence research priorities, the application of research results, and the social and commercial benefits of research.

Opportunities for Collaboration

Concluding Observations

Robert E. Skinner, Jr., *Transportation Research Board, Washington, D.C., USA, presiding*

Robert E. Skinner, Jr., kicked off the final session of the symposium with two questions:

- Do we need to have more interaction among researchers?
- Do we need institutional collaboration?

Lance Grenzeback said he heard two themes on which there was interesting research to be done. He noticed two cultures: an academic culture and a private-firm culture. Academics are interested in network analysis and in the system—the average truck flow, not the individual trip—but private firms consider trip-level data to be important. He noted that in the successful projects mentioned, such as the Binnenstadservice and Holguín-Veras's off-hour delivery project in New York City, the project planners brought together people from the academic and private sectors, as well as people representing the political view. Painting a picture of the structure and dynamics of those academia–industry–policy partnerships would be interesting.

Rolf Schmitt noted that two subjects were missing. The first missing subject was the whole issue of truck routes in cities, which he said were a "blood sport": a battle between community and interstate commerce. The broader question of this subject is that of managing vehicles in downtown areas. Some work has been done on this, but more needs to be done. The second subject Schmitt mentioned is that of how to best integrate urban logistics into land use planning.

Vikenti Spassov proposed the European Cooperation in Science and Technology (COST) as a model for cooperative research among members from different countries and suggested looking at www.cost.eu/ for more information.

José Holguín-Veras commented that the objective of this meeting was to foster cooperation. Many attendees of this symposium were from universities, and it is important to create opportunities for international collaboration in this area. The National Science Foundation (NSF) provides models and projects specifically aimed at joint funding of projects, he said.

Skinner agreed with the need to remove some of the barriers to international cooperation and to provide some incentives in existing projects and explore joint funding mechanisms.

Edoardo Marcucci pointed out the need to encourage international cooperation and proposed creating a glossary that would define "city logistics" so that researchers understand its scope and boundaries. Second, to alleviate the problems of data collection that result in data that cannot be compared with data from other sites, Marcucci proposed finding common basic indicators when collecting data so that the data could be shared.

Lanfranco Senn said the one of the results of the symposium's two days was the knowledge that participants gained from each other. The question is how to maintain that path. The answer is to pick some issues and accumulate our knowledge, because research is a cumulative process. In the area of data, administrative data are less costly to obtain, and a glossary of definitions would be useful.

Skinner mentioned the idea of "twinning" on research, with a researcher on each side of the Atlantic working on an issue.

Genevieve Giuliano supported Holguín-Veras's point about facilitating or incentivizing more collaborative research, because otherwise the barriers to such collaboration win out. She proposed identifying the value added that international research can generate. She mentioned that 50 years of research on travel behavior identified that the principles that drive travel behavior (i.e., the basic motivations of travel) are the same regardless of location. Institutions and policy both play a role in city logistics, she continued, and we are at a point at which we might want some understanding of the players. A main theme of the symposium has been the interplay of private-sector behavior and public interventions to address the external costs. It would behoove us, she said, to have an understanding of why freight works and where policy interventions work and don't work.

Barbara Lenz summarized that the symposium participants discussed freight, urban freight, and logistics. The purpose of the meeting was to compare logistics in different contexts, and researchers should think about the context: In which context does freight work in which way? European cities are different from each other, and they are even more different from U.S. cities. Context has an impact on what can be done.

Ken Button said that collaborative international work has taken place in the past and that the best results come from involving academics, government, and industry. All three pillars need to be involved. He also noted that there was a graying of the transport community, especially among those who attended this conference, and he called for bringing in younger academics and stellar young government workers from the United States and the EU, because they will be the future of research.

Skinner pleaded "guilty" in that one of the reasons for the disproportionate number of older researchers at this conference was the result of figuring out how to blend the U.S. and EU research communities. He agreed that involving younger researchers has long-term payoff.

Michel Savy praised the symposium as being a rich two days, and he said that although no period of time is stable, we are currently living in a transition period. He suggested that another research direction could be long-range studies; not just prediction, but building scenarios to explore possibilities to put a magnifying glass on trends, policies, and so forth. The important result is to develop long-range scenarios for urban logistics.

Rosário Macário offered the example of Atlantis. This program, jointly sponsored by the U.S. Department of Education and the European Commission's Directorate–General for Education and Culture, promoted a student-centered, transatlantic dimension to higher education and training through work placements and internships, as well as supporting innovative curricula and teaching tools. She said this program was very successful and could possibly serve as a model.

An unidentified participant said that different initiatives and best practices to support administrations' quality management schemes in city logistics could be researched. That is, there are many best practices, such as the London case, of all the stakeholders being at the table. Just as there are voluntary schemes for fleets and operators, there could also be a voluntary scheme for quality management in city logistics. This would touch on many of the themes discussed today, he said, from data collection and analysis to the cycle of setting strategies, analysis of the problem, definition of the actions, implementations, monitoring, and evaluation. The question is, what are the critical success factors and steps that governments and politicians should take to develop city logistics policies in this cycle approach?

Kazuya Kawamura added that BESTFACT was a very effective way to convince the skeptics, by showing them something that works.

Alessandro Damiani said that he was very happy with the symposium and saw it as a success, given the sincere comments he had gotten from colleagues, who said it was a very positive experience. His personal key performance indicator, he said, is that he confesses to often getting bored at conferences, but this time he did not get bored. Despite getting only 3 hours of sleep, he was engaged and learned a lot. There are many great experts to learn from, and the symposium was a success that exceeded his expectations.

He thanked Bob Skinner for the original idea of the symposium and Martine Micozzi for her investment of time over the past several months. He also thanked Mike Walton and Alan McKinnon, the cochairs, as well as the other experts and rapporteurs. Much preparation went into organizing the symposium, and it was worth it.

Damiani recapped what he learned, namely that city logistics is at the heart of most negative connotations concerning transport (i.e., the inefficiencies and congestion), but there is also great potential for improvements in efficiency and sustainability. Second, he learned and confirmed his belief in the value of comparing experiences across locations. Another take-away from the symposium was that academic models need to include business models and corporate models, and that behaviors are often more important than technology. Even more important is enabling the applicability of the research, which is influenced by the framework, features, governance, data collection, and engagement of the stakeholders.

Damiani concluded by offering a message to the attendees: there is a great opportunity to be seized now for collaborative research, and we are ready to seize it. Participants have gotten valuable input on the issues and topics, and we have a moral obligation to do something about it. He called for institutional partners, the European Commission, the U.S. Department of Transportation (DOT), and the Transportation Research Board (TRB) to identify programs and funding schemes to follow up the symposium. He said that he could make a precommitment, or statement of availability, on the side of the European Commission for Research and Innovation and the Director–General. He hoped that the Research and Innovative Technology Administration (RITA) and the Federal Highway Administration might be able to comparably help.

Damiani also suggested leaving the door open to a core nucleus for other partners, such as in Japan, to become involved. Emerging nations could also be interested partners. Finally, he suggested making some additional effort to make this visible, counting on the proceedings, TRB, RITA, and the European Commission to start doing that valorization.

Kevin Womack also offered his congratulations to the participants on their perseverance and paraphrased Senn that this was not a "one and done" event. Much energy went into it. He wished he could say that the U.S. DOT had funds to offer, but he could not mislead the group to say so. He hoped that, going forward, collaboration would be expanded and new relationships created. There are funding opportunities for U.S. researchers who have an EU twin, because the NSF would look favorably on such a pairing. It will be up to the attendees to set the agenda, develop new and expanded relationships, fill in the gaps, and bridge industry and academia on the broader social issues.

He reiterated a conversation he had had with another planning committee member, Chip White, that the paradigm in academia has to be changed to convince academic administrators that implementation of the research done is important. Womack concluded by thanking participants for contributing their intelligence and expertise.

Alan McKinnon said that the choice of city logistics was a good research topic; it is a mature field with enthusiastic researchers to tap into it. The next symposia in this series of four will not be subject-specific but will concern implementation, with a more amorphous group of researchers, so it may be harder to get people who know each other. He also urged researchers to use this event as a catalyst but not to overlook other collaborative networks that may already be in place, such as other conferences, databases, and journals that this event reinforces. The EU Commission can take pride in the generous funding for city logistics over 10 to 15 projects that were funded on a collaborative basis with close networking between EU academics. The EU, with its 28 member countries, is collaborating on funding, and the U.S. DOT or TRB might learn from that to integrate research across the United States. McKinnon concluded with his own key performance indicator, which was looking through journal articles to see which had been coauthored by someone from the United States and someone from the EU. In doing that in preparation for this conference, he didn't see many such coauthorships. He hoped that when doing that exercise again in 2 or 3 years, he would see more collaboration measured by a transatlantic coauthorship index.

Conference chair **C. Michael Walton** closed the conference by paraphrasing Emerson: "There are events like this that can be characterized as the wine of the human experience." He said it was great to work with such talented people and thanked the planning committee for its efforts and the participants for making time in their schedules to participate. He officially closed the symposium.

APPENDIX A: COMMISSIONED WHITE PAPERS

Approaches to Managing Freight in Metropolitan Areas

Genevieve Giuliano, *University of Southern California, Los Angeles, California, USA*
Laetitia Dablanc, *Institute of Science and Technology for Transport, Development, and Networks (IFSTTAR), France*

1. Introduction

The flow of freight in metropolitan areas has emerged as a major urban planning challenge. Most urban freight is moved in trucks. Although trucks make up a relatively small share of all vehicle traffic, they generate a disproportionate share of many externalities, including congestion on local streets and highways, infrastructure damage, vehicle emissions, greenhouse gases, and noise. The purpose of this paper is to examine strategies, policies, and practices that have been implemented in different countries to manage freight impacts on metropolitan areas and assess their effectiveness and potential for transferability.

Researchers and local stakeholders have explored a broad range of measures aimed at reducing truck travel, emissions, or carbon consumption. Examples include freight partnerships, smaller or newer trucks, better routing algorithms, consolidated local delivery stations, alternative modes, off-peak deliveries, and low-emission zones (LEZs). These efforts have had varying levels of success. On the basis of an extensive review of the literature,[1] an assessment of the most effective strategies for solving urban freight problems is presented. The authors find that policy strategies and outcomes are quite different between the United States and the European Union and explain these differences as a function of local context, including political and regulatory structures. They conclude that experimentation is extensive and that there appear to be many possibilities for addressing urban freight externalities. More research and more careful and comprehensive evaluations of policy experiments are suggested by the authors to improve the understanding of urban freight problems.

The paper is organized as follows: Section 2 discusses the nature of the urban freight problem and the challenges of effectively addressing freight problems. Section 3 provides an overview of policies and strategies organized around four major urban freight areas:

1. Freight flows in the metropolitan core,
2. Emissions,
3. Metropolitanwide truck vehicle miles traveled (VMT), and
4. Freight hubs.

Section 4 presents conclusions, and Section 5 offers suggestions for EU-U.S. collaborative research.

2. The Urban Freight Problem

Freight has been key to the functioning of cities from ancient times, yet only recently has urban freight been identified as an essential element in urban transport planning and policy, as well as a major source of environmental externalities. Managing urban freight is challenging for several reasons. First, the current approach to urban

[1] This paper is based in part on *NCFRP Report 23: Synthesis of Freight Research in Urban Transportation Planning* (NCFRP Project 36[05]) (Giuliano et al. 2013). It provides a review of international literature including journal publications, government reports, consultant reports, and unpublished papers and materials, resulting in 261 references, of which 108 are academic papers and scientific books.

sustainability takes little account of freight. There is broad consensus that urban sustainability is enhanced by increasing density, mixing population and economic activity, promoting public transportation and nonmotorized modes of transportation, and reducing automobile use (e.g., Newman and Kenworthy 1999; Duany and Speck 2010). Thus, cities are investing in public transport rather than in highways and roads, and reducing road and parking space in favor of pedestrians and transit.

There is a tension between freight and such practices. Scale economies make larger shipments, warehousing, and distribution more efficient; hence, there is an increase in the decentralization of logistics activities to large facilities at the periphery of metro areas. Dense urban areas have limited road capacity and are incompatible with large trucks. Efforts to reduce road capacity to enhance pedestrian circulation or prioritize public transport flows create more compatibility problems. Existing freight facilities in urban areas are often seen as undesirable. Efforts to remove them (e.g., for smart growth urban development projects) actually contribute to more truck miles on regional highways (Dablanc and Rakotonarivo 2010). The challenge is how to best accommodate freight and other critical urban functions.

Second, urban freight is extremely diverse from one economic sector to another and across urban areas. Such diversity makes it difficult to identify common technologies and strategies that fit many unique markets. Solutions developed to address the specific problems of one industry or metropolitan area are not necessarily transferable to other industries and areas.

Third, freight famously "has no borders" as opposed to passenger transportation, which tends to be contained within a commuting area. Metro areas are not economically self-sufficient; they are part of a global network of economic flows. Local firms may produce goods for global markets, and local residents consume many goods coming from global markets. The largest metro areas serve as global and national trade nodes via ports, airports, distribution centers, and intermodal hubs; these activities become notable elements in the urban landscape, often generate significant externalities, and are important contributors to local economies. The volume and pattern of freight flows is the result of market demand, supply chain organization, relative prices of inputs, and government policies such as trade agreements and currency policy (Dicken 2007). Local governments have little influence on these basic drivers of freight flows, yet local communities bear many of the associated externalities.

Fourth, the ability to "act locally" is further constrained by jurisdictional authority. National governments negotiate trade liberalization conditions within their borders. Highways, railroads, and waterways are either owned by state or national governments or subject to regulation. In most countries, environmental and operating standards are set by state or national governments. Local government authority, such as limiting access on the basis of truck weight or setting rules for truck loading, has limited effect (and may actually intensify local impacts) because such policies do not affect the underlying demand for freight movements.

Local authority is also hampered by the fragmentation of local governance. Large metro areas—where freight problems are most severe—include many cities and other government units, such as public transit operators, port authorities, and planning agencies. Addressing freight problems more often than not crosses jurisdictional boundaries. In Europe, metropolitan-level authority is generally stronger than that in North America, but metropolitan authorities often disregard freight issues and neglect the use of regional planning or truck traffic coordination, even when these options are available.

Finally, the complexity and flexibility of supply chains make the outcomes of policy interventions uncertain. The "new distribution economy" as described by Cidell (2010), Hesse and Rodrigue (2004), and others is heavily dependent upon efficient and increasingly globalized networks of goods distribution and just-in-time operations. This has led to a reduction in large inventories of intermediate and final products but also to a concomitant rise in hub distribution centers. Global supply chains require more logistics facilities, and the way these facilities are spatially organized has become a key feature of a logistics network. The efficiency of goods distribution depends on the optimal location and sizing of freight terminals rather than directly on transportation costs, which have decreased over the past decades. Downstream logistics are driven by consumer demand. In cities, store inventory levels have shrunk and businesses are increasingly supplied on a just-in-time basis. The number of different products sold has increased considerably, and product ranges change several times a year. With the rise of the service economy, the demand for express transport and courier services is also soaring. These factors have made urban economies more dependent on efficient transportation systems, with more frequent and customized deliveries. The result is greater frequency of urban freight distribution.

The supply chain is a difficult target for local policy efforts. Because of the interdependencies within the chain, policies to address a problem generated by one part of the chain affect other links. Controls on delivery hours, for example, affect the upstream operations of warehouses and the downstream operations of receivers.

3. Strategies

In response to growing urban freight problems, cities around the world have engaged in extensive experimentation. Here, discussion of urban freight mitigation strategies is organized around four categories of problems: freight flows within the metropolitan core, vehicle emissions, metropolitan truck travel, and freight hubs. Effectiveness is assessed on the basis of the literature, the authors' own research, and their professional judgement. Table 1 (pages 66–67) presents specific examples of each type of strategy.

3.1 Freight Flows in the Metropolitan Core: Last Mile Strategies

Competition for road and parking space is particularly serious in the cores of metropolitan areas, where traffic is congested, accommodates multiple modes (including nonmotorized), and where the density of activity generates high demand for both freight and passenger flows. The first pickup or final delivery of a product is commonly known as the "last mile" problem. Last mile pickups and deliveries are inherently inefficient because they are typically composed of very small lots. Additional inefficiencies are generated by multiple daily deliveries in some industry sectors. Small deliveries across many destinations generate complex routing problems. Restrictions on night deliveries or the reluctance of urban business owners to change delivery schedules forces more trips to take place during peak hours, adding to congestion. Home delivery is particularly inefficient because of the small size of deliveries, spatial dispersion of residences, competition within the local delivery industry, and the frequency of failed deliveries. While all last mile deliveries have these characteristics, high density and limited road capacity make the problem particularly challenging in metro core areas.

3.1.1 Traffic and Parking Regulations

City efforts to manage last mile problems have traditionally focused on local traffic and parking regulations because these tools are clearly within local authority. In theory, traffic and parking regulations are effective as long as they are enforced. However, cities have no control over demand for pickups and deliveries, and consequently traffic and parking regulations have limited effectiveness. In practice, highly restrictive regulations are costly to enforce and may lead to other problems. Restricting truck parking areas may result in trucks double-parking in the roadway or using curb space reserved for other purposes. When the demand for truck pickup and delivery greatly exceeds the supply of loading and parking areas, enforcement becomes costly and increasingly difficult, as the risk of being fined becomes less costly than the delays incurred in waiting for a parking spot. Another related strategy is the prohibition of large trucks in core areas. Allowing access only to vans and small trucks can lead to an increase in the total number of vehicles and vehicle miles for deliveries, again because such policies have no effect on demand.

Traffic and parking regulations have a mixed record of success. Restrictions on truck access or limiting truck deliveries to certain days of the week tend to shift truck traffic to smaller vehicles (generating a net increase in truck VMT) or concentrate traffic into shorter time periods (generating more congestion). Regulations that seek to use road resources as efficiently as possible tend to be successful. Barcelona's policy of allowing use of traffic lanes for pickup and delivery during off-peak hours is an example. San Francisco's recent implementation of dynamic parking charges is another. The lesson drawn from these examples is that local freight demand must be accommodated; hence, strategies that *manage* rather than *restrict* freight deliveries tend to be more effective.

3.1.2 Local Planning Policy

Local jurisdictions have land use planning authority and hence may set policies and guidelines for incorporating freight deliveries into new developments, for the design of loading docks, and for parking and loading standards. New development or redevelopment offers the opportunity to implement planning standards for on-site freight facilities, freeing up curb space for other purposes. Examples include Tokyo's and New York's requirements for new commercial developments. Barcelona goes further, adding a requirement for minimum storage areas for new restaurants and bars specifically to reduce the frequency of deliveries. On-site facilities lessen the need for on-street loading zones, reducing conflicts with passenger demands. On-site facilities also add to building costs and hence may be resisted by the development community.

Cities may also develop freight loading and parking standards for off-site activities (e.g., in a public right-of-way). There are more opportunities in developing areas where the road infrastructure is still being constructed. However, standards can have an impact over time, even in already developed areas, if they are tied to future development and redevelopment.

Experiences with on-site planning policies have been largely positive. Although such requirements add to development costs, they also add to commercial property value by assuring that freight deliveries are accommodated. Shippers and truck drivers clearly benefit from having reliably available loading facilities. These policies are a good fit in cities where the authority of local governments to develop and implement planning and building guidelines is clearly established. The ability to negotiate

TABLE 1 Freight Mitigation Strategies

1. Freight Flows in the Urban Core	Location	Description
Consultation processes and certification schemes	London (UK) London Paris (France) Netherlands, 25 cities	Freight Quality Partnership Freight Operator Recognition Scheme Delivery charter PIEK label program
Traffic and parking regulations	Paris São Paulo (Brazil) New York City Barcelona (Spain) Los Angeles downtown (U.S.)	Daytime hours truck ban (>29 square meters) Access 2 days/week/vehicle Commercial vehicle parking plan Off-peak hours use of roadways for unloading–loading Increased enforcement of use of loading bays
Intelligent transportation systems (ITS)	Several European and Asian cities London Europe	Automatic control systems for truck access regulation (plate-reading cameras) Transport for London freight website DHL Packstation in Germany, French Cityssimo: automated self-service parcel delivery lockers (see also USPS Gopost in the United States)
Planning strategies, building requirements	Tokyo (Japan) Barcelona Paris	Loading–unloading facilities requirements for new commercial of >2,000 square meters New York loading–unloading requirements for new commercial of >8,000 square feet Minimum 5-square-meter storage for new bars, restaurants Technical guidelines to on-street delivery bays for the City of Paris
Consolidation schemes and measures targeted toward urban supply chains	Paris Europe Bristol (UK), Motomachi (Japan), Cityporto (Italy), Elcidis (France) London	Urban Logistics Spaces: subsidized rental rates for small freight facilities in municipal car parks Pickup points networks for home deliveries (Hermes, Kiala, Pickup services) Urban consolidation centers Construction consolidation center
Off-hours deliveries	New York City Los Angeles–Long Beach Dublin (Ireland), Barcelona, Paris	2009–2010 experiment, focus on receivers PierPASS off-peak program Tests for early morning deliveries in partnership with urban grocery retailers

2. Environment	Location	Description
Truck fleet emission standards	California (U.S.) United States	CARB truck, diesel particulate filter standards EPA 2011 truck CO_2 emissions and fuel efficiency standards
Low-emission zones (LEZs)	Greater London Milan (Italy) Swedish, Dutch, and Danish cities	LEZ: Access restrictions on old trucks and large vans Area C: Historic center truck regulations Truck access regulations based on Euro standards
Alternative fuels, electric delivery vehicles	London, Milan U.S. cities European cities France Los Angeles–Long Beach ports	Congestion charge exemption for alternative-fuel vehicles Delivery company use of alternative-fuel trucks and vans Electrically assisted cargocycles Program to group purchases of electric vans for commercial fleets for public administrations CAAP Technology Advancement Program
Promotion of alternative modes, cargo diversion	United States San Francisco Bay Area (U.S.) Paris Dresden (Germany)	U.S. Department of Transportation (MARAD) Marine Highways–Short Sea Shipping Grant program FedEx BART pilot program Cargotram, large retailers using Monoprix rail, Franprix waterway deliveries CargoTram for Volkswagen plant
Restriction on truck idling	California United States	5-minute limit on diesel truck idling Truckstop electrification
Delivery noise reduction	Netherlands Atlanta (U.S.)	PIEK research, development, and regulation program ASTROMAP, strategic truck route master plan
Environmental justice, community mitigation measures	Greater Los Angeles County of Riverside (U.S.) New York City Baltimore (U.S.) Europe Atlanta United States	SCAG Toolkit for Goods Movements Truck Routing and Parking Study Truck Route Management and Community Impact Reduction Study Maritime Industrial Zone Overlay District Freight villages, logistics parks Regional Commission's freight studies Environmental justice guidelines publications (NCHRP 320, NCFRP 13 and 14)

3. Metropolitanwide Truck VMT	Location	Description
Congestion pricing, road pricing	New York City Switzerland Germany France (start October 2013)	Proposed pricing for New York City bridges Truck VMT pricing, based on weight, emissions standard, and peak time, on all roads and streets Truck VMT pricing, based on weight, Euro standard, and peak time, on major highways only
Truck-only lanes	Georgia South Boston, Southern California, Port of New Orleans	Statewide truck-only lanes (proposed) Short distance, truck-only access roads
Truck traffic management	United States	PrePass weigh station bypass system
Driverless truck convoys	Tokyo (test)	Driverless trucks connected to each other and to the infrastructure
Trolley trucks	Long Beach–Los Angeles (proposed pilot project)	Siemens proposal: hybrid trucks powered by electricity supplied by overhead wires on congested corridors
Elimination of at-grade crossings	Los Angeles Greater Los Angeles Chicago Seattle	Alameda Corridor Alameda Corridor East CREATE FAST program

4. Freight Hubs, Port Management	Location	Description
Regional logistics–freight plans	Toronto (and others) (Canada) Region of Ile de France (Paris) (and others)	Freight-supportive land use guidelines Development of logistics parks, intermodal facilities integrated to the regional master plan
Building requirements for loading–unloading bays	U.S. and EU cities	Zoning codes, conditional use permits, building codes
Facilitating accommodation of urban freight terminals	Tokyo Paris	Freight facilities located in city centers, well accepted by municipality Sogaris projects: Chapelle International, Beaugrenelle (Paris)
Port congestion pricing: Marine terminal gates	Los Angeles–Long Beach ports Vancouver (Canada) Busan (South Korea)	PierPASS off-peak program Off-peak gate program Evening gate program
Truck reservation and appointment system	Ports of Los Angeles, Long Beach, and Oakland Port of Vancouver U.S.–Mexico border crossing	AB 2650 gate appointment mandate Reservation system Pilot program
Accelerated emissions reduction	Los Angeles–Long Beach ports Port of Vancouver New York and New Jersey, Seattle, Oakland	Clean Air Action Plan; Clean Trucks Program Truck Licensing System Voluntary truck emissions programs
Equipment management	New York and New Jersey, Oakland Worldwide	Virtual container yards Industry-driven chassis pools

through the zoning and approval process allows for flexibility in enforcement and is widely accepted.

3.1.3 *Off-Hours Deliveries*

Off-hours (outside regular hours) deliveries seek to shift truck activity out of the peak traffic periods and hence reduce congestion and emissions, yet few examples of off-hours delivery programs exist. Off-hours deliveries affect the end of the supply chain, and hence affect shipper and final receiver. Constraints on the trucking side include regulatory hours of service requirements[2] and late-shift premium pay for unionized drivers. Constraints on receivers include having to open receiving facilities early and to operate loading terminals more hours of the day, late-shift premium pay for terminal workers, and local zoning codes that prohibit after-hours truck activities in residential neighborhoods. Examples in Europe, where shippers and trucking organizations generally support off-hours deliveries, include the cities of Dublin, Barcelona, and Paris. These cities benefit from the results of the Dutch national PIEK program, which provided research and development efforts for quieter delivery trucks and handling equipment. PIEK equipment is used, with PIEK labels made visible on the trucks operating at night.

There is only one permanent off-hours program in the United States, the PierPass program at the Los Angeles–Long Beach ports. It was implemented under unique circumstances that do not exist in other U.S. metropolitan areas. A New York City demonstration was the first and only in-city program. It has resulted in reduced congestion, energy consumption, and emissions and thus demonstrates the potential benefits of such programs (Holguín-Veras et al. 2006). The New York City research indicates that shippers and receivers are willing to support off-hours deliveries if they are compensated for the additional costs incurred. Off-hours delivery may have potential as a voluntary or negotiated program.

3.1.4 *Negotiated Programs*

When their regulatory authority is weak or absent, many local governments have implemented voluntary programs to mitigate freight impacts. Termed voluntary regulation, these are typically the result of a negotiation between the public sector and private industry to develop a set of voluntary targets or operating rules that confer either recognition or special benefits such as flexible delivery hours. Examples include the various "green" certification programs that promote use of cleaner vehicles or operations during less congested periods of the day. Voluntary programs are not confined to last mile problems. Many ports have voluntary programs to reduce ocean vessel emissions, and many city programs are aimed at reducing truck emissions. Effectiveness depends on how much these agreements change behavior. Certification programs that allow access to loading facilities or extended delivery hours offer a significant benefit to shippers, and therefore make it easier to justify the purchase of new compliant vehicles. Certification programs are often the result of freight forums or participatory processes that include public and private stakeholders.

The certification programs reviewed by the authors were perceived as very successful, both by the public sponsors and private participants. One potential problem is the buy-in and participation of all industry segments; for example, large shippers are more capable of negotiating program conditions with public sponsors, so programs may be designed to their advantage. Certification programs may increase trust and foster more collaborative relationships between industry and government. Shippers may also enjoy a competitive advantage when bidding for contracts because more clients place value in doing business with "green" firms. Finally, certification programs are relatively low cost, with most of the costs in the form of transactions costs—establishing and maintaining public–private relationships. They may also evolve: as targets are reached, new targets are negotiated, leading to significant improvements over time.

There are many examples of voluntary programs in Europe and the United States. Two well-known freight forums, called freight quality partnerships in the United Kingdom, were established in London and Paris in the early 2000s and are still active today. Trade organizations meet with local decision makers and practitioners on a regular basis, negotiating the content of municipal policies. In London, for example, the Congestion Pricing scheme was discussed prior to its implementation in 2003. In Paris, the freight partnership discussed the deployment of on-street delivery bays. Voluntary regulation is a particularly good fit within the U.S. context of decentralized governance and dispersed regulatory authority. In cases where direct regulation is either impossible (because of a lack of authority) or infeasible, voluntary regulation may be the best available alternative.

3.1.5 *City Logistics and Consolidation Programs*

The goal of consolidation programs is to reduce truck traffic by finding ways to combine pickups and deliveries of different shippers or different receivers. Such pro-

[2] U.S. federal law and EU laws limit the total number of hours of driving per shift and the elapsed time between driving shifts.

grams often focus on changing the supply chain rather than on the final (or initial) step of the chain. The simplest (from a supply chain perspective) consolidation schemes are those that focus on final delivery or pickup; for example, on the end of the chain, such as pickup centers for online purchases. These common pickup points reduce home deliveries (truck trips), but their impact on private vehicle trips is unknown and depends on how consumers access the centers.

Another version of consolidation is shared logistics spaces, where multiple shippers use an in-town facility to consolidate loads (typically from different out-of-town logistics facilities) before final deliveries. The intent is to reduce truck VMT by more efficient routing of final deliveries (or initial pickups). The most ambitious version is the urban consolidation center, where goods from multiple shippers or vendors are combined and delivered by third-party trucking firms. These consolidation centers can be found in large integrated shopping malls (especially in the United Kingdom), but they are much less common for local shops in central areas. Although shippers may benefit from the lower costs of consolidated deliveries, whether these benefits offset the rental and added labor costs of transloading is unclear. In many European experiments, consolidation centers were not feasible without public subsidies, and many have since closed.

Consolidation experiments are observed almost exclusively in Europe. In the United States, there are a few examples of voluntary consolidation programs within an industry segment (e.g., central city hospitals in Orlando, Florida, and Atlanta, Georgia, established a suburban warehouse to receive deliveries, with third-party truckers making final deliveries to ensure reliable access to critical supplies). European-style consolidation centers are unlikely to appear in the United States. Subsidies to freight operators would be politically difficult, even if local jurisdictions had the funding to provide. Any effort to force consolidation in the United States via regulation (as in several European cities) would be very difficult because of interstate commerce laws.

3.2 Environmental Issues: Strategies to Reduce Trucks' Impacts

There are many externalities associated with freight in metropolitan areas. The most serious, from a public health perspective, is particulate emissions. Research has shown that fine particulates are associated with increased incidence of morbidity and mortality from asthma, lung cancer, and other respiratory diseases (Peters 2004). Freight movement is a significant source of both ozone precursers and particulate matter (PM). Table 2 (page 70) gives examples of contributions of PM-10 emissions from the freight sector for six U.S. metro areas. Trucks contribute the largest share in every case, but in the port regions of Houston, Texas, and Los Angeles, California, a large portion comes from marine freight. To provide some context on freight contributions to pollution, when PM-10 emissions from the entire transport sector are considered (air, rail, marine, onroad), freight accounts for about 56% of the total.[3]

Related to vehicle emissions is the long-term problem of greenhouse gas emissions and energy consumption. Energy efficiency improvements in transport—particularly in freight transport—are challenging in part because of the need for high-energy and high-density fuels (Greene 2004) and partly because of less aggressive regulation relative to passenger cars. Livability impacts, notably noise in dense European cities and around major intermodal facilities, are also of concern to urban residents.

Strategies to reduce emissions and energy consumption include the following:

- Efficiencies in routing (more fully loaded trucks, optimized delivery routes),
- More efficient or cleaner diesel engines,
- Use of alternative fuels, or
- Shifts to more energy-efficient modes.

3.2.1 Truck Fuel Efficiency and Emissions Standards

Truck fuel and efficiency standards have been demonstrated to be among the most effective tools for reducing emissions. The recent changes in U.S. light-truck CAFE standards will have a significant impact on the light-truck portion of the freight vehicle fleet. The shift to cleaner diesel engines and fuels is having a similar impact on heavy-duty trucks. In the European Union, emission standards for vehicle manufacturing follow designated "Euro standards." For trucks, the current standard is Euro V[4] (trucks manufactured after October 2009), with the more stringent Euro VI standard due at the end of 2013.[5] The authors expect fuel efficiency and emissions regulations to continue to be one of the most effective tools for reducing air pollution and carbon dioxide emissions in metro areas in Europe and the United States.

[3] Calculated by the authors from the 2008 U.S. National Emissions Inventory Data, available at http://www.epa.gov/ttn/chief/net/2008inventory.html.

[4] By convention, the Euro name is followed by arabic numerals when it applies to light-duty vehicles, and roman numerals when it applies to heavy-duty vehicles.

[5] These standards target emissions of local air pollutants, not CO_2. In some cases the introduction of technologies to reduce pollutant emissions results in increased fuel consumption. Efforts today aim at achieving both a reduction in local pollutants and in CO_2 emissions.

TABLE 2 Contribution of PM-10 Emissions by Mode of Freight Transport

	Trucking		Rail Freight		Marine Freight		Air Freight		Freight Total	
Region	PM-10 tons	%	PM-10 tons	%	PM-10 tons	%	PM-10 tons	%	PM-10 tons	%
Baltimore	734	74	71	7	190	19	1	.01	996	100
Chicago	2,541	73	792	22	173	5	10	0.3	3,616	100
Dallas-Ft. Worth	884	88	113	11	0	0	4	0.4	1,002	100
Detroit	2,382	96	58	2	27	1	2	0.1	2,469	100
Houston	1,256	54	141	6	915	40	2	0.1	2,314	100
Los Angeles	2,210	54	345	8	1,521	37	14	0.3	4,091	100

SOURCE: FHWA 2005, Table ES-3.

3.2.2 Low-Emission Zones

LEZs limit the types of vehicles that may enter a given part of the city. The limitation is based on emissions and energy consumption characteristics. LEZs have been established in several European cities; examples include London, Copenhagen, and Milan. The London scheme is the largest and most stringent. It has progressively extended application to more vehicle types (including vans) and raised engine standards. Transport for London (2008) reports significant reductions in PM and oxides of nitrogen (NOx). Impacts on shipping costs, businesses, or the trucking industry are not yet known. LEZs have some obvious advantages: to the extent that performance standards are imposed on all trucks, the entire urban fleet is affected, and emissions reductions could be large. LEZs may generate secondary benefits by forcing the reorganization of the local trucking industry into larger and hence more efficient operations (there is uncertainty that LEZs will generate net benefits because the elimination of small operators would eliminate jobs and small businesses). The authors are unaware of any central city–oriented LEZ program in the United States. A few ports have implemented clean truck programs, which either restrict access to trucks that meet certain standards or charge fees on trucks that do not meet the standard. The most ambitious program is the clean truck program implemented at California's Los Angeles and Long Beach ports in 2006, which required the use of 2007 or newer trucks phased in over a 2-year period. The U.S. regulatory environment (the national government is vested with regulation of interstate commerce) requires such programs to be implemented on a voluntary basis.

3.2.3 Alternative Fuels and Vehicles

Alternative-fuel vehicles (AFVs) have been widely promoted in Europe and the United States but have achieved little market penetration because of higher capital and operating costs, the complexities of operating diverse fleets, limited range, lack of fueling infrastructure, and uncertainties regarding the long-term promise of different fuel alternatives.[6] In Europe, even large subsidies have not prompted adoption of AFVs on any significant scale. AFVs are not yet sufficiently competitive with heavy-duty diesel engines, and the progress being made in reducing diesel emissions may make it more difficult for AFVs to compete. However, the largest private delivery firms—FedEx, DHL, and UPS—are all experimenting with AFVs and have small numbers of electric and hybrid electric trucks operating in various cities.

In Europe, already noted are experiments with smaller AFVs, such as small vans and cargo cycles for local deliveries. Niche markets may exist in the most dense U.S. city centers (New York, Chicago, Boston), depending on the costs (labor and new vehicles) relative to conventional vans or small trucks, but such experiments have not yet appeared. Lack of a potentially large market suggests that these strategies, focused on city centers only, would have little impact on emissions reductions.

3.2.4 Community Environmental Mitigation

The United States has taken the lead in the incorporation of environmental justice as a performance measure for new freight projects. In part, this can be explained by the sociogeography of U.S. cities, where poor and minority populations tend to be concentrated near major freight facilities. The environmental review process provides a venue for environmental justice concerns. More recent research on the relationship between emissions and health has created an imperative for industry to find solutions to problems that might otherwise prevent them from securing the needed support from elected officials and regulatory agencies. Environmental justice considerations are therefore widely institutionalized in the transportation planning process and often involve industry–government partnerships. Examples include the Southern California Association of Government's Toolkit for Goods Movement, New York City's truck impact study, and Baltimore's industrial overlay zone study.

[6] A discussion of the characteristics, advantages, and disadvantages of the various alternative fuels is beyond the scope of this paper.

U.S. ports have been particularly proactive in addressing environmental justice concerns. In addition to the extreme case of Southern California, clean truck programs, freight rail investments, and elimination of at-grade rail crossings are part of programs in New York–New Jersey, Seattle, and Oakland, as well as Chicago and Atlanta (two major intermodal hub cities).

3.2.5 Alternative Modes

Efforts to shift truck freight to slower but more energy-efficient and cleaner modes in urban areas have not been successful (there are examples of successful interregional programs, such as the European Union's Marco Polo program). In addition to general problems related to rail versus trucking,[7] moving freight by rail in urban areas requires infrastructure capacity that is scarce because of conflicts with regional and urban passenger trains. Rail freight is also commonly opposed by urban residents, especially for nighttime operations. Experiments in Europe that use the regional rail system to ship goods to central areas for delivery show that large public subsidies are required. Studies of using commuter rail for package delivery failed to result in demonstrations or experiments. Efforts to shift freight to water have been similarly unsuccessful, both in the case of coastal shipping and river transport. Recent operations using barges on the Seine for deliveries in Paris City Center were successfully implemented (technically), but at a high cost. The most promising segments for mode shifting are through freight traffic (port or airport imports and exports) in large volumes, as, for example, increasing on-dock rail facilities to eliminate short drayage trips; or large-volume, longer-distance deliveries (say to distant distribution and warehouse centers) where rail is close to competitive with trucking.

3.3 Freight Flows in Metropolitan Regions: Reducing Congestion and Truck VMT

In addition to the concentrated last mile problems described in Section 3.1, truck traffic affects the entire metropolitan transport system. Large trucks contribute more than proportionately to traffic congestion; they account for about 7% of all urban travel, but 22% of all urban congestion cost (Texas Transportation Institute 2012). These costs—estimated as the value of delay and wasted fuel—amounted to approximately $27 billion in 2011 for 439 U.S. urban areas (Texas Transportation Institute 2012). The growth in freight rail traffic in the United States has also contributed to congestion by blocking at-grade rail–road intersections more frequently and for longer periods of time. These problems have motivated efforts to reduce truck-related congestion and truck VMT.

3.3.1 Road Pricing and Dedicated Truck Lanes[8]

Road pricing is an efficient method for managing truck-related congestion, damage to roadways, or emissions. There is an increasing use of pricing strategies in Europe and Asia; whereas, in the United States, pricing strategies continue to be difficult to implement. The most notable European examples (not primarily urban oriented) are the pollution–weight–distance fees in Switzerland, Austria, and Germany, and—in urban areas—the cordon pricing scheme in London. The Swiss example stands out because all types of roads are included in the pricing scheme, including urban and local roads. The Swiss truck fee has contributed to a decrease in truck kilometers together with an increase in truck tons since its introduction in 2001 (Confédération Suisse 2012). Studies have shown that trucks inflict large externalities on regional and local roads, but few toll schemes target these. In Germany, only national highways are included in the pricing scheme, generating an incentive to divert to nonpriced roads. The Paris region is famous for an entirely free-of-charge network of regional highways and roads, while truck tolls are very high on nonmetropolitan highways, which are actually much less congested. There are numerous proposals for truck tolls in the United States, especially in metropolitan areas, including the New York bridge toll plan, and proposed tolled truck lanes in Atlanta and Los Angeles, but none of them have even reached the stage of being part of an accepted project.

Truck pricing may be more difficult than pricing passenger cars because of the competition between trucking and rail, a limited understanding of truck value of time, and the complexity of devising pricing schemes that would address multiple externalities. Uncertainty regarding truck value of time makes it more difficult to establish efficient prices. For example, road pricing to reduce congestion should promote less VMT via more full loads and use of larger trucks, but more use of larger trucks would increase road damage. Hence, efficient pricing would need to take into account these expected shifts and incorporate road damage costs.

A second strategy (often linked with tolls to offer a funding mechanism) is truck-only lanes on highways.

[7] To use a slower mode, cargo owners must hold the inventory longer, and these inventory costs tend to exceed the higher costs of using faster modes. Mixing modes adds to the number of times shipments must be handled, further increasing labor and facility costs. In Europe, rail transport is usually more expensive than trucking. Thus shifting to slower modes adds both time and money costs.

[8] Adapted from a section of Giuliano et al. (2013) authored by Thomas O'Brien.

They have been proposed in major metropolitan areas (most notably Atlanta) and included in regional transportation plans. With the exception of short segments to manage specific conditions (e.g., climbing lanes in steep terrain or lanes for port-access facilities), no examples of truck-only lanes on metropolitan highways in the United States or Europe can be found. U.S. proposals have to date not been implemented because of a lack of funding (Atlanta) or local community opposition (Los Angeles).

3.3.2 Real-Time Traffic Information, Smart Truck–Road Interfaces

Intelligent transportation system (ITS) applications hold promise for better managing urban freight. The authors distinguish between ITS technologies applied within companies and ITS technologies aimed at connecting vehicles with transport system information and management. The focus here is on the latter, which requires public involvement. Very few traffic management techniques are actually specific to (dedicated to) commercial vehicles. Examples include various forms of ID tags automatically read to monitor access or charge fees, weigh-in-motion technology, and truck parking reservation systems.

ITS research and development is moving quickly; there are major efforts in progress in both the United States and Europe. Examples are the U.S. CVISN (commercial vehicle information systems and networks) program and the SMARTFREIGHT project in Europe. Among the most anticipated solutions are real-time detailed traffic information focused on truck drivers (with more details on incidents than currently used navigation systems) and online reservation of loading–unloading areas. Innovative longer-term solutions are currently being tested, such as driverless convoys of trucks, tested at real scale on a Tokyo suburban highway in March 2013. Only the first truck of a convoy of four has a driver. Onboard computers and cameras recognize lane markers, communicate with the other trucks, and control speed. The test proved successful in reducing total energy consumption of the trucks. To date, ITS technologies have led to incremental improvements. Whether automation or fully implemented vehicle–infrastructure systems lead to significant system efficiencies remains to be seen.

3.3.3 Better Accommodation of Rail in Metropolitan Areas[9]

High-volume rail corridors conflict with surface road traffic at at-grade rail crossings and with passenger commuter rail traffic. The main city strategy to address these problems is capital investment to increase rail capacity and to eliminate at-grade rail crossings. The Alameda Corridor in Los Angeles remains the showcase project in the United States. A partnership of the ports, railroads, and various public agencies, the 20-mile cargo expressway was built on time and within budget. Other major rail–road infrastructure projects have proven more difficult; these include the CREATE project in Chicago and the Alameda Corridor East project in Los Angeles. The major challenge to capital investment strategies is the lack of an obvious funding source. Local jurisdictions have no authority to force railroads to incur these costs, and they also have little incentive to pay because they view the rail traffic as a national responsibility. At the national level there is no specific funding source for such projects.

[9] Adapted from a section of Giuliano et al. (2013) authored by Thomas O'Brien.

3.4 Freight Hubs: Reducing Impacts of Major Freight Facilities and Clusters

Freight hubs are locations where freight flows are large and geographically concentrated. They include ports, airports, intermodal transfer points, border crossings, or large logistics clusters. Freight hubs are associated with national and international trade, and they also serve an important local market. Freight hubs are further defined by the scale and scope of operations that take place within them, particularly in the port, warehousing, and distribution sectors. A combination of rising trade volumes, demand for larger facilities, and the cost of land has pushed distribution centers and warehouses to the periphery of metropolitan areas. These facilities generate freight-related activity that may pass through the urban core on the way to and from ports and airports to markets outside the region.

3.4.1 Logistics Land Uses

In large metropolitan areas, logistics activities are both growing and decentralizing (i.e., moving away from the central city) (Dablanc and Ross 2012; Cidell 2010), which can generate more truck traffic on the regional roads (Dablanc and Rakotonarivo 2010). This shift is market driven by land prices and scale economies, and policy strategies are often ineffective. The fragmentation of local governments makes things worse. Planners confronted with the development of freight facilities make land use, zoning, and permitting decisions based on local issues and do not take the regional impacts of warehouse locations into consideration.

Some examples of a more careful attention given to freight facilities in the planning process can be found.

They include looking at accessibility, the provision of adequate infrastructure, and the minimization of impacts of freight facilities in the surrounding communities; see, for example, the Freight Supportive Land Use Guidelines for the Greater Toronto Area. Some also include promoting the local employment base and offering training programs for warehousing jobs. At the metropolitan–regional level, successful planning processes include the studies of freight flows and (such as is common in Europe) the promotion of logistics clusters; that is, the concentration of logistics facilities in one zone sharing services such as safety, catering, and truck maintenance. In the United States, since 1996 six publications of the Transportation Research Board of the National Academies have demonstrated the increasing consideration of freight planning. The 2011 *Freight Facility Location Selection: A Guide for Public Officials* (NCFRP 2011) provides a comprehensive set of recommendations to local governments regarding the integration of freight facilities.

In the literature on smart growth and sustainable transport, little is said about freight. Some of the smart growth ideas that include freight also include urban consolidation centers, freight facilities that are geographically much closer to final–original destinations. Their implementation faces important difficulties, as presented in Section 3.1. By contributing to a better coordination of infrastructure planning and land use decisions, logistics planning can lead to interesting strategies, but the authors believe that it requires supplementary strategies such as truck pricing on regional roads (see Section 3.3) to be effective. For the European case, Hesse (2004) identifies the rise of specialized global players in logistics real estate as another challenge for land use planning. He argues that the influence of global players results in poorly sited distribution centers with limited attention to local considerations such as public transport access for employees or access routes to the site.

3.4.2 Better Management of Port Operations

Ports are particularly large truck and train traffic generators. Large ports generate many thousands of truck trips per day, imposing traffic impacts, noise, and pollution on local residents. As a result, ports are a target for interventions to reduce these impacts. Examples of strategies to reduce or better manage truck traffic are appointment systems and pricing. Appointment systems offer definite pickup times or deliveries arranged in advance. They are intended to both increase efficiency of dock operations and reduce truck queuing. Appointments have been implemented at several ports, including Vancouver, Southampton (UK); Sydney, Australia; Los Angeles, and Long Beach. To date there is little evidence that such efficiencies are being realized. Appointments require operational changes by terminal operators, so they are likely to be used effectively only when yard congestion makes it worthwhile.

The sole example of pricing-based terminal gate operations is the PierPASS program in Southern California. PierPASS charges a traffic mitigation fee (currently $123 per 40-foot container) on certain containers moved into and out of the Los Angeles and Long Beach ports between 8:00 a.m. and 5:00 p.m. on weekdays. The program has shifted about 30% of truck traffic to evenings and weekends and has been successful in reducing the number of peak-period drayage trips and reducing congestion on major highway routes linked with the ports (Giuliano and O'Brien 2008). No other U.S. metropolitan area has the severity of congestion and air pollution to motivate use of peak fees, and no other port is inclined to take the risk of losing business in response to a fee. Shifting truck traffic at the ports generates changes along the rest of the supply chain. The net benefits at the system level are not yet known.

3.4.3 Reducing Port-Related Emissions

Ocean vessels are the largest contributors to PM emissions (in the case of Los Angeles–Long Beach, they account for 59% of port-related PM emissions). Ports use various incentive programs to reduce emissions by reducing speed or using cleaner fuels, because ocean vessels are not subject to national regulation. Examples include the European Seaport Association's recognition program for lower-emissions ships, the Northwest Ports Clean Air Strategy (Vancouver, Seattle, Tacoma) that offers reduced harbor dues for reduced emissions, and the vessel speed reduction program, which offers recognition, time-definite berthing, and sometimes reduced berthing fees in exchange for vessels slowing down on approach to the port (Los Angeles and Long Beach). The vessel speed reduction program has achieved a compliance rate of about 90% and has resulted in a nearly 50% reduction in PM emissions (compared with no program base case), demonstrating the potential of voluntary incentive programs to achieve mitigation goals (Linder 2010).

Several U.S. ports have clean truck programs that are intended to accelerate the use of cleaner diesel beyond existing regulatory requirements and promote AFVs in drayage trucking. The most aggressive effort is the clean truck program at the Los Angeles–Long Beach ports, discussed in Section 3.2 above. Seattle, Oakland, and New York–New Jersey have programs with more flexibility and less aggressive targets. These programs are examples of voluntary regulation: the targets are reached via negotiation and are beyond regulatory requirements.

4. What Works, What Doesn't, and Why

In the introduction to this paper, the authors noted that efforts to manage urban freight and mitigate its impacts have been diverse and widespread. Strategies organized around four urban freight problems have been discussed. Throughout the discussion, the differences between the European Union and United States have been noted with respect to policy approach, strategies implemented, and outcomes. Table 3 (below) seeks to synthesize all of this information. Strategies used or proposed to address the four problem areas have been listed. The authors give their assessment of effectiveness in addressing those problems based on the available literature. Effectiveness depends on whether the strategy generates anticipated outcomes (or solves the targeted problem).

The remaining text provides the authors' assessment of applicability (defined potential for broad implementation) in the United States and the European Union. It is an assessment that is their own and is preliminary. Sufficient research has not yet been conducted to understand why some strategies appear more frequently in the European Union than in the United States. Applicability depends on institutional arrangements, regulatory structures, policy perspectives, and geography. Differences that affect applicability include the following:

1. U.S. interstate commerce protections, which limit the ability of state and local governments to regulate urban freight;
2. Greater acceptance of subsidies to and regulation of private firms in the European Union;
3. The challenging geography of historic cores of European cities, which physically limit circulation and motivate more aggressive solutions to truck traffic problems; and
4. The relatively more fragmented and complex governance environment in U.S. metropolitan areas, which makes region-level strategies more difficult to develop and implement.

Table 3 shows that despite these differences our applicability assessment is rather consistent across the United States and European Union. Very generally, it would seem that the EU environment is more amenable to a broader array of strategy choices as a consequence of a more supportive institutional and political environment.

5. Future Research

Following are some of the authors' suggestions for EU-U.S. collaborative research. One of the priorities for

TABLE 3 Summary of Strategies: Effectiveness and Applicability to the United States and the European Union

	Strategy	Effectiveness	U.S. Applicability	EU Applicability
Metro Core	Traffic and parking regulations	Medium	High	High
	Local planning policy	High	High	High
	Off-hours deliveries	High	Medium	Medium
	Negotiated programs	High	High	High
	City logistics and consolidation programs	Low	Low	Medium
Environment	Truck fuel efficiency and emissions standards	High	High	High
	Low-emission zones (LEZs)	High	Low	High
	Alternative fuels and vehicles	Low	Medium	Medium
	Alternative modes	Low	Low	Low
	Community environmental mitigation	Medium	High	Medium
Metro Flows	Intelligent transportation systems (ITS)	Medium	Medium	Medium
	Road pricing	High	Low	Medium
	Dedicated truck lanes	Low	Low	Low
	Mitigating rail impacts	High	Medium	Medium
Freight Hubs	Logistics land uses	Medium	Medium	Medium
	Port appointment systems	Medium	High	High
	Port pricing	High	Low	Low
	Equipment management	Medium	Medium	Medium
	Accelerated truck emissions reduction programs	High	Medium	High
	Ocean vessel emissions reduction programs	High	High	High

research in urban freight is data collection. Data accessible to planners and researchers on delivery characteristics, operators, truck movements, impacts, and externalities are almost nonexistent. Although progress has been made in the last decade, especially in Europe, survey methods remain heterogeneous, making it difficult to compare results from one city to another. Without urban freight data, it is hard to confirm or refute claims that the density of deliveries in cities has increased over time, or that e-commerce has led to more truck VMT (and less car traffic). A sustained effort in freight data collection and modeling is merited on both sides of the Atlantic.

A thorough understanding of the urban mobility of freight in European and North American cities will make it possible to go further and engage in comparative analyses. An important comparative research objective is to identify relationships within the urban freight system. For example, French urban freight surveys identified a ratio of one delivery per week per job in large metropolitan areas. Is this a valid estimate for other countries or regions? Another relationship observed for European cities is a decrease in the size of trucking firms, increase in the rate of subcontracting for final deliveries, and increase in the size of cities. Are these changes observed in other regions?

A third research need is a careful and systematic evaluation of existing policies and experiments. With few exceptions, lacking is a careful, systematic analysis of the impacts of certification schemes, truck access restrictions, and requirements for alternative fuel trucks. Ongoing experimentation provides a rich resource for discovering whether these efforts have the expected results or have unintended consequences that reduce their benefits. For example, there is limited information on the relative benefits and costs of LEZs. Research is needed to better understand their effectiveness: What are the costs associated with an LEZ, both in terms of the government and logistics firms? What is the impact on the trucking industry? Where do evicted trucks go? What is the global impact of an LEZ once all consequences are taken into account, such as the relocation of a trucking company using old trucks to another city with no LEZ?

A fourth proposed research topic is the effect of the decentralization of logistics facilities away from city centers (logistics sprawl) on truck traffic and VMT. Because many urban areas are watching their logistics industry simultaneously decentralize and consolidate, studying the effect of this phenomenon on total VMT is critical. It may be that the efficiency gains of consolidation outweigh the increase in VMT attributable to decentralization. If so, cities may wish to facilitate or even encourage these shifts. With regard to consolidation, do dense freight centers generate more—or less—total truck VMTs than multiple, smaller, dispersed facilities?

Finally, comparative research on voluntary and negotiated freight mitigation strategies is suggested. Faced with multiple and diverse local government partners and limited jurisdictional authority, metropolitan areas appear to be benefitting from collaboration, consensus building, and engagement with industry to solve urban freight problems. Under what circumstances are such agreements most likely? What is their effectiveness? Do they establish a structure that allows for progressive improvements and change? Urban freight problems are pervasive around the world. There is much to be gained from international collaborative research.

References

Cidell, J. Concentration and Decentralization: The New Geography of Freight Distribution in U.S. Metropolitan Areas. *Journal of Transport Geography*, Vol. 18, No. 3, 2010, pp. 363–371.

Confédération Suisse. *Equitable et efficiente, la redevance sur le trafic des poids lourds liée aux prestations (RPLP) en Suisse*. Report. 2012. http://www.are.admin.ch/themen/verkehr/00250/00461/index.html?lang=fr. Accessed April 15, 2013.

Dablanc, L., and D. Rakotonarivo. The Impacts of Logistic Sprawl: How Does the Location of Parcel Transport Terminals Affect the Energy Efficiency of Goods' Movements in Paris and What Can We Do About It? *Procedia—Social and Behavioral Sciences, Sixth International Conference on City Logistics* (E. Tanguchi and R. G. Thompson, eds.), Vol. 2, No. 3, 2010, pp. 6087–6096.

Dablanc, L., and C. Ross. Atlanta: A Mega Logistics Center in the Piedmont Atlantic Megaregion. *Journal of Transport Geography,* Vol. 24, 2012, pp. 432–442.

Dicken, P. *Global Shift: Mapping the Changing Contours of the World Economy*, 5th ed. Sage Publications, London, 2007.

Duany, A., and J. Speck *The Smart Growth Manual*. McGraw-Hill, New York, 2010.

Federal Highway Administration (FHWA). *Assessing the Effects of Freight Movement on Air Quality at the National and Regional Level*. 2005. http://www.fhwa.dot.gov/environment/air_quality/publications/effects_of_freight_movement/chapter08.cfm#s1. Accessed October 29, 2013.

Giuliano, G., and T. O'Brien. Extended Gate Operations at the Ports of Los Angeles and Long Beach: A Preliminary Assessment. *Journal of Maritime Policy and Management*, Vol. 35, No. 2, 2008, pp. 215–235.

Giuliano, G., T. O'Brien, L. Dablanc, and K. Holliday. *NCFRP Report 23: Synthesis of Freight Research in Urban Transportation Planning*. NCFRP Project 36(05). Transportation Research Board of the National Academies, Washington, D.C., 2013.

Greene, D. Transportation and Energy. In *The Geography of Urban Transportation* (S. Hanson and G. Giuliano, eds.), Guilford Press, New York, 2004, pp. 274–293.

Hesse, M. Land for Logistics: Locational Dynamics, Real Estate Markets and Political Regulation of Regional Distribution

Complexes. *Tijdschrift voor Economische en Sociale Geographie*, Vol. 95, No. 2, 2004, pp. 162–173.

Hesse, M., and J.-P. Rodrigue. The Transport Geography of Logistics and Freight Distribution. *Journal of Transport Geography*, Vol. 12, No. 30, 2004, pp. 171–184.

Holguín-Veras, J., Q. Wang, N. Xu, K. Ozbay, and J. Polimeni. The Impacts of Time of Day Pricing on the Behavior of Carriers in a Congested Urban Area: Implications to Road Pricing. *Transportation Research Part A*, Vol. 40, 2006, pp. 744–766.

Linder, A. *Linking Participation, Program Design and Outcomes: Voluntary Air Quality Programs at the Ports of Los Angeles and Long Beach*. PhD dissertation. University of Southern California, Los Angeles, 2010.

National Cooperative Freight Research Program (NCFRP). *NCFRP Report 13: Freight Facility Location Selection: A Guide for Public Officials*. Transportation Research Board of the National Academies, Washington, D.C., 2011.

Newman, P., and J. Kenworthy. *Sustainability and Cities: Overcoming Automobile Dependence*. Island Press, New York, 1999.

Peters, J. M. *Epidemiologic Investigation to Identify Chronic Effects of Ambient Air Pollutants In Southern California*. Prepared for the California Air Resources Board and the California Environmental Protection Agency, May 2004. http://www.arb.ca.gov/research/apr/past/94-331a.pdf. Accessed October 29, 2013.

Texas Transportation Institute. *Urban Mobility Report*. 2012. http://mobility.tamu.edu/ums/. Accessed May 16, 2013.

Transport for London (TfL). *London Freight Data Report*. 2008. http://www.tfl.gov.uk/microsites/freight/documents/publications/tfl-freight-data-report-2008.pdf. Accessed October 29, 2013.

APPENDIX A: COMMISSIONED WHITE PAPERS

Modeling Approaches to Address Urban Freight's Challenges

A Comparison of the United States and Europe

Michael Browne, *University of Westminster, London, United Kingdom*
Anne V. Goodchild, *University of Washington, Seattle, Washington, USA*

1. Introduction

The rise in urbanization at a global level has reinforced the need to understand complex city growth patterns and rapidly changing urban systems. These urban environments present special challenges to the movement of people and goods. The flow of freight is essential to the growth and functioning of cities but also contributes to problems such as congestion, air pollution, and degradation of the urban environment.

Researchers bring insight to these challenges through their work. Analytical models support a better understanding of urban freight and constitute an important tool in addressing these problems. This paper identifies the problems that urban freight research aims to address in Europe and the United States; provides a better understanding of existing data, analytical tools, and methods; and lays out some gaps and challenges in addressing these problems with existing resources.

The past 10 years have seen a significant increase in research activity regarding issues of urban freight. While passenger travel has been well studied for some time, goods movement presents a different and arguably more complex set of challenges than personal travel. This is in part due to the great diversity of products, business models, and actors involved. The increased research activity is illustrated by the number of researchers working in the field, the increase in freight-specific conferences and seminars, and the increase in the publication of papers. The United States funded the National Cooperative Freight Research Program (NCFRP), and the European Union research and demonstration programs have funded many studies and pilot projects concerned with urban freight. The recent announcement by the Volvo Research and Education Foundations (VREF) that they will support two new centers of excellence focused on urban freight and sustainability issues is also significant. This increase in academic and research activity has been mirrored by the greater interest shown by policy makers at municipal, regional, and national levels (and, indeed, the international level in terms of the European Union's European Commission). This also extends beyond agencies responsible for transportation to other sectors, such as the environment (e.g., the U.S. Environmental Protection Agency's Smartway program), and economic development. The private sector has also seen the opportunity and need to address urban freight issues in a more coherent and active manner, which has lead to many private-sector initiatives happening in cities around the world, both at the enterprise level (e.g., Coca-Cola's sustainability initiatives and DHL's program of city logistics work) and through organizations such as the Forum for the Future.

Research developments have been supported by researchers becoming more actively engaged in international research networks that provide increasing opportunities to compare and contrast developments and challenges between different regions; the U.S.-EU comparative study syposium for which this paper was commissioned is an example.

This paper addresses the use of models to analyze urban freight problems. The term "model" is used to describe a tool, which includes a system of mathematical relationships that help explain a system, study the effects of different components, and make predictions about travel or travel behavior. While there are many urban freight problems of interest and concern, such as the safety of pedestrians around freight vehicles or noise irritation, discussion is confined to pressing problems most amenable to modeling approaches, including air pollution and congestion.

The recent attention to the issues of freight transportation has brought new interest in freight modeling research. Currently, significant development is under way to improve and implement freight models for a variety of applications. It is not the intent of this paper to capture these most recent developments but, rather, to describe the tools currently used to support analysis and decision making. Discussion of models is limited to the following:

1. Models applied at the urban or metropolitan spatial scale. While models exist on the multistate, national, and international scales, this paper examines models that assist with urban-scale freight transportation challenges.
2. Models designed to model road freight. Modal split will not be considered because the overwhelming majority of urban regions rely solely on road vehicles for distribution of freight.
3. Freight-specific models or freight-specific components of models.
4. Transport models, rather than economic models such as input–output or computable general equilibrium models.

Finally, models for planning applications are considered. This inclusion implies strategic models rather than real-time operational models.

Enterprise-level tools, such as those used for facility location, vehicle assignment, routing, and scheduling, are important elements of a firm's logistics planning. These models often use optimization or heuristic algorithms to find the solution that minimizes–maximizes or greatly reduces–increases the desired objective. While some insights can be gleaned from knowledge of these tools—for example, where firms may locate warehouses and distribution centers or which routes they may use—these models are not used to analyze urban freight systems.

The choice was made to consider the research issues of congestion, energy, and air quality because they are important research themes that are receiving attention in both the European Union and the United States. From an initial review of 110 academic papers, Lammgård and Hagberg (2013) made a detailed review of 76 papers published since 2000 to identify the key research themes for those papers regarding work on urban freight and city logistics topics. The most important research topics identified were the following:

1. Congestion,
2. Emissions, and
3. Safety (although safety lagged behind the first two topics in terms of the number of papers that address the topic).

The rest of the paper is structured as follows: Section 2 discusses research on congestion and urban accessibility; Section 3 examines research in energy use, greenhouse gas (GHG) emissions, and air quality. Section 4 considers the availability of data to support analysis, and Section 5 presents the strengths and weaknesses of the research methods presented. Section 6 outlines the authors' view of the challenges to urban freight analytical research, and Section 7 outlines some of the differences between U.S. and European approaches. The paper concludes with recommendations in Section 8.

2. Congestion and Urban Accessibility

Moving goods and people around urban environments is a great challenge. Congested streets cause delay to travelers and goods, making travel times unreliable and scheduling difficult. Congestion increases fuel consumption and emissions for the same amount of travel on an uncongested network. Lack of parking, loading, and unloading places causes vehicles to park illegally and leads to a disruption of traffic flow and decreasing capacity.

Transportation planning and a range of transport policies have been implemented in an attempt to address these difficulties. For example, vehicle weight and access time restrictions and congestion charging schemes attempt to reduce or shift demand. Analysis and modeling are often used to support planning and policy evaluation through estimation of future traffic flows and a better understanding of travel and travel behavior. Travel demand forecasting is used to predict future traffic conditions within a variety of operating, infrastructure, and demand scenarios. In addition, traffic modeling work has explored ways in which to redistribute flows.

2.1 Topics in Freight Congestion Research

Despite these actions, congestion remains a major challenge. Freight transport activity contributes to this congestion through vehicle volumes, but also through traffic disruptions from loading and unloading. Freight vehicles also suffer delays resulting from general urban traffic congestion, and this has direct impacts on their costs and the efficiency of their operations. Research on this topic has addressed the following:

1. The scope to reschedule deliveries (off-hours, out of hours, or night delivery);
2. Ways to allocate, manage, or regulate use of curb space;
3. Pricing and charging: charging vehicles for entering zones within the city or the city itself and shifting demand through parking pricing;
4. Controlling or altering land use; and
5. Using regional consolidation centers.

2.1.1 Rescheduling Deliveries

One way to make better use of road capacity is to deliver outside normal working hours (referred to in the United States as off-hours deliveries and in the United Kingdom as out of hours delivery, perhaps partly to avoid the use of the term "night delivery," which has negative connotations of noise and disturbance for residents). However, it has proved very difficult to change deliveries to off-peak hours. From a societal and environmental perspective, making vehicle deliveries and collection journeys at noncongested times can help reduce the contribution of freight transport to traffic congestion; potentially reduce fuel consumption and pollutant emissions; and improve safety due to fewer goods vehicle operations at times when most pedestrians, cyclists, and other vulnerable road users are on the roads.

There are many research questions examining the scope for rescheduling deliveries, and a wide variety of research approaches have been adopted. For example, work in the Netherlands has concentrated on research into technological improvements for delivery operations to reduce noise (the PIEK Program: Ainge et al. 2007; NICHES, n.d.; Klaasse et al. 2002); whereas, in the United Kingdom, most research has been in the form of pilot projects and small-scale demonstrations. Lammgård and Browne (2012) have summarized a range of research studies carried out on the opportunity for time shifting in EU countries. In many instances, researchers model existing flows and then consider the implications of changing the time of day of an operation. The resulting costs and benefits can then be calculated. The behavior of businesses that ship and receive freight affects the ability to gain a temporal shift in freight movements. One may find that while carriers are willing to shift operations to off-peak hours, users of the service may not want to staff their facilities during these times just to ship or receive freight. Some benefits have already been mentioned, but examples of additional costs may be more expensive labor for nighttime working and the imposition of wider costs for additional noise. The most widely reported U.S. research on this topic took place in New York (see Holguín-Veras et al. 2011). This research built on an extensive series of surveys followed by a number of trials that have received considerable attention beyond the academic community; see, for example, a recent reference in *TIME Magazine* (Sanburn 2013). To address the costs and benefits, the pilot studies have been supported with extensive modeling exercises; see, for example, Holguín-Veras et al. (2007, 2008, 2010).

2.1.2 Allocating, Managing, or Regulating Curb Space

Congestion at the curbside is also important from an urban freight perspective. Freight transport operators suffer from congestion at the curbside when trying to make deliveries and collections at busy times. Urban freight surveys show that demand for curb space is intense on some of the busiest urban streets during peak times (e.g., see Cherrett et al. 2012; NICHES, n.d.; Transport for London 2009). Many deliveries take place from the curbside because retail stores and offices do not have separate off-street loading bays that can be used by carriers. Research into the use of curb space and how to optimize its use is limited. Surveys provide insights, but only limited modeling work appears to have been undertaken to consider the consequences of changing the curbside loading regime on both freight operations and the wider general traffic flows. Traffic models can be used to illustrate the impact of double-parking on loading and unloading operations.

2.1.3 Pricing and Charging

A few EU cities have instigated road user charging (e.g., London, Stockholm, and Gothenburg). In addition, some cities apply tolls to parts of the network, such as bridge crossings that may be important in access trips to, from, and within cities (e.g., New York City). The Ports of Los Angeles and Long Beach charge a traffic mitigation fee between 3:00 a.m. and 6:00 p.m. to address congestion, security, and air quality. With the revenue, the ports established five new shifts per week outside of these hours. The consequences for freight transport have been considered, but research is limited. The research typically shows that freight carriers do not respond to urban road pricing by changing the times at which they operate (Golob and Regan 2000; Hensher and Puckett 2005). Instead, they either absorb the charge or seek to pass the additional cost on to their customers. Whether they can pass the costs on will depend upon relative bargaining or negotiating strengths between the carrier and their customer. Urban freight operations may be carried out by small companies in a weak bargaining position with customers, and in these circumstances they likely will simply carry on operating as before and be forced to absorb the extra costs. The design of the charging system may also affect whether carriers are able or willing to respond by changing their behavior. For example flat-rate charges for cordon-based systems may have different implications compared with charges that vary by road type, location, and time of day. Supply-chain decision making is clearly a complicated mix between carrier and shipper–receiver, and the consequences may be quite varied among different urban supply chains.

2.1.4 Controlling or Altering Land Use

Urban freight movements are strongly influenced by land use patterns, and many of the trends in recent years have forced urban distribution and storage activity further from the metropolitan centers as land use values and changes of use work against having traditional stockholding and transshipment points within the more central areas of the city. At a detailed level, specific land use patterns will influence trip generation and attraction rates. These topics have been the subject of research on logistics sprawl in Paris and Atlanta (e.g., Dablanc and Rakotonarivo 2010; Dablanc and Ross 2012). This sprawl means that vehicles run more mileage in urban areas, thereby contributing to and being affected by congestion to a greater extent than in the past. Land use trip generation studies have been carried out by many researchers (e.g., see Debauche 2008; Fischer and Han 2001; Hunt et al. 2006; Jessup et al. 2004; Kriger et al. 2007; Lau 1995; Lawson and Strathman 2002; Patier and Routhier 2008; Shimuzu et al. 2008). However, land use patterns and urban freight have a complicated relationship. For example, retail land use is heterogeneous, leading to very different trip patterns (number of trips, average consignment size, time of delivery) for specific types of retailers, such as grocery compared with fashion. The research at the Laboratoire d'Economie des Transports (LET) based on the FRETURB model and urban surveys has been of particular interest here (see Routhier and Toilier 2007; Ambrosini et al. 2010; Patier and Routhier 2009). Ownership patterns can also be influential. Studies have shown that independent retail outlets often receive many more deliveries per 100 square meters of floorspace than the branches of retail chains, which reflects multiple retailers' greater control of the upstream supply chain (Anderson et al. 2005; Cherrett et al. 2012). So to understand the congestion implications of different types of land use, a detailed picture is required. These detailed issues could be modeled, but the underpinning data are often weak, particularly those relating to logistics systems and supply chain structures; therefore, it can be very difficult to incorporate these features into freight models.

2.1.5 Using Regional Consolidation Centers

Commercial supply chains (including those serving urban areas) have evolved to become more efficient and responsive to customer requirements. This has allowed transport companies (carriers) and third-party logistics companies to group (or consolidate) flows to improve truck utilization and reduce costs for movement in the supply chain. Policy makers have become interested in the scope for consolidation activity to influence congestion within cities. Clearly reducing the number of vehicles required to achieve a given level of service should reduce miles traveled and have beneficial impacts. But it is possible that supply chains may be optimized and yet the miles run within the city (especially in the center) may not be reduced by this optimization; hence, there has been continued research interest, particularly in Europe, in the opportunity for area-based consolidation, in which operators would concentrate the flows of traffic for a given location through a small number of well-located terminals (e.g., see Allen et al. 2012; Browne et al. 2011; Gonzalez-Feliu and Morana 2010; van Duin et al. 2010). To understand the impact of such centers it is necessary to model the impact of the changes, while taking account both of the new flows that arise and of what happens to the changed trip patterns of companies that now deliver to a consolidation point instead of direct to the final customer. In addition, with the rising interest in the issue of clean vehicles (see Section 3), many studies attempt to combine an understanding of changes in miles traveled with an assessment of the implications for new types of vehicles, such as electrically powered vans and cargo cycles. The use of models is an important way of understanding the potential impact of such schemes and systems, but the modeling is challenging because changes in the behavior of carriers and the way in which a supply chain responds is often poorly understood. Thus, although a carrier may now deliver to a consolidation point for one customer or even several customers (offering an opportunity for a reduction in urban miles traveled), they may continue to deliver into the city center for other customers. This scenario could mean that a consolidation center might have the effect of increasing miles traveled in the city rather than reducing them, although this requires further investigation.

2.2 Forecasting Models

Many of the previously mentioned research approaches rely on the ability to forecast demand for freight transportation under future scenarios. The models used for this forecasting are called travel demand forecasting models. The nature of these models and their characteristics are briefly described here.

Urban forecasting models that account for trucks are relatively common in large urban areas in the United States, with many of the modeling programs operated by metropolitan planning organizations (MPOs). A report published by the Transportation Research Board of the National Academies (TRB), *Special Report 288: Metropolitan Travel Forecasting: Current Practice and Future Direction* (2007), surveyed MPOs about travel modeling and noted the following: "Truck trips are modeled in some fashion by about half of small and medium MPOs and almost 80% of large MPOs." This percentage has certainly increased since the survey, and there is particular emphasis since the adoption of MAP-21 transportation legislation in the United States. While many MPOs have some accommodation for trucks in their modeling efforts, they do not adequately explain the impacts on trucks from land use patterns.

An overview of the state of truck modeling is provided in TRB's *NCHRP Synthesis 384: Forecasting Metropolitan Commercial and Freight Travel* (Kuzmyak 2008). This report identified urban goods movement forecasting methods used in professional practice (primarily in the United States) and completed a survey of organizations with active urban goods movement modeling programs. The report provided supplementary case studies highlighting more innovative goods movement forecasting methods and approaches. NCHRP 384 noted that almost all metropolitan planning organizations and urban areas that model goods movement are actually forecasting trucks using an adaptation of the traditional four-step process common in passenger forecasting. The four-step process estimates trip productions and attractions, matches these productions and attractions into origin–destination pairs, assigns trips between origin–destination pairs to modes, and then selects routes for each set of trips (Virginia Department of Transportation, n.d.). Following are the four steps (Kuzmyak 2008) adapted for truck forecasting; while some locations are considering improvements to this approach, the authors have yet to see a novel framework being consistently used at the metropolitan level for policy analysis.

1. *Trip generation*. For trucks trip generation is usually an estimate of production or consumption linked to the economic activity represented within zones. Truck trips between internal locations or between locations external and internal to the study area can be factored in at this point. A number of studies have found the linkage between several land use variables (specifically employment) and truck trips to be weak, and better data are needed (Fischer and Han 2001).

2. *Trip distribution*. Truck data are often integrated into the overall model during this step by the use of a zone-to-zone trip table (origin–destination matrix), which accounts for truck travel between zones. For a truck model, the external and internal trips are added, and flows are often sorted by truck size or type. This process creates a correspondence between actual and forecast link counts. Validating this step requires truck classification counts and survey data.

3. *Mode choice*. The mode choice step is not commonly used for urban goods movement models because most goods move on trucks, and freight rail, shipping, and pipelines are not usually included. Mode choice could be used to select the type or size of trucks used, but this is not often done in practice.

4. *Trip assignment*. All vehicles, including passenger vehicles and trucks, are assigned by type or class to the roadway network, typically using shortest-path or lowest-cost travel times, often by time of day. The network is typically a limited set of the roadways (e.g., residential streets may be excluded).

Reviews of these adapted four-step truck models reveal that they do not work well in dense urban environments. Comi et al. (2012) provide a review of the state of urban freight transport demand modeling (primarily in Europe), taking a broad view, and including strategic, tactical, and operative models. They categorize models into four types: truck based, commodity based, tour based, and mixed, and discuss their advantages and disadvantages. They categorize four-step models as truck based. One significant limitation is that the four-step process fails to account for the trip and tour (chaining) behavior of truck activity in urban areas,[1] thus creating the existence of a separate class of tour-based models. Four-step models that fail to address multiple-stop tours cannot capture the number of, or the routes associated with, this type of travel. For example, this type of model may do a poor job of capturing the impact of the growth in large consolidation and distribution centers and their impact on the pattern of urban truck travel (Kuzmyak 2008; Donnelly et al. 2010).

These four-step models are also not capable of accounting for the impacts of truck parking or the impact other transportation modes have on truck routing choices. In addition, they rely on fixed vehicle trip rates by land use type and industry sector.

This paper does not consider commodity-based models because such models are generally applied at a larger-than-metropolitan scale due to data characteristics.

There are several alternative approaches to the four-step, commodity, and tour-based models. These include activity-based models, simulation, and agent-based approaches, among others (Abdelgawad et al. 2011; Andreoli and Goodchild 2012; Samimi et al. 2012). TRB's Second Strategic Highway Research Program

[1] In Europe the term "multidrop round" or "multistop round" may be used for these more complicated chained trips.

held a workshop in 2012 on freight demand modeling and data improvement. Their report summarizes many state-of-the-art research approaches (Chase et al. 2013). Tavasszy (2008) provides an earlier overview of international approaches.

Activity-based models, which can be considered an extension of trip-based or tour-based models, use a demand-based approach. Unlike the traditional four-step model that uses single trips as the basic modeling step, these models forecast flow based on travel demand derived from activities that people (or goods) need to perform. Travel is based on the activities to be completed and modeled in tours. Activity models may offer a more effective approach to modeling because trips made by trucks are not independent of each other and can be connected for efficiency or convenience (PB Consult Inc. 2007).

In their review, Comi et al. (2012) point out that in the current urban freight demand modeling literature, the relation between policies–measures and stakeholders' behaviors is not sufficiently represented; in particular, urban-scale shopping trips and the siting of freight centers–platforms and shopping centers. Within current models, industrial employment or land use data are typically used to estimate truck trip generation. Increasingly, however, goods deliveries are being made to residential locations, which has the effect of substituting freight vehicles for passenger vehicles on the last link in the supply chain. This change in retail activity in urban areas and the increase in home shopping has been the subject of much urban freight research, including Feliu et al. (2012), who provide a review of recent trends in urban goods movement and suggest a framework for modeling the changes due to e-commerce and home delivery. Others ask whether these new models present an increase or decrease in vehicle miles traveled (VMT) and emissions, and how travel demand models should be restructured to reflect this change; for example, see Wygonik and Goodchild (2012).

3. Energy Use, GHG Emissions, and Air Pollution

The contribution of transport to GHG emissions has been widely recognized. Within the European Union and the United States there have been many research studies to look at opportunities to reduce energy consumption in transport, some at the level of specific operating strategies for individual fleets (Wygonik and Goodchild 2012). At the urban freight level, the scope to reduce energy consumption has been featured in research (e.g., Kanaroglou and Buliung 2008; Sorrell et al. 2009; Yannisa et al. 2006; Zanni and Bristow 2010; Figliozzi 2010). At the EU level, attention has been increased by the EU white paper on transport (European Commission 2011). A number of challenging goals were set, including the aim of achieving essentially carbon dioxide (CO_2)-free city logistics in major urban centers by 2030. The white paper makes the point that achieving essentially CO_2-free city logistics would also substantially reduce other harmful emissions (see discussion below about air quality issues).

London provides a clear example of the importance of transport within total CO_2 emissions. Ground-based transport is responsible for 22% of total CO_2 emissions in London, and within that freight transport by trucks and vans accounts for 23% (Allen et al. 2010). Among 18 European city regions reported in the GRIP Project (Carney et al. 2009), transport emissions accounted for 66% of total emissions in Oslo (the highest among the 18 regions), and for only 7% in Rotterdam (the lowest), reflecting the very different patterns of energy use influenced by the varied city economies. The proportion of CO_2 accounted for by freight transport was not shown. In a U.S. context, the city of Boulder, Colorado, reported that transport accounted for 21% of CO_2 (Boulder 2010), while Seattle reported that transport represented 71% of core CO_2 split between 41% passenger transport and 30% freight. However, this calculation included residential and commercial CO_2 from buildings but not CO_2 from industry or the port (see Lazarus et al. 2011).

Research into energy consumption and emissions reduction in urban freight has focused on several questions, including the following:

- How large is the scope to use alternative fuels (e.g., electric vehicles)?
- Can new organizational approaches play an important role in minimizing freight transport demand (e.g., improving vehicle utilization and consolidating flows)?
- What are the impacts of vehicle performance improvements and changes to behavior (such as driver training), and how can these be achieved?

It is important to note that the research examining energy use in supply chains since this includes an assessment of energy use (and CO_2 emissions) in freight transport including transport in urban areas. Much of this research adopts a life-cycle approach (e.g., Böge 1995; Browne et al. 2005; Jespersen 2004; McKinnon 2010; Rizet et al. 2012). The life-cycle assessment (LCA) approach is concerned with tracking a product from origin to consumption (and beyond, including waste and recycling). At each stage calculations are made about the energy used. The research is usually underpinned by data collection from surveys. However, to extend the research to consider (*a*) total energy use and (*b*) the impact of different supply chain configurations, it becomes necessary to scale up the findings from the surveys. This may require modeling of typical goods vehicle flows and assumptions about the energy consumption for different types of vehicles that are making different types of trips (e.g., trips in urban areas). Emissions factors can be obtained from environmental agencies such as the U.S. Environmental Protection Agency's MOVES model. The LCA approach can be complicated by the need to make decisions about the boundary of the system to be considered—for example, does it include the energy used in manufacture of the equipment that made the machinery for producing the item being considered? In addition, at the transport level there are questions about how to allocate energy use between different products when goods are delivered using shared vehicle space—for example, in a parcel operation. Because many products are consumed in urban areas, there is a need to consider urban freight trips within the LCA approach. Edwards and McKinnon (2010) compare the carbon footprint of the conventional and online retail supply chain, thereby including an assessment of urban freight transport energy use. Yet this type of modeling is not usually linked to the urban freight modeling approaches discussed so far.

Given the existence of the link between energy use, emissions, and air quality, some of this research into energy consumption overlaps with research into air quality standards within cities and the impact of urban freight transport. Urban regions have concentrated transportation activity, increasing emissions and pollution exposure to those who live and work in the region. Often background levels of pollutants are also higher than in nonurban regions because of manufacturing and industrial activities that may also be concentrated in urban areas. Many urban regions have conducted emissions inventories (e.g., EMFAC), which will not be discussed here.

In the EU context, much of the research concerned with air pollution in cities has been framed by the desire to create low-emissions zones in urban areas. As noted by the Low Emission Zone in Europe Network (LEEZEN),

> [A]ir pollution is responsible for 310,000 premature deaths in Europe each year . . . more than caused by road accidents. Air pollution particularly affects the very young and the old and those with heart and lung diseases—both common causes of death in Europe. It also triggers health problems like asthma attacks and increases hospital admissions and days off sick. The human health damage that air pollution causes is estimated to cost the European economy between €427 and €790 billion per year. Because of this danger to health, many countries around the world, as well as the European Union (EU), have set air quality targets to be met. In the EU, it is in order to meet these targets that LEZs are being implemented. (LEEZEN 2008)

There are now more than 160 such zones in Europe, and they apply to both small and large cities. A key element in the creation of such zones is the underpinning research to demonstrate how large the zone needs to be, how stringent the emission standards, and how the enforcement can be managed, all of which influence the cost–benefit analysis.

Research into the results of the implementation of low-emission zones (Allen and Browne 2009; Johansson and Burman, n.d.; Joint Expert Group on Transport and Environment 2005; Transport for London 2008) suggests that they are a useful policy measure to help improve local air quality conditions to achieve threshold air quality values, especially in relatively small areas that suffer from regularly exceeded conditions. However, there are problems and questions that require more research. For example, low-emission zones can result in vehicle detours to avoid the zone, thereby imposing additional pollution from noncompliant vehicles on locations outside the zone, as well as the redeployment of more polluting vehicles to operate in other locations without such emissions restrictions. Low-emission zones also impose vehicle replacement and retrofitting costs on some vehicle operators, which can lead to higher freight transport costs for supply chain partners. Thereby such zones can result in additional operational, financial, and administrative burdens. Further research is required to determine whether countrywide or even European-wide measures concerning vehicle pollutants might be easier to implement, have a greater geographical coverage, and be more cost-effective overall than a proliferation of low-emission zones in urban areas. Research also needs to take into account that even though emissions from electric vehicles are low or zero, the method of generating the electricity may not be, and this may temper the benefits of switching to such vehicles.

Many urban regions (e.g., Berkeley, Calif; and Seattle, Wash.) have conducted emissions inventories (e.g., using EMFAC); indeed, some of the research concerned with air quality and emissions is probably best considered as a process of accounting rather than as modeling (Boswell et al. 2012). In this accounting or inventory approach, it is important to consider the number of vehicles, the number of trips, and then find agreed-upon and transparent assumptions about typical emissions values (e.g., using the U.S. Environmental Protection Agency's MOVES model). The trips and distance run (and therefore the emissions) can then easily be summed. Different scenarios can be explored without reference to modeling simply by making different assumptions about the fleet mix, distance run, and typical emissions values. However, this ignores some of the important feedback loops that would ideally be considered—for example, as the mix of vehicles or the time of day of operation changes, so does the average vehicle speed and, therefore, emissions values change. To accommodate these more complex patterns, modeling becomes essential. When these interactions are considered, the models need to be able to estimate existing and future traffic flows (including issues such as average speed). This information can then be linked to data on the vehicle fleet operating in urban areas to estimate changes in energy use and pollutant emissions. This approach applies both to freight and nonfreight trips. However, in the case of freight-related trips, the approach is complicated by factors such as uncertainty over the types of freight vehicle in use, their relative age and fuel efficiency, and a lack of data about trip patterns and trip distances for freight.

To estimate human exposure to pollution, detailed population modeling must be combined with emissions models, and the spatial nature of these data retained. However, with GHG emissions, the concern is not localized human exposure, but the planetary impacts of the release of the GHG into the atmosphere. This means the spatial component of the release may not need to be tracked in the analysis or modeling effort. In addition, CO_2 production is often estimated directly from fuel consumption, significantly altering the modeling approach or data inputs required for the analysis.

To reduce emissions, many urban regions are considering how to move people and freight onto lower-carbon transport modes. This requires both an understanding of the contributions of various modes to regional air pollution and an understanding of the financial and behavioral aspects of travel. This question applies to freight operations as well as passenger travel. For example, what are the emissions consequences–benefits of shifting freight onto smaller vehicles that may be powered by cleaner fuels?

With increasingly available computing power and data management tools, some research is moving toward very detailed models applied on larger geographic scales to model detailed vehicle speed, weight, and performance data at the regional level (Boriboonsomsin et al. 2012).

4. Data Requirements and Availability

Models can be applied at smaller and larger spatial extents of the urban freight transportation system, from an intersection, where pedestrian behavior may be examined, to the entire urban region and beyond. Similarly, models may be designed to capture short-term variations in travel demand or predict flows over decades. Finally, the models may represent origins and destinations as individual parcels or as aggregate parcels in larger zones. These variations determine the data requirements and should be aligned with the objectives of the modeling effort. Table 1 (below) identifies the criteria on which models may vary in their scope. For example, most models represent urban regions as a series of zones. These zones may be small, representing each parcel or establishment and, therefore, the travel behavior associated with each parcel; or they may be large, aggregating travel to or from the zone.

Model structures and logic are based on relationships observed from empirical data. Data are collected to build an understanding of the urban freight transportation system and serve as inputs to models once developed and comparisons for validation of model outputs—and, of course, model outputs are also used as data to support decision making and knowledge development. Much of the data used for urban freight transportation modeling and analysis are collected for a purpose other than urban freight research. For example, truck-count data are generally collected for pavement design and maintenance. This presents significant challenges with respect to statistical sampling and spatial or temporal relevance. For example, while Global Positioning System (GPS) data provide an opportunity to track truck trips, the market penetration of GPS or how this varies across subsectors of the trucking industry are unknown. In addition, surrogate measures must often be used in place of metrics of interest. For example, because total truck trip generation is unknown, employment or establishment size is often used as a surrogate.

Table 2 (page 85) describes categories of data, examples of data sets of this type in the United States, and some of their qualities, with an emphasis on transportation data for urban freight analysis.

The utility of national data sources is limited by the granularity they provide for urban scale analysis.

TABLE 1 Scale of Model Application

Descriptor	Range		
Spatial extent	Urban region	Neighborhood	Intersection
Spatial granularity	Large zones		Establishment
System components	All traffic	All truck traffic	Enterprise
Temporal granularity	Typical day	Day divided into 3 to 5 periods	Hourly or by minute
Temporal extent	40 years	Seasonal	Hours
Network granularity	Represent only highways and arterials		Detailed representation of lanes and all roadway links

TABLE 2 Data Sources for Model Applications

Scale	Example	Description
National	Commodity Flow Survey, Freight Analysis Framework 3	Limited spatial detail, must disaggregate for urban scale
Spot data	Truck counts and speeds, highway performance monitoring system or state department of transportation	Most highways and Interstates, less available at arterial or residential street level; limited truck categories, if truck counts at all
Fleet activity data	GPS, partnerships with firms or fleets	Sampling often unknown, offers challenges with representation
Third-party data providers	INRIX, TRANSEARCH	Details of interpretation not transparent; not publicly available
Surveys	Detailed, tailored data	Expensive, not repeated
Public metropolitan, not transportation data	Parking, land use, employment	Must estimate models to convert to trip or travel data
Commodity or industry-specific data	Some federal agencies, some industry groups or organizations	Potentially good for industry-specific analysis, difficult to estimate entire traffic stream from this approach
Demographic (not transport) or economic data	Census	Must estimate models to convert to trip or travel data

Because of this, many regions in the United States find that national data sources must be either disaggregated or complemented with local data collection efforts, including vehicle counts at specific locations. This disaggregation is often accomplished using demographic or economic data such as employment or economic activity. Some guidance has been published on how to accomplish this disaggregation, for example, the report from TRB's NCFRP Project 20, Guidebook for Developing Suboperational Commodity Flow Data (NCFRP 2013).

Some spot-count data are available because of collection for alternative purposes, including roadway and pavement design and maintenance, and they usually categorize trucks in categories relevant for these purposes. However, this is not always relevant for urban freight demand modeling because vehicles of less than 14,000 lbs (6,350 kg) are combined into light-duty vehicles, making it difficult to differentiate smaller vans from passenger vehicles. The situation is broadly similar within the European Union, albeit that the maximum weight limit for light-duty vehicles (also referred to as light-goods vehicles or vans) is set at 3,500 kg.

More recently, fleet activity data have become available in both the United States and the European Union, either through GPS data records or partnerships with individual fleets or groups of fleets. These data are collected for fleet management or, in some cases, tax purposes, and to protect confidentiality are stripped of any identifying information prior to being shared with researchers. These data are well suited for applications where GPS records serve to represent general traffic flow, but the use of these data for other applications is limited by a lack of information on the population represented by this data set. This is also a concern for third-party data providers.

In the United States, data with sufficient spatial resolution for many urban freight applications are generally collected at the urban scale and paid for by local and regional agencies. This includes localized surveys or data collection efforts. This practice presents several challenges to urban freight researchers in that data are (1) not collected on a regular basis, which causes difficulty evaluating changes over time; (2) collected for a short period, which makes them unrepresentative of seasonal or other temporal factors; and (3) not collected using the same methodology in different locations, which makes them difficult to compare over space. The need to supplement national data at the city level is also apparent in the European Union. The most comprehensive urban freight surveys to provide better data were carried out in France in the 1990s (Patier et al. 1997, 2000). These surveys are now being repeated in several French cities and will be an important contribution to our understanding of changes during the past 15 years. A review of data requirements and availability at an EU level was carried out within the BESTUFS Project (BESTUFS 2006). Commodity or industry-specific data can be useful for analyses of individual sectors of the freight system, but cannot be used to represent all freight flows.

5. Strengths and Weaknesses of Current Approaches

In the United States, travel demand models are used extensively by MPOs to inform planning and support decision making. Generally, these models are accepted as useful tools and have been integrated into the decision-making process. Many organizations have built truck modeling capacity into these travel demand models, with use of the same four-step process. While some organizations have developed significantly more than others, as discussed, the structures of most four-step freight travel demand models significantly limit their ability to address some of the challenges to urban freight research. Typically, truck trip generation is most often a function of employment or establishment size and therefore independent of system performance or land use mix; therefore, the models cannot capture responses to access regulation, service improvement, land use mix, or street design. This means trip rates are inelastic to changes in performance from infrastructure modifications or tolling.

In addition, available regional modeling tools have limited ability to address some of the more detailed changes or effects of dense urban environments. These models typically use a zone as their basic spatial unit, capturing trips from, to, and within each zone. Trips within each zone are not applied to the road network. These model results therefore do not comment on the impact of the last mile of travel because it occurs within one zone. This information can be incorporated into the model as an input by modifying the number manually, but adequate data are not currently available to ensure that changes to terminal times are appropriate. Models with zones larger than a city block were not designed to, and cannot in any detailed way, model loading areas, mixed-use development, or on-street parking. Microsimulation models would be more appropriate for this type of evaluation.

A further issue that limits the ability of travel demand models to address the contemporary challenges of urban freight is the lack of explicit tours for trucks in most truck models and the limited handling of intermediate locations. Again, reference is made to the models currently in use by MPOs to address urban freight challenges. Because a four-step model represents individual trips, it cannot account for the synergies apparent in routing and trip planning available through the sophistication of logistics firms. Unfortunately, in the absence of considerable data development and research to validate improved models, tour-based models are unlikely to be operational in the near term for the majority of MPOs.

Emissions modeling is a more recent development for metropolitan planners. Most agencies take advantage of emissions factors provided by other sources and can then consider the net emissions from transportation activity when these emissions factors are tied to transportation activity from a travel demand model. Because of this, the limitations of the travel demand models also apply to the emissions modeling. Also, emissions modeling is sensitive to the additional data requirements, such as the emissions factors available, transportation activity data quality, and fleet data. In addition to having these current data, the values must also be estimated for the future.

Most travel demand models were not designed to capture detailed transportation activities; for example, all vehicles travel the same speed on a link, and speed variations are not considered. This makes the travel modeling frameworks somewhat inappropriate for emissions modeling, which is more sensitive to speed variations.

A significant limitation to both travel demand modeling and emissions modeling is validation. If the intent is to improve, or make the models better, how are they defined better? How is the efficacy and utility of these modeling approaches judged? Will making the model better produce better policy outcomes?

These questions can be separated into two issues:

1. Can the model be demonstrated to replicate observed data?
2. Is the model output used to influence decision making?

Rules of good practice suggest that any model output should, to the extent possible, be validated, or compared against observations of the phenomema being modeled. Travel demand models are designed to estimate systemwide travel, but the validation must be conducted with time- and location-specific data. However, travel demand model outputs are usually compared with available data, including travel surveys and traffic counts (PSRC Travel Demand Model Documentation 2007). While limited, this is an important step; however, this process cannot comment on the predictive abilities of the model. If travel demand model output is used as an input into another process, multiple errors will be propagated through the modeling system, and the secondary estimate (e.g., emissions) could be extremely uncertain. With emissions modeling, one challenge is that ambient air quality measurements include background emissions but the models do not, and ambient air quality is a function of many additional features of the environment (e.g., see Friedman et al. 2001).

The issue of whether the models are effective at affecting decision making is more difficult to address, but discussion is encouraged around this topic at the symposium. Often these observations are spatially or temporally limited.

6. Challenges

It is clear from the discussion in the previous sections that research into urban freight has many analytical and modeling challenges. This section summarizes these challenges by considering the following:

- Challenges driven by complexity and rapid change,
- Challenges driven by a lack or limitation of knowledge or data, and
- Gaps in communication.

6.1 Challenges Driven by Complexity and Rapid Change

Researchers concerned with urban freight have increasingly sought to incorporate a supply chain approach into their analysis of urban freight. Adding the supply chain approach contributes to an understanding of the scope for changes in vehicle flows that result from changes in supply chain strategies and operations (e.g., changes in inventory management strategies by retailers). But this approach inevitably leads to greater complexity, and the current analytical tools and freight models are not easily manipulated or adapted to include the supply chain. This challenge is magnified when consumer behavior and trips are considered. Yet, this becomes increasingly important with the rise in e-commerce and home delivery of products leading, in turn, to changes in the flow of goods and vehicles (both for passengers and freight) within urban areas.

Indeed, work on behavioral issues in general is weaker in freight transport than in passenger travel. Stated preference surveys allow some understanding of trade-offs made by freight buyers, but much of this work is hard to incorporate into existing modeling frameworks. At the micro level of driver behavior, far less is known about the behavior of truck and van drivers (and the complex interactions with trip planners and managers) than is known about car users and travelers generally.

Trip generation studies that underpin many planning initiatives also have flaws. Many of them are based on assumptions derived from relatively limited surveys, and it is not clear how the trip generation work can readily be adapted to changes in the wider economy—for example, more service activity, the rise of internet shopping, mobile working, and so on.

Complexity is also influenced by the number of stakeholders engaged in urban freight decision making, whether at the public policy planning level or the supply chain level. Structuring problems in a way that allows for decisions can be difficult. In some cases there is pressure for simple solutions and a reluctance to spend sufficient time and money on detailed research of the problems and issues.

The speed of technology development (especially in communications) has produced major opportunities for research in urban freight. For example, the scope to acquire information from new technologies related to vehicle and cargo tracking is enormous. However, the rapid pace of the change also creates some problems and challenges. One opportunity relates to the vast amounts of travel data becoming available (also referred to as the challenge of "Big Data"). Among the most important challenges are the following:

- How to capitalize on the vast amount of data that are available but remain in private hands,
- How to prevent data confidentiality and privacy from inhibiting the use of data from some of the commercial systems implemented by companies, and
- How to understand the statistical sampling and statistical confidence of the analytical results.

6.2 Challenges Driven by a Lack of or Limitations of Knowledge or Data

A major weakness in the understanding of urban freight flows concerns smaller vehicles (below 3.5 tons in the European Union and 14,000 pounds in the United States). These vehicles make up a significant part of the vehicle flow in urban areas (in France, 50%) and are responsible for many of the deliveries and collections and for almost all of the service trips. Yet very little data are collected about these vehicles, and few models address the activity of the van sector. National data collection at the EU level for trucks of more than 3.5 tons is a statutory requirement; but for smaller vehicles, it is optional. And with cuts in public spending there are fewer efforts to collect such data than in the past. In the United States, delivery vans are not trackable in any existing data set; this means the magnitude of the VMT is hard to estimate, origin–destination and time of day patterns are not well understood, and therefore public-sector involvement in the field is limited.

In urban freight it is apparent that sometimes research is directed at the vehicle, sometimes at the flow of freight, and sometimes at both factors. However, there is a lack of data matching cargo with vehicles. While vehicle flows and counts are reasonably well measured and modeled, very little data are available demonstrating which commodities or products use which elements of the infrastructure. This particular lack of data limits the ability to understand the economic value of elements of the infrastructure and make investments based on these criteria. It also inhibits the analysis of freight-related environmental impacts at sector, industry, or commodity levels.

At the EU level there are clear challenges when trying to make comparisons between the member states (and this can be extended to consider countries that are not EU members). Some comparisons are difficult because data are not collected in a consistent and common manner. But there are also challenges in terms of definitions (some likely caused by questions of language). For example, within urban freight surveys published in Europe, there are many terms used to describe delivery rounds (including tours, trips, and journeys), and even information about the delivery itself can be difficult to compare when terms such as drop, delivery, consignment, and item are all used without any standard definition for their meaning. The largest and most detailed surveys on urban freight movement (in Europe) have been carried out in France (see Patier et al. 1997, 2000), and yet the results and approaches are not very well known in the UK, primarily because few of the results and approaches (at any detailed level) have been widely disseminated in English.

6.3 Gaps in Communication

Before discussing whether there is a gap between research and practice in urban freight it is relevant to mention the gaps that can be found within the urban freight research community. Perhaps one of the most striking that certainly existed until the past few years is the gap between those engaged primarily in urban freight modeling and those working on policy or business-related research issues. This gap has been closing in recent years, and conferences addressing both perspectives are now more common. Improvements in modeling urban freight flows do not necessarily have to take account of the policy perspective. This lack of policy relevance may not be a problem from a scientific perspective, but it may make it much harder to use the models in a more pragmatic way to support decisions. Researchers focusing on policy questions do not seem to have framed some of these questions in terms of the possible role of models in providing relevant answers, and this simply continues the divide.

There would seem to be a gap between practitioner requirements for simple solutions that can be implemented relatively quickly and the requirement for rigorous research that often highlights complexity. As argued at the start of this paper, the urban freight system is complex, with multiple stakeholders and difficult decision-making trade-offs to consider. This complexity may be very interesting from a research perspective, but for the practitioner, given the task of resolving problems and improving the urban area, it can make it hard to achieve progress. And research often seems to identify the many different possibilities without giving a clear direction as to which of them is most appropriate.

7. Other U.S.-EU Differences

This white paper provides a review of two areas of urban freight research where modeling approaches are used. The paper compares the approaches and their supporting data between U.S. and European cities. While modeling is one aspect of urban freight research, it cannot be forgotten that decisions regarding how to address urban freight challenges are made in a political environment. The political cultures across the Atlantic, but also within Europe and the United States, are varied, meaning that some policy solutions are acceptable in some locations but not in others. The roles of municipal governments in relation to regional or national governments vary, as do political ideologies and cultural values.

In Europe, multinational cooperation has been strongly encouraged by the European Union. To encourage this, funding opportunities have explicit requirements on member state collaboration. While there is not an equivalent funding mechanism in the United States, one could argue that the lack of one reflects a lack of need, that collaborative partnerships between states are more implicit or occurring naturally.

Data programs vary. Freight data collected for European cities are very hard to compare, individual cities often have discretion over the monitoring and analysis of freight data, and there are also national differences in definitions and approaches. As noted in Section 6, there is little consistency or commonality in terms of the data collected about urban goods and vehicle flows. This can make comparisons between cities difficult and expensive (if new data need to be captured). This lack of a common data approach may also inhibit the development of models. Models have been developed, but at the European level those used in urban freight analysis very often remain national in context and application.

Infrastructure in historical European cities is more constrained, and the development more dense than any location in the United States. Historical European centers have tourist attractions whose integrity is threatened by vehicle emissions and vibrations. This has made many cities sensitive to the problems imposed by urban freight. In some cases, this problem-centered approach may stimulate research but it also leads to conflict between the freight transport community and those engaged in policy making and regulation enforcement. The nature of many urban areas has clearly influenced research topics in Europe, with many studies carried out on the use of small vehicles (and even cargo cycles in recent years).

Within Europe there is a strong emphasis on the idea of transferability. Many European-funded projects explicitly seek to address this question. There have also been projects where there are lead cities and follower cities to test whether it is possible to speed up the learning and implementation cycle for urban freight–related improvements. While of course this is valued in the United States, projects have not been set up in this fashion.

Private-sector participation has been encouraged on both sides of the Atlantic. In Europe, it seems that transport companies and vehicle manufacturers have been engaged—and to a lesser extent, retailers and suppliers. This is reversed in the United States, where shippers and receivers (and to a lesser extent, carriers) have been engaged in planning efforts.

8. Recommendations

In this review, several urban challenges to which freight transport is a significant contributor have been identified. It is intended that these identified challenges will serve to raise issues for discussion. These include the following questions:

1. Should additional behavioral aspects be built into models? Will this allow them to be more policy sensitive?
2. To what extent can and should supply chain behaviors be built into freight models? Given their tendency to change over time, what modeling approaches are appropriate? Can a probabilistic approach be used?
3. How can the effectiveness of these models at addressing urban challenges be measured?
4. Why has there been little attention to small-scale problems, such as the impact of on-street parking and loading zones, and the impact of bicycle and pedestrian facilities on traffic flow and capacity? How can greater research attention be brought to these problems?

The authors feel there is an opportunity to improve the communication and transfer of knowledge between urban freight researchers and policy makers. Why does this communications gap persist? How does this relate to analytical tools? To what extent do these tools address the urban freight problems that policy makers are most concerned with? This may be more than a communication problem; for example, are academic projects not sufficiently relevant and therefore not considered by policy makers? Are the data requirements or modeling knowledge too onerous? Does academic research sufficiently capture the key features of private-sector activities?

To further explore these questions, it is recommended that the following activities be considered by symposium participants:

1. Conduct a more systematic review of the state of modeling and analytical work completed with joint support from the United States and Europe;
2. Fund joint projects, especially those that address the modeling–policy gaps;
3. Organize a showcase for some examples where the analytical and policy gap has been overcome or narrowed;
4. Organize an annual meeting aimed at encouraging European–United States cooperation between researchers; and
5. Consider a journal special issue built around the workshop addressing the questions raised by the papers and presentations.

Acknowledgments

The authors thank the paper's reviewers, whose comments have strengthened the paper considerably.

References

Abdelgawad, H., B. Abdulhai, G. Amirjamshidi, M. Whaba, C. Woudsma, and M. J. Roorda. Simulation of Exclusive Truck Facilities on Urban Freeways. *ASCE Journal of Transportation Engineering*, Vol. 137, No. 8, 2011, pp. 547–562.

Ainge, M., P. Abbott, C. Treleven, P. Morgan, P. Nelson, G. Watts, and R. Staite. *Alternative Methods for the Management of Night-Time Freight Noise in London*. Project Report PPR 286. TRL, Camberley, United Kingdom, 2007.

Allen, J., and M. Browne. Environmental Zones in European Towns and Cities and the Implications for Freight Movement. In *Supply Chain Management and Logistics in a Volatile Global Environment* (E. Sweeney, ed.), Blackhall, Dublin, 2009.

Allen, J., M. Browne, and A. Woodburn. *London Freight Data Report 2010*. Transport for London, 2010.

Allen, J., M. Browne, A. Woodburn, and J. Leonardi. The Role of Urban Consolidation Centres in Sustainable Freight Transport. *Transport Reviews*, Vol. 32, No. 4, 2012, pp. 473–90.

Ambrosini, C., D. Patier, and J.-L. Routhier. Urban Freight Establishment and Tour-Based Surveys for Policy-Oriented Modelling. *Procedia—Social and Behavioral Sciences*, Vol. 2, No. 3, 2010, pp. 6013–6026.

Anderson, S., J. Allen, and M. Browne. Urban Logistics—How Can It Meet Policy Makers' Sustainability Objectives? *Journal of Transport Geography*, Vol. 13, No. 1, 2005, pp. 71–81.

Andreoli, D., and A. Goodchild. A Supply Chain Analysis of Truck Trip Generation: A Case Study in Washington Potatoes. *Transportation Letters*, Vol. 4, No. 3, 2012, pp. 153–166.

BESTUFS. *BESTUFS Best Practice in Data Collection, Modeling Approaches, and Application Fields for Urban Commercial Transport Models.* Deliverable D3.1, 2006. www.bestufs.net.

Böge, S. The Well-Travelled Yoghurt Pot: Lessons for New Freight Transport Policies and Regional Production. *World Transport Policy and Practice*, Vol. 1, No. 1, 1995, pp. 7–11.

Boriboonsomsin, K., M. Barth, W. Zhu, and A. Vu. Eco-Routing Navigation System Based on Multisource Historical and Real-Time Traffic Information. *IEEE Transactions on*

Intelligent Transportation Systems, Vol. 13, No. 4, 2012, pp. 1694–1704.

Boswell, M., A. Greve, and T. Seale. *Local Climate Action Planning*. Island Press, Washington, D.C., 2012.

Boulder. Boulder's Community Greenhouse Gas Inventory. 2010. http://www.bouldercolorado.gov/index.php?option=com_content&view=article&id=15354&Itemid=5158. Accessed May 14, 2013.

Browne, M., J. Allen, and J. Leonardi. Evaluating the Use of an Urban Consolidation Centre and Electric Vehicles in Central London. *International Association of Traffic and Safety Sciences Research*, Vol. 35, No. 1, 2011, pp. 1–6.

Browne, M., C. Rizet, S. Anderson, J. Allen, and B. Keïta. Life Cycle Assessment in the Supply Chain: A Review and Case Study. *Transport Reviews*, Vol. 25, No. 6, 2005, pp. 761–782.

Carney, S., N. Green, R. Wood, and R. Read. *Greenhouse Gas Emissions Inventories for 18 European Regions*. Report. EUCO2 80/50 Project, 2009. http://www.euco2.eu/resources/EUCO2-Results-Summary-Small.pdf. Accessed May 14, 2013.

Chase, K. M., P. Anater, and T. Phelan. *SHRP 2 Report S2-C20-RR1: Freight Demand Modeling and Data Improvement*. Transportation Research Board of the National Academies, Washington, D.C., 2013.

Cherrett, T., J. Allen, F. McLeod, S. Maynard, A. Hickford, and M. Browne. Understanding Urban Freight Activity—Key Issues for Freight Planning. *Journal of Transport Geography*, Vol. 24, 2012, pp. 22–32.

Comi, A., P. Delle Site, F. Filippi, and A. Nuzzolo. Urban Freight Transport Demand Modelling: A State of the Art. *European Transport*, Vol. 51, 2012.

Dablanc, L., and D. Rakotonarivo. The Impacts of Logistics Sprawl: How Does the Location of Parcel Transport Terminals Affect the Energy Efficiency of Goods' Movements in Paris and What Can We Do About It? *Procedia—Social and Behavioral Sciences, Sixth International Conference on City Logistics* (E. Tanguchi and R. G. Thompson, eds.), Vol. 2, No. 3, 2010, pp. 6087–6096.

Dablanc, L., and C. Ross. Atlanta: A Mega Logistics Center in the Piedmont Atlantic Megaregion (PAM). *Journal of Transport Geography*, Vol. 24, 2012, pp. 432–442.

Debauche, W. An Investigation into the Delivery of Goods to the City Centre of Liege. In *Innovations in City Logistics* (E. Taniguchi and R. Thompson, eds.), Nova Science Publishers, New York, 2008, pp. 261–276.

Donnelly, R., G. D. Erhardt, R. Moeckel, and W. A. Davidson. *NCHRP Synthesis 406: Advanced Practices in Travel Forecasting*. Transportation Research Board of the National Academies, Washington, D.C., 2010.

Edwards, J. B., and A. C. McKinnon. Comparative Analysis of the Carbon Footprints of Conventional and Online Retailing: A "Last Mile" Perspective. *International Journal of Physical Distribution and Logistics Management*, Vol. 40, No. 1, 2010.

European Commission. Roadmap to a Single European Transport Area—Towards a Competitive and Resource Efficient Transport System. White paper. COM/2011/0144 final. Brussels, Belgium, 2011.

Feliu, J., C. Ambrosini, and J. L. Routhier. New Trends on Urban Goods Movement: Modelling and Simulation of E-Commerce Distribution. *European Transport*, Vol. 50, 2012.

Figliozzi, M. A. Vehicle Routing Problem for Emissions Minimization. In *Transportation Research Record: Journal of the Transportation Research Board, No. 2197*. Transportation Research Board of the National Academies, Washington, D.C., 2010, pp. 1–7.

Fischer, M. J., and M. Han. *NCHRP Synthesis 298: Truck Trip Generation Data*. TRB, National Research Council, Washington, D.C., 2001.

Friedman, M. S., K. E. Powell, L. Hutwagner, L. M. Graham, and W. G. Teague. Impact of Changes in Transportation and Commuting Behaviors During the 1996 Summer Olympic Games in Atlanta on Air Quality and Childhood Asthma. *Journal of American Medical Association,* Vol. 285, No. 7, 2001, pp. 897–905.

Golob, T., and A. Regan. Freight Industry Attitudes Towards Policies to Reduce Congestion. *Transportation Research Part E: Logistics and Transportation Review*, Vol. 36, No. 1, 2000, pp. 55–77.

Gonzalez-Feliu, J., and J. Morana. Are City Logistics Solutions Sustainable? The Cityporto Case. *Territorio Mobilità e Ambiente*, Vol. 3, No. 2, 2010, pp. 55–64.

Hensher, D., and M. Puckett. Refocusing the Modelling of Freight Distribution: Development of an Economic-Based Framework to Evaluate Supply Chain Behaviour in Response to Congestion Charging. *Transportation*, Vol. 32, No. 6, 2005, pp. 573–602.

Holguín-Veras, J., K. Ozbay, A. Kornhauser, M. Brom, S. Iyer, W. Yushimito, S. Ukkusuri, B. Allen, and M. Silas. Overall Impacts of Off-Hour Delivery Programs in New York City Metropolitan Area. In *Transportation Research Record: Journal of the Transportation Research Board, No. 2238*, Transportation Research Board of the National Academies, Washington, D.C., 2011, pp. 68–76.

Holguín-Veras, J., K. Ozbay, A. Kornhauser, A. Shorris, and S. Ukkusuri. *Integrative Freight Demand Management in the New York City Metropolitan Area*. Final report. U.S. Department of Transportation, 2010.

Holguín-Veras, J., M. Silas, J. Polimeni, and B. Cruz. An Investigation on the Effectiveness of Joint Receiver–Carrier Policies to Increase Truck Traffic in the Off-Peak Hours, Part I. *The Behavior of Receivers, Networks, and Spatial Economics*, Vol. 7, 2007, pp. 277–295.

Holguín-Veras, J., M. Silas, J. Polimeni, and B. Cruz. An Investigation on the Effectiveness of Joint Receiver–Carrier Policies to Increase Truck Traffic in the Off-Peak Hours, Part II. *The Behavior of Carriers, Networks, and Spatial Economics*, Vol. 8, 2008, pp. 327–354.

Hunt, J., K. Stefan, and A. Brownlee. Establishment-Based Survey of Urban Commercial Vehicle Movements in Alberta, Canada: Survey Design, Implementation, and Results. In *Transportation Research Record: Journal of the Transportation Research Board, No. 1957*, Transportation Research Board of the National Academies, Washington, D.C., 2006, pp. 5–83.

Jespersen, P. H. The Transport Contents of Products. *World Transport Policy and Practice*, Vol. 10, No. 3, 2004, pp. 28–35.

Jessup, E., K. Casavant, and C. Lawson. *Truck Trip Data Collection Methods*. Final Report SP343. Oregon Department of Transportation, Salem, 2004.

Johansson, C., and L. Burman. *Swedish Experience with Low Emission Zones*. Environment and Health Protection Administration, Air and Noise Analysis, Institute of Applied Environmental Research, Stockholm University, Stockholm, Sweden, no date.

Joint Expert Group on Transport and Environment. *Report from the Working Group on Environmental Zones: Exploring the Issue of Environmentally Related Road Traffic Restrictions*. European Commission, Brussels, Belgium, 2005.

Kanaroglou, P., and R. Buliung. Estimating the Contribution of Commercial Vehicle Movement to Mobile Emissions in Urban Areas. *Transportation Research Part E*, Vol. 44, 2008, pp. 260–276.

Klaasse, M., C. Maaskant, and R. de Lang. *PIEK Project Piektrekker*. DAF Rapport No. 51212/02-140. 2002.

Kriger, D., E. Tan, and A. Clavelle. Results of the TAC Project on the Framework for the Collection of High-Quality Data on Urban Goods Movement (Phase 1). Resource paper. Annual Conference of the Transportation Association of Canada, Saskatoon, Saskatchewan, 2007.

Kuzmyak, V. *NCHRP Synthesis 384: Forecasting Metropolitan Commercial and Freight Travel: A Synthesis of Highway Practice*. Transportation Research Board of the National Academies, Washington, D.C., 2008.

Lammgård, C., and M. Browne. Night-Time Deliveries: Supply Chain Dream or Policy Nightmare? Logistics Research Network Conference, Cranfield, United Kingdon, 2012.

Lammgård, C., and J. Hagberg. Designing for Sustainable Logistics in Urban Areas: What Do We Know? World Conference on Transport Research, Rio de Janeiro, Brazil, 2013.

Lau, S. *Truck Travel Surveys: A Review of the Literature and State of the Art*. Metropolitan Transportation Commission, Oakland, Calif., 1995.

Lawson, C., and J. D. Strathman. *Survey Methods for Assessing Freight Industry Opinions*. Final Report SPR 328. Oregon Department of Transportation, Salem, 2002.

Lazarus, M., P. Erickson, C. Chandler, M. Daudon, S. Donegan, F. Gallivan, and J. Ang-Olson. *Getting to Zero: A Pathway to a Carbon-Neutral Seattle*. Report. City of Seattle Office of Sustainability and Environment, Seattle, Wash., 2011. http://www.seattle.gov/environment/documents/CN_Seattle_Report_May_2011.pdf. Accessed May 14, 2013.

LEEZEN. Low Emission Zones in Europe Network (LEEZEN). Europe-wide Information on LEZs. 2008. http://www.lowemissionzones.eu. Accessed Aug. 25, 2009.

McKinnon, A. Product-Level Carbon Auditing of Supply Chains: Environmental Imperative or Wasteful Distraction? *International Journal of Physical Distribution & Logistics Management*, Vol. 40, No. 1–2, 2010, pp. 42–60.

National Cooperative Freight Research Program. *NCFRP Report 26: Guidebook for Developing Subnational Commodity Flow Data*. Transportation Research Board of the National Academies, Washington, D.C., 2013. http://www.trb.org/Main/Blurbs/169330.aspx.

NICHES. Innovative Approaches in City Logistics: Inner-City Night Delivery. NICHES, no date.

Patier, D., and J.-L. Routhier. How to Improve the Capture of Urban Goods Movement Data. 8th International Conference on Survey Methods in Transport, Annecy, France, 2008.

Patier, D., and J.-L. Routhier. Une Méthode d'enquête du Transport de Marchandises en Ville pour un Diagnostic en Politiques Urbaines. *Cahiers Scientifiques du Transport*, Vol. 55, 2009, pp. 11–38.

Patier, D., J.-L. Routhier, and Ch. Ambosini. *Transport de marchandises en ville: Enquête quantitative réalisées à Dijon et Marseille*. Rapport finaux MELT-DRAST. Laboratoire d'Economie des Transports, France, 2000.

Patier, D., J.-L. Routhier, Ch. Ambosini, P. Bossin, P. Gelas, and M. Le Nir. *Transport de Marchandises en ville: Enquête Quantitative réalisée à Bordeaux*. Rapport final MELT-DRAST. Laboratoire d'Economie des Transports, France, 1997.

PB Consult Inc. *An Independent Expert Review of the Calgary Regional Transportation Model*. Forecasting Division, Transportation Department, City of Calgary, Alberta, Canada, 2007.

PSRC Travel Demand Model Documentation. Cambridge Systematics. http://www.psrc.org/assets/1511/model_doc_final_.pdf. 2007.

Rizet, C., M. Browne, E. Cornelis, and J. Leonardi. Assessing Carbon Footprint and Energy Efficiency in Competing Supply Chains: Review—Case Studies and Benchmarking. *Transportation Research Part D*, Vol. 17, No. 4, 2012, pp. 293–300.

Routhier, J.-L., and F. Toilier. FRETURB V3: A Policy Oriented Software of Modelling Urban Goods Movement. *Proc., 11th World Conference on Transport Research*, Berkeley, Calif., 2007.

Samimi, A., A. Mohammadian, and K. Kawamura. Behavioral Freight Movement Modeling. In *Travel Behaviour Research in an Evolving World* (C. R. Bhat and R. M. Pendyala, eds.), Lulu Publishers, 2012.

Sanburn, J. Deliver a Fix for Traffic Jams. *TIME Magazine*, March 25, 2013, p. 40.

Shimuzu, M., T. Hyodo, H. Takebayashi, H. Kuse, and Y. Hagino. Study of Delivery Distribution in the Central Area by Tokyo Metropolitan Freight Survey. In *Innovations in*

City Logistics (E. Taniguchi and R. Thompson, eds.), Nova Science Publishers, New York, 2008, pp. 231–248.

Sorrell, S., M. Lehtonen, L. Stapleton, J. Pujol, and T. Champion. Decomposing Road Freight Energy Use in the United Kingdom. *Energy Policy*, Vol. 37, 2009, pp. 3115–3129.

Tavasszy, L. A. Freight Modeling: An Overview of International Experiences. In *Conference Proceedings 40: Freight Demand Modeling: Tools for Public-Sector Decision Making*. Transportation Research Board of the National Academies, Washington, D.C., 2008, pp. 47–55.

Transport for London. *London Low-Emission Zone Impacts Monitoring Baseline Report*. 2008.

Transport for London. *Regent Street: Delivery and Servicing*. Report. ARUP, 2009.

Transportation Research Board. *Special Report 288: Metropolitan Travel Forecasting: Current Practice and Future Direction*. Transportation Research Board of the National Academies, Washington, D.C., 2007.

van Duin, R., H. Quak, and J. Munuzuri. New Challenges for Urban Consolidation Centres: A Case Study in The Hague. *Procedia—Social and Behavioral Sciences, Sixth International Conference n City Logistics*, Vol. 2, 2010, pp. 6177–6188.

Virginia Department of Transportation. What Is Travel Demand Modeling? http://www.virginiadot.org/projects/resources/vtm/What_is_Travel_Demand_Modeling.pdf.

Wygonik, E., and A. Goodchild. Evaluating the Efficacy of Shared-Use Vehicles for Reducing Greenhouse Gas Emissions: A U.S. Case Study of Grocery Delivery. *Journal of the Transportation Research Forum*, Vol. 51, No. 2, 2012, pp. 111–126.

Yannisa, G., J. Goliasa, and C. Antonioua. Effects of Urban Delivery Restrictions on Traffic Movements. *Transportation Planning and Technology*, Vol. 29, No. 4, 2006, pp. 295–311.

Yu, R., Y. Wang, and T. Larson. Quantifying the Relationship Between Near-Road Concentrations of Fine Particulate Matter and Traffic Flow Observations.

Zanni, A., and A. Bristow. Emissions of CO_2 from Road Freight Transport in London: Trends and Policies for Long-Run Reductions. *Energy Policy*, Vol. 38, 2010, pp. 1774–1786.

APPENDIX B

Final Program

CITY LOGISTICS RESEARCH: A TRANSATLANTIC PERSPECTIVE

EU-U.S. Transportation Research Symposium 1

Organized by the
European Commission
Research and Innovative Technology Administration, U.S. Department of Transportation
Transportation Research Board

May 30–31, 2013
National Academy of Sciences Building
2101 Constitution Avenue, NW
Washington, D.C.

Thursday, May 30, 2013

7:15 a.m. Continental Breakfast, *East Court*

8:00 a.m. **Welcome and Introductory Remarks,** *Lecture Room*
Robert E. Skinner, Jr., Transportation Research Board, *presiding*

Recognition of Planning Committee Members
C. Michael Walton, University of Texas at Austin

Welcome from the European Commission
Alessandro Damiani, European Commission Directorate–General for Research and Innovation

Welcome from the U.S. Department of Transportation
Kevin Womack, Research and Innovative Technology Administration

8:30 a.m. **Presentation of Commissioned White Papers,** *Lecture Room*
Alan C. McKinnon, Kühne Logistics University, *presiding*

Approaches to Managing Freight in Metropolitan Areas
Laetitia Dablanc, Institute of Science and Technology for Transport, Development, and Networks
Genevieve Giuliano, University of Southern California

Modeling Approaches to Address Urban Freight's Challenges: A Comparison of the United States and Europe
Michael Browne, University of Westminster
Anne V. Goodchild, University of Washington

Discussion and Question-and-Answer Session

9:30 a.m. Break, *East Court*

10:00 a.m. **Demand Patterns and Trends,** *Lecture Room*
Christopher Caplice, Massachusetts Institute of Technology, and Laetitia Dablanc, Institute of Science and Technology for Transport, Development, and Networks, *presiding*

French Cities' Urban Freight Surveys
Jean-Louis Routhier, Laboratoire d'Economie des Transports

U.S. Cities' Urban Freight Surveys
Miguel Jaller, Rensselaer Polytechnic Institute

Shifts and Trends in Urban Retailing and Buying Behavior
Robert Chumley, 7-Eleven

Synthesis and Summary
Laetitia Dablanc, Institute of Science and Technology for Transport, Development, and Networks

12:30 p.m. Lunch, *Great Hall*

1:30 p.m. **Schemes and Technologies for Enhancing Urban Distribution,** *Lecture Room*
Marcel Huschebeck, PTV AG, *presiding*

Case Studies of Innovation
Cathy Macharis, Free University of Brussels

Impact Evaluation
Martin Ruesch, RAPP Trans AG

Implementation Aspects
Jack Levis, UPS
David Logsdon, Waste Management
Chris Kozak, Wal-Mart

Discussion and Question-and-Answer Session

4:00 p.m. Break, *East Court*

4:30 p.m. **Open Forum on Cross-Cutting Issues,** *Lecture Room*
Alan C. McKinnon, Kühne Logistics University, *presiding*

6:00 p.m. Welcome Reception and Networking, *Great Hall*

Friday, May 31, 2013

7:15 a.m. Continental Breakfast, *East Court*

8:00 a.m. **Review of Day 1,** *Lecture Room*
Rapporteurs, Andrea Meyer and Dana Meyer, Working Knowledge, *presiding*

8:30 a.m. **Terminals and Hubs: Impacts and Strategies,** *Lecture Room*
Lanfranco Senn, Bocconi University, and Genevieve Giuliano, University of Southern California, *presiding*

	Part 1: Impacts of Terminals and Hubs on Metropolitan Areas **Intermodalism and Urban Logistics: Impacts of Terminals on Metropolitan Areas** Jean-Paul Rodrigue, Hofstra University
	Part 2: Strategies for Mitigating Impacts of Terminals and Hubs **Consolidation Hubs and Freight Villages** Thierry Vanelslander, University of Antwerp
	Environmental Regulation Clarence Woudsma, University of Waterloo
	Operational Strategies Thomas O'Brien, California State University, Long Beach
	Discussion and Question-and-Answer Session
10:30 a.m.	Break, *East Court*
11:00 a.m.	**Logistics Efficiency in Urban Areas, Part 1**, *Lecture Room* Alan C. McKinnon, Kühne Logistics University, and Chelsea (Chip) White, Georgia Institute of Technology, *presiding*
	Measuring Efficiency and Inefficiency in Urban Freight Transport Teodor Gabriel Crainic, Université du Québec à Montréal
	Opportunities for Improving Efficiency José Holguín-Veras, Rensselaer Polytechnic Institute
12:00 noon	Lunch, *Great Hall*
1:00 p.m.	**Logistics Efficiency in Urban Areas, Part 2,** *Lecture Room* Alan C. McKinnon, Kühne Logistics University, and Chelsea (Chip) White, Georgia Institute of Technology, *presiding*
	Barriers and Constraints Birgit Hendriks, Binnenstadservice
	Opportunities for Public Policy Intervention Ian Wainwright, Transport for London
	Discussion and Question-and-Answer Session
2:30 p.m.	**Review of Day 2,** *Lecture Room* Rapporteurs, Andrea Meyer and Dana Meyer, Working Knowledge, *presiding*
3:00 p.m.	**Concluding Observations: Opportunities for Collaboration,** *Lecture Room* Robert E. Skinner, Jr., Transportation Research Board, *presiding*
3:30 p.m.	**Adjournment**

APPENDIX C

Symposium Attendees

Scott Babcock
Transportation Research Board
Washington, D.C., USA

Paul Bingham
CDM Smith
Washington, D.C., USA

Edgar Blanco
Massachusetts Institute of Technology
Cambridge, Massachusetts, USA

Maria Boile
Hellenic Institute of Transport
Thessaloniki, Greece

Thomas Bolle
Research and Innovative Technology Administration
U.S. Department of Transportation
Washington, D.C., USA

Stane Božicnik
University of Maribor
Maribor, Slovenia

Michael Browne
University of Westminster
London, United Kingdom

James Bryant
Transportation Research Board
Washington, D.C., USA

Kenneth Button
George Mason University
Fairfax, Virginia, USA

Alasdair Cain
Research and Innovative Technology Administration
U.S. Department of Transportation
Washington, D.C., USA

Christopher Caplice
Massachusetts Institute of Technology
Cambridge, Massachusetts, USA

Tina Casgar
San Diego Association of Governments
San Diego, California, USA

Thomas Cherrett
University of Southampton
Southampton, United Kingdom

Robert Chumley
7-Eleven
Dallas, Texas, USA

Alison Conway
City University of New York
New York, New York, USA

Thomas Corsi
Robert H. Smith School of Business
University of Maryland
College Park, Maryland, USA

Téodor Gabriel Crainic
Université du Québec à Montréal
Montréal, Québec, Canada

Laetitia Dablanc
Institute of Science and Technology for Transport, Development, and Networks
Paris, France

Theodore K. Dahlburg
Delaware Valley Regional Planning Commission
Philadelphia, Pennsylvania, USA

Alessandro Damiani
European Commission
Brussels, Belgium

René de Koster
Erasmus University
Rotterdam, Netherlands

Alan Erera
Georgia Institute of Technology
Atlanta, Georgia, USA

Heike Fläemig
Hamburg University of Technology
Hamburg, Germany

Genevieve Giuliano
University of Southern California
Los Angeles, California, USA

Anne V. Goodchild
University of Washington
Seattle, Washington, USA

Lance Grenzeback
Cambridge Systematics
Boston, Massachusetts, USA

Birgit Hendriks
Binnenstadservice
Hertogenbosch, Netherlands

José Holguín-Veras
Rensselaer Polytechnic Institute
Troy, New York, USA

Jaclyn Hubersberger
Transportation Research Board
Washington, D.C., USA

Marcel Huschebeck
PTV AG
Karlsruhe, Germany

Miguel Jaller
Rensselaer Polytechnic Institute
Troy, New York, USA

Kazuya Kawamura
University of Illinois
Chicago, Illinois, USA

Christopher Kozak
Wal-Mart
Fayetteville, Arkansas, USA

Barbara Lenz
German Aerospace Center (DLR)
Berlin, Germany

Hervé Levifve
Atelier Parisien D'Urbanisme
Paris, France

Jack Levis
UPS
Baltimore, Maryland, USA

David Logsdon
Waste Management
Houston, Texas, USA

Rosário Macário
Technical University of Lisbon
Lisbon, Portugal

Cathy Macharis
Free University of Brussels
Brussels, Belgium

Edoardo Marcucci
Roma Tre University
Rome, Italy

Alan C. McKinnon
Kühne Logistics University
Hamburg, Germany

Sandra Melo
Instituto Superior Técnico
Lisbon, Portugal

Andrea Meyer
Working Knowledge
Boulder, Colorado, USA

Dana Meyer
Working Knowledge
Boulder, Colorado, USA

Michael Meyer
Parsons Brinkerhoff
Atlanta, Georgia, USA

Martine Micozzi
Transportation Research Board
Washington, D.C., USA

Jesús Muñuzuri
University of Seville
Seville, Spain

Mark Norman
Transportation Research Board
Washington, D.C., USA

Thomas O'Brien
California State University
Long Beach, California, USA

Alberto Preti
European Network of Logistics Competence Centers
Bologna, Italy

Hans Quak
TNO
Delft, Netherlands

Caitlin Rayman
Federal Highway Administration
Washington, D.C., USA

Amelia Regan
University of California
Irvine, California, USA

Jean-Paul Rodrigue
Hofstra University
Hempstead, New York, USA

Jean-Louis Routhier
Laboratoire d'Economie des Transports
Institut des Sciences de l'Homme
Lyon, France

Martin Ruesch
RAPP Trans AG
Zürich, Switzerland

Michel Savy
University of Paris-East
Paris, France

Rolf Schmitt
Bureau of Transportation Statistics
Research and Innovative Technology Administration
U.S. Department of Transportation
Washington, D.C., USA

Lanfranco Senn
Bocconi University
Milan, Italy

Hyeon-Shic Shin
National Transportation Center
Morgan State University
Baltimore, Maryland, USA

Robert E. Skinner, Jr.
Transportation Research Board
Washington, D.C., USA

Frank Smit
European Commission
Brussels, Belgium

Vikenti Spassov
T. Kableshkov University of Transport, Sofia
Sofia, Bulgaria

Carlo Vaghi
Bocconi University
Milan, Italy

Thierry Vanelslander
University of Antwerp
Antwerp, Belgium

Ian Wainwright
Transport for London
London, United Kingdom

C. Michael Walton
University of Texas
Austin, Texas, USA

Chelsea C. White III
Georgia Institute of Technology
Atlanta, Georgia, USA

Kevin Womack
Research and Innovative Technology Administration
U.S. Department of Transportation
Washington, D.C., USA

Clarence Woudsma
University of Waterloo
Waterloo, Ontario, Canada

TRB

TRANSPORTATION RESEARCH BOARD
500 Fifth Street, NW
Washington, DC 20001

www.TRB.org

ADDRESS SERVICE REQUESTED

ISBN 978-0-309-29487-4
90000
9 780309 294874