Center of Excellence First-Year Progress Report

Project Number: COE-2012-01

Project Title: METROFREIGHT: the Local/Global Challenge of Urban Freight

Name and Affiliation of Main Applicant(s):
METRANS Transportation Center
Sol Price School of Public Policy
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Time period that this report covers: March 2013 – December 2013

Starting date of the project: March 1, 2013

Expected end date of the project: December 31, 2017

Received Funding for Year 1: US $324,750 SEK 2,131,253

Requested Funding for Year 2: US $673,700 SEK 4,421,325

Date and signature of main applicants:

Genevieve Giuliano

___________________________________ ____**12-3-13**________________

Genevieve Giuliano, Director Date

METROFREIGHT
Volvo Center of Excellence

Project Description

Project Activities

The main tasks for Year 1 were 1) setting up the center, 2) Phase 1 research, freight flows and their impacts, 3) curriculum guide and course development, 4) outreach.

Setting up organization and administration of the Center

The launch of METROFREIGHT began with a kick-off meeting with VREF sponsors in Gothenburg at the end of February 2013. The contract processing took quite some time, with the master contract set up in May 2013, and the subcontracts being issued after the master contract was in place. The last of the subcontracts was finalized in September 2013. The long contracting process delayed the start of the major work of Year 1.

Setting up the center involves hiring staff, establishing a communications structure, and establishing mechanisms for collaborative work across three countries and four time zones. Our METRANS budget calls for a part-time project manager. USC has an elaborate hiring process, and the part-time position had to be matched from other grants. While getting through this process, we hired a graduate student, Ryan Cassutt, to serve as interim project manager. Ryan is a second year Master of Public Policy student. The new position has been posted and advertised, and we are now in the process of evaluating applications. METROFREIGHT (MF) administration and management is further supported by METRANS staff members, which are funded from other sources. Staff include Vicki Valentine, METRANS Administrator (promotion to Assistant Director in progress), and Elizabeth Gatchalian, Price School contracts and grants administrator.

A communications structure is essential, given the spatial dispersion of the MF team. We have created a directory of all faculty and staff associated with MF, and have assigned people as communications leads for each group. Included in the directory are the administrative staff who manage the contracts and accounts at each university or research institution. We have a monthly conference call schedule to share information and progress on the research task. We have purchased Adobe Connect to allow real-time sharing of documents during our conference calls. We have piloted Adobe Connect but are not yet using it regularly. A Dropbox site has been created for all MF documents and files. The site is accessible to all faculty, staff and students involved in the project. The Dropbox system is working well.

In addition, we have established a policy of “opportunistic meetings”, meaning that we are using major conferences as venues for in-person meetings. We first met at the January 2013 Transportation Research Board; a small group met at the EU/US Urban Freight Symposium in May 2013, and 14 members gathered at the International Urban Freight Conference (INUF) in October 2013. The in-person meetings are extremely helpful in establishing working relationships among the MF team members and guiding the many activities of the CoE. We realize that in-person meetings are essential, and are planning to build them into the future years of the grant. We have scheduled 2014 meetings at January TRB in Washington DC and April TRA in Paris (see future plans section for details).

The CoE plans include an executive committee and advisory committee. The MF executive committee is composed of the team and theme leaders. They have met several times via conference call and in person. The METRANS portion of the MF Advisory Committee is meeting in December 2013; we anticipate a full virtual meeting of the group in spring of 2014.

Finally, we have launched the branding and marketing of MF. We are doing a complete re-design of the METRANS website and establishing a new MF website that will be accessed either directly or via the METRANS main page. Website development is in the stage of organizing the path trees and writing content for the various landing pages. We have designed a MF logo that will brand all activities and products generated from the grant. The public launch of the center took place at a reception preceding the INUF conference.

Other notable organizational activities include:

- The IFSTTAR team had a kick-off meeting with Metrofreight institutional partners on June 12. Participants included City of Paris DoT, Region Ile-de-France DoT, City of Paris' Planning agency APUR, Region Ile-de-France's Planning Agency IAU, and State regional transport agency DRIEA. IFSTTAR signed the Paris Sustainable Urban Logistics Charter on Sept 18 (with the City of Paris and 80 other regional stakeholders).
- METRANS hosted Henrik Nolmark's site visit on October 11. The purpose of the site visit was to introduce our management team, USC and CSULB researchers, and students. We discussed management structure, progress on the grant, and collaboration opportunities with other CoEs. We also discussed the VREF theme on urban freight and how it might be enlarged.

<u>Deviations from Year 1 Plan</u>: The project manager is not yet hired; should be in place by end of 2013 or early 2014 (USC security review of new hires can take months). The website is not yet completed; should be in place by early 2014.

Phase 1 Research

The major research task for Year 1 is a comparative analysis of the state of urban freight in each of our four case study metropolitan areas. The first part of this task is creation of comprehensive and comparable data bases. We have developed a data collection document that describes categories of data and itemizes specific data elements to be collected in each metro area. The data collection document is the result of a collaborative process aimed at obtaining as much comparable data as possible. The document is available as Attachment 1. We are using the metropolitan area as our main unit of analysis, but are collecting more detailed information for the central city of each metro area. It is not feasible to collect highly detailed data (for example truck parking locations) for such large metro areas, and each central city itself has a lot of variation in land use and flow patterns.

The New York region poses a unique challenge for data collection. It encompasses parts of four different states (New York, New Jersey, Connecticut and Pennsylvania). This unit is an official designation known as the New York-Newark, NY-NJ-CT-PA Combined Statistical Area (CSA). Many types of data are not consistent across states. Data collection for the New York region will be limited to the New York and New Jersey portions of the CSA.

We are now in the process of collecting the data. Graduate students have been hired at USC, CCNY, IFSTTAR, and KOTI to search for data sources and generate the database. For the Paris survey, IFSTTAR is working directly with the Laboratory of Transport Economics, University of Lyon, which is leading the survey. USC has the lead in coordinating the data collection and generating the master files. The database is geo-coded in ArcGIS. Work on the database began in the fall semester. Attachment 2 summarizes the current state of the data collection in a spreadsheet. The tabs correspond to the main topic areas as described in the data collection document. Data sources, format and other details are available in files generated by each research group. As anticipated, vehicle fleet and flow data (especially truck data) is the most difficult to obtain, and the amount and granularity of these data vary across the four metro areas.

Each team is exploiting special data sets or opportunities for data collection. The Paris survey has already been mentioned. The KOTI team is working with Hyundai Logistics, CJ Korea Express, and Hanjin Transportation. These three companies play major roles in delivering parcels in Korea. Using their parcel delivery data for a month of 2012, the KOTI team has analyzed parcel movement patterns both within the Seoul metro area and to and from Seoul. The Seoul team plans to collect more data in order to study what influence institutional and social regulation have on the logistics strategies of the private parcel delivery companies. The METRANS team has access to archived real-time transportation system data that will be used for various modeling efforts in Year 2.

A rough estimate of progress on this task is 60%. Most of the data has been identified as available or not available, and many data sources have been identified, but the data has not yet been acquired. We anticipate that data collection will continue throughout the grant so that we can continue to enrich the research possibilities. The data will be made publicly available after we have fully vetted data quality and comparability.

In addition to the descriptive task of characterizing freight flows in each of our metro areas, we are working on a comparative analysis that will describe "freight landscapes", the characteristics of freight generation and flows associated with different urban spatial structures. This work builds on Dablanc and Rodrigue's city logistics typology. We hypothesize that differences in freight patterns across metro areas are associated with differences in spatial form, as well as industry mix, role in international trade, etc. Identifying freight landscapes would allow us to predict freight flow characteristics based on spatial data.

Deviations from Year 1 Plan: The data collection is not yet complete; we anticipate that the collection of basic data will be completed by January 2014. We expect to conduct the comparative analysis in early 2014 and have it completed by end of March 2014. Because the Year 2 research activities will involve other faculty and graduate students, we will launch the various Year 2 projects as scheduled.

Year 1 Education

The education strategy involves two dimensions. 1) development of curriculum materials that can be used by scholars, practitioners and the general public; 2) professional training, including formal (accredited) and informal programs to train scholars and practitioner in concepts, methods, and applications of city logistics.

Principal year 1 education efforts include the development and dissemination of a curriculum guide based on an international scan of readings, case studies, media, exercise and examples of experiential learning. This project is designed in part to help us identify the current state of the art as well as gaps in the curriculum which will then allow us to develop a graduate course in urban freight, an urban freight curriculum, and professional training courses, all of which follow in years 2-5. Research for the curriculum guide is currently under way and includes outreach done with participants at the International Urban Freight Conference. The guide will be completed by the end of March 2014, along with the remaining Year 1 tasks. A graduate student at CSULB supports this effort.

Rodrigue and Dablanc have developed educational material on the principles of city logistics as part of a large, freely available transportation related web site (http://people.hofstra.edu/geotrans/eng/ch6en/appl6en/ch6a2en.html). This background curriculum will be expanded on during years 2 and 3 with the development of full standing courses on city logistics.

Other team educational activities include:

- Seo and Jeong offered a one day Logistics Specialist Training Seminar at Inha University in November.
- Giuliano developed a 1.5 day curriculum in goods movement for local and regional government leaders in Indonesia.

Year 1 Outreach

METRANS hosted the International Urban Freight Conference (I-NUF) October 8-10. Total attendance reached 225 and represented 16 different countries. Several members of both MF and SUFS presented papers. We had two feature sessions for each CoE to highlight the CoE faculty and their research. Proceedings of the conference will be available in December. We had a formal celebration of the launch of MF on Monday evening, 10/7. As part of the conference, we solicited papers for a journal volume on urban freight for *Research in Transportation Business and Management*. We received over 30 submissions for the journal issue. We are currently in the manuscript review process, with publication scheduled for March 2014. We have already started working with hotels to schedule the 2015 conference.

As a follow-up to INUF, METRANS organized a webinar called "Urban Freight Transportation - Selected Presentations from the METRANS International Urban Freight Conference." The webinar took place on October 16, 2013 and was part of the US Department of Transportation's Federal Highway Administration Talking Freight series. O'Brien and Rodrigue took part as presenters. Talking Freight seminars are held monthly via the web and are eligible for continuing education credits. There were 135 registered participants for the webinar, a national audience of researchers and practitioners. The webinar is available at http://www.fhwa.dot.gov/planning/freight_planning/talking_freight/index.cfm.

Several MF researchers submitted papers for presentation and poster sessions at the Transport Research Arena conference, to take place in Paris in April 2014. TRA provides an additional venue for presentation of MF research.

Other outreach activities include:

- Another aspect of outreach is the sharing of expertise within MF. Professor Jean-Paul Rodrigue presented a distinguished lecture at USC, and met with faculty, students, government and industry sponsors. Such visits are intended to share expertise across the partner institutions. The lecture was recorded and is available at www.metrans.org.
- MF researchers participated in numerous conferences, including the May 2013 EU/US Conference on Urban Freight (Conway, Dablanc, Giuliano, O'Brien, Rodrigue). Conference participation is listed in the scientific production section.
- In addition to setting up our MF website, we are developing a set of media communications. The forthcoming issue of *METRANS News* features the launch of MF and INUF. MF news will become a regular feature of *METRANS News.* In November IFSTTAR published its first

METROFREIGHT-Paris newsletter. Please see Attachment 3.

Deviations from Year 1 Plan: None

Overall evaluation of Year 1

Year 1 has been an investment in developing the organizational structure of the CoE, establishing new working relationships among a large and diverse set of partners, and creating a database that will form the foundation of many research projects in the coming years. MF has benefitted from the ongoing urban freight research, education and outreach activities of the partners. The CoE has also benefitted from the synergies of being part of METRANS, IFSSTAR, UTRC, and KOTI. In each case, contributions of faculty and staff have leveraged the MF funds.

When writing the proposal, we did not anticipate how important it would be to meet face-to-face, and to have some shared knowledge of the particular characteristics of the urban freight system in our four metropolitan areas. It became apparent that periodic in-person meetings should be built into the later years of the grant. As will be discussed in the Future Plans sections, in 2014 we are meeting in Paris in conjunction with the TRA meetings. We plan to meet in Seoul and again in Los Angeles in 2015, and in New York in either 2014 or 2016. We are also identifying specific conferences to target as team meeting venues.

List of Scientific Production

Our list of scientific production is drawn primarily from research conducted outside the MF grant, as MF research did not begin until mid-2013. We list publications and presentations within the area of urban freight.

Publications

Conway, A, J. Cheng, D. Peters, & N. Lownes (2013). Characteristics of multimodal conflicts in urban on-street bicycle lanes. *Transportation Research Record*, forthcoming.

Dablanc, L. (2014). Logistics sprawl and urban freight planning issues in a major gateway city - the case of Los Angeles. In J. Gonzalez-Feliu et al. (eds.) *Sustainable Urban Logistics: Concepts, Methods and Information Systems*, 49-69. EcoProduction, DOI: 10.1007/978-3-642-31788-0_4, Springer-Verlag Berlin Heidelberg.

Dablanc, L., G. Giuliano, K. Holliday, & T. O'Brien (2013). Best practices in urban freight management: Lessons from an international survey," TRB paper 13-2903, presented at the 2013 TRB Annual Meeting and forthcoming, *Transportation Research Record.*

Dablanc, L. & J-P Rodrigue (2013). Urban freight distribution: A global typology, in G. Giuliano and S. Hanson (eds) *The Geography of Urban Transportation*, 4th Edition, New York: The Guilfold Press.

Giuliano, G. & L. Dablanc (2013). Approaches to managing freight in metropolitan areas. White paper prepared for the EU/US Urban Freight Symposium. Washington DC: Transportation Research Board.

Giuliano, G. & A. Linder (2013). Impacts of the Clean Air Action Plan on the port trade industry. presented at the WCTR Conference (May 2012), *International Journal of Shipping and Transport Logistics,* forthcoming.

Giuliano, G. & A. Linder (2013). Motivations for voluntary regulation: The Clean Air Action Plan. *Energy Policy,* forthcoming.

Giuliano, G., T. O'Brien, L. Dablanc, & K. Holliday (2013). NCFRP Project 36(05) synthesis of freight research in urban transportation planning. Washington D.C.: National Cooperative Freight Research Program.

Hall, P.V., O'Brien, T. & C. Woudsma (2013). Environmental Innovation and the Role of Stakeholder Collaboration in West Coast Port Gateways. *Research in Transportation Economics*, 42, 87-96.

Kamga, C., B. Miller, & J. Spertus (2013). Eliminating trucks on Roosevelt Island for the collection of Wawtes. UTRC, 7-2013, http://www.utrc2.org/sites/default/files/pubs/pneumatic-waste-roosevelt-island-report-Final.pdf

Kamga, C., B. Miller, & J. Spertus (2013). A study of the feasibility of pneumatic transport of municipal solid waste and recyclables in Manhattan using existing transportation infrastructure. UTRC, 7-2013, http://www.utrc2.org/sites/default/files/pubs/pneumatic-waste-manhattan-report-Final_0.pdf

Mu, S. and M. M. Dessouky (2013). Efficient Dispatching Rules on Double Tracks with Heterogeneous Train Traffic," *Transportation Research, Part B: Methodological*, 51, 45-64.

Nguyen, C., A. Toriello, M. M. Dessouky, and J. E. Moore (2013). Evaluation of Transportation Practices in the California Cut Flower Industry, *Interfaces*, 43, 182-193.Rodrigue, J-P. (Ed.). (2013). (ed) *The geography of transport systems*, Third Edition, London: Routledge.

Rodrigue, J-P. (2013). Urban goods transport, in *Planning and design for sustainable urban mobility: global report on human settlements 2013*. United Nations Human Settlements Programme, London: Earthscan.

Rodrigue, J-P, T. Notteboom & J. Shaw (Eds.). (2013).The Sage Handbook of Transport Studies, London: Sage. 592 pages.

Seo, S., Hyukku, K., & A. Chanjin (2013). Investigation and study on appropriate industries and regions for introducing Logistics Collaboration. Ministry of Land, Infrastructure and Transportation. (written in Korean)

Conference Presentations

Acciaro, M, C. Ferrari, G. Giuliano, S. Kapros, J. Lam, A. Roumboutsos, C. Sys, & T. Vanelslander (2013). Green innovation in seaports: A framework for the successful implementation of innovation in ports in the area of environmental sustainability. Presented at the *International Association of Maritime Economists Conference*, July 2013, France, and submitted to *Journal of Maritime Policy and Management*.

Chanjin, A., Lee, J-S, & Seo., S. (2013). Development of urban freight mode and strategies for the CBD of Seoul and its challenges for the future. *METRANS International Urban Freight Conference*, Long Beach, CA, October 9, 2013.

Conway, A. (2013). Building sustainability through partnering: transportation and material reuse in New York City. *Urban Affairs Association Conference*, San Francisco, CA.

Conway, A., G. Faivre, & M. Conway (2013). Accommodating freight on mixed-use urban streets: a case study of Williamsburg and Greenpoint, Brooklyn. *METRANS International Urban Freight Conference*, Long Beach, CA.

Conway, A., O. Thuillier, E. Dornhelm, & N. Lownes (2013). Commercial vehicle-bicycle conflicts: a growing urban challenge. Conference proceedings, *TRB 92nd Annual Meeting*, Washington, D.C.

Dablanc, L. (2013). La métropole logistique, Activités logistiques et mise en oeuvre des compétences d'aménagement et d'urbanisme dans deux grandes métropoles américaines. In *Transports et métropolisation*, Comité National français de Géographie, Université de Toulouse II-Le Mirail, Toulouse, 10-12 septembre.

Dablanc, L. (2013). Logistics sprawl in Los Angeles, *Association of American Geographers* Annual Meeting, April 12, Los Angeles.

Dablanc, L. (2013). Logistics sprawl in Los Angeles and large urban regions, *World Conference on Transport Research*, 14-18 July, Rio, Brazil.

Dablanc, L. & J-P Rodrigue (2013). The geography of urban freight: a city logistics typology. *METRANS International-National Urban Freight Conference*, 8-10 October, Long Beach, USA.

Dablanc, L., Giuliano, G., O'Brien, T. & K. Holliday (2013). Best practices in urban freight management: lessons from an international survey. *Transportation Research Board*, January 13-17, Washington, D.C.

Diziain, D., Taniguchi, E. & L. Dablanc (2013). Urban logistics by rail and waterways in France and Japan, *8th International Conference on City Logistics*, Bali, Indonesia, 17 – 19, June.

Dessouky, M. M. & L. Fu (2013). Dynamic headway in positive train control. *METRANS International Urban Freight Conference,* Long Beach, CA.

Dessouky, M. M., & L. Fu (2013). Dynamic headway in positive train control. *2013 National Meeting of INFORMS*, Minneapolis, MN.

Dessouky, M. M. & L. Fu (2013). Headway allowance in positive train control. *2013 Industrial and Systems Engineering Research Conference*, San Juan, Puerto Rico.

Dessouky, M.M., C. Nguyen, & A. Toriello (2013). Consolidation Policies for the Shipping of Perishable Products. *METRANS International Urban Freight Conference*, Long Beach, CA.

Dessouky, M. M., C. Nguyen, & A. Toriello (2013). Consolidation policies for the shipping of perishable products. *2013 National Meeting of INFORMS*, Minneapolis, MN.

Dessouky, M. M., P. Murali & F. Ordonez . Strategies for railway track capacity management. *2013 TRISTAN VIII*, San Pedro De Atacama, Chile.

King, D., Gordon, C. & J. Peters (2013). Does road pricing affect port freight activity: recent evidence from the port of New York and New Jersey. *METRANS International Urban Freight Conference (I-NUF)*, Long Beach (USA).

Miller, B. (2013). Reducing the environmental impacts of first-mile urban freight: the feasibility and projected costs and benefits of pneumatic waste collection in three specific New York City cases. *METRANS 5th International Urban Freight Conference (I-NUF),* Long Beach (USA).

Morganti, E., Dablanc, L., Fortin, F., Gouvernal, E. (2013). Final deliveries for online shopping: French operators' strategies according to the customers and the area they live in. *International-National Urban Freight Conference*, 8-10 October, Long Beach, USA.

O'Brien, T. (2013). Best practices in urban freight management. *Association of American Geographers*, Los Angeles, CA April 2013.

O'Brien, T. (2013). Delivering the goods in an urban world. *2013 UC Davis Biennial Asilomar Conference on Transportation and Energy*: *Climate Policy in an Energy Boom*, Pacific Grove CA, August 2013.

O'Brien, T (2013). Efficiency and competitiveness: securing cargo and jobs. *FuturePorts Strong Ports=Strong California*, Long Beach CA, June 2013.

O'Brien, T. (2013) Logistics system primer: key trends driving decision making in supply chains. *California Air Resources Board 2013 Haagen-Smit Symposium*, Long Beach CA, May 2013.

O'Brien, T. (2013). November 2013 global supply chain practices: delivering the goods in an urban world. *LegalPorts 2013 Conference*, Long Beach CA, September 2013.

O'Brien, T. (2013). Operational strategies for mitigating impacts of terminals and hubs. City Logistics Research: A Trans-Atlantic Perspective*, EU-U.S. Transportation Research Symposium No. 1*, European Commission and Research and Innovative Technology Administration, USDOT and TRB, Washington, D.C.

O'Brien, T. (2013). Planning for freight management: urban freight and gateway strategies. *UC Davis and Union of Concerned Scientists Freight Policy Forum*, Sacramento CA, May 2013.

O'Brien, T. (2013). Trends in global trade and what they mean for supply chains. *Institute for Supply Management-Los Angeles*, Torrance CA.

Rodrigue, J-P (2013). The cyclical behavior of city logistics: a terminal centric perspective. *METRANS 5th International Urban Freight Conference (I-NUF)*, Long Beach (USA).

Rodrigue, J-P (2013). From global freight distribution to city logistics: the role of intermodal terminals. Metropolitan Planning & Urban Design Centre of Istanbul (BIMTAS), *Urban Logistics Workshop*, Istanbul, (Turkey).

Rodrigue, J-P (2013). The geography of urban freight: a city logistics typology. Urban Freight Transportation – Selected Presentations from the *METRANS International Urban Freight Conference*, Talking Freight Seminar, United States Department of Transportation - Federal Highway Administration.

Rodrigue, J-P & M. Hesse (2013). Intermodalism and city logistics: impacts of terminals on metropolitan areas. *EU/US Freight Symposium*, National Academy of Sciences, Washington, DC (USA).

Rodrigue, J-P. & L. Dablanc (2013). City logistics and sustainability: a global typology. *From the Outside In: Sustainable Futures for Global Cities and Suburbs*, Hofstra University (USA).

Seo, S., & J-S Lee. Improving the parcel service performance in the Seoul Metropolitan Area: Differentiated approaches by urban land use pattern. *Transport Research Arena 2014*, Paris, France, April, 2014, (submitted).

Wang, Q. & J. Hu (2013). Destination choice of urban commercial vehicle trips: perspective from the built environment. *The 5th METRANS International Urban Freight Conference (I-NUF)*. Long Beach, CA. October 8-10, 2013.

Zhou, Y., Wang, X., Conway, A. & Q. Chen. Investigation of freight delivery patterns in New York City. Accepted for presentation at the TRB 93rd Annual Meeting, Washington, DC, January 13, 2014.

Other Presentations

Conway, A. (2013). Freight and bicycles in NYC: interactions and opportunities. Department of Civil Engineering, Rensselaer Polytechnic Institute.

Conway, A. (2013). Multi-modal conflicts in urban on-street bicycle lanes. Featured as an AASHTO TV "News in Design" segment, posted May 12,2013: http://www.transportationtv.org/Pages/default.aspx?VideoId=324 .

Miller, B. (2013). A working model of a closed loop transportation system for urban solid waste: a temporary public sculpture--the shake chute. City as Living Laboratory, 11-2013, http://cityaslivinglab.org/?page_id=656.

O'Brien, T. (2013). Focus on energy (Moderator). *PortTech Los Angeles Expo 2013*, San Pedro CA, September 2013.

O'Brien, T. (2013). International trade trends. *BAFT-International Financial Services Association, 2013 West Coast Global Trade Finance Workshop*, Los Angeles CA, July 2013.

Seo, S. & S-J Jeong (2013). Introducing major cases and the improvement policies of the logistics collaboration in Korea. Invited talk at Korea Post, Seoul, Korea, May 7, 2013. (written and presented in Korean)

List of Research and Management Partners

MF includes four teams. The Los Angeles team is the lead, and the CoE is housed in the METRANS Transportation Center at University of Southern California. The overall funding allocation shares are approximately 45/13/16/16/10 for METRANS-USC, METRANS-CSULB, UTRC, IFSSTAR, and KOTI respectively. The following tables summarize management, staff, and researchers engaged in MF. Institutional affiliations are also given. Degree of funding is approximated; actual budget numbers can be provided upon request.

METRANS Team

Name and affiliation	Role in MF	MF funding
Genevieve Giuliano, Professor and Director Price School of Public Policy, USC	CoE Director, theme leader, team leader, researcher	Yes, for CoE management, specific research projects; 15% of annual
Maged Dessouky, Professor, Industrial and Systems Engineering, USC	Theme leader, researcher	No, support via graduate student support
Petros Ioannou, Professor, Electrical Engineering-Systems, USC	Researcher	No, research task begins Year 2
Victoria Valentine, METRANS Administrator, USC	Center administrator	No, contribution as cost share
Ryan Cassutt, graduate student, public policy, USC	Program manager (temporary)	Yes, 25% fall semester
Sanggyun Kang, PhD student, urban planning, USC	Graduate research assistant	Yes, 50% fall semester
Jack Yuan, PhD student, urban planning, USC	Graduate research assistant	Yes, 25% fall semester
Lunce Fu, PhD student, industrial and systems engineering, USC	Graduate research assistant	Yes, 25% fall semester
Thomas O'Brien, Director of Research, Center for International Trade and Transportation, CSULB	Leader, education programs, outreach programs; researcher	Yes, to be charged in Year 2
Seiji Steimetz, Professor, Economics, CSULB	Researcher (replaces Kristen Monaco)*	No, research task begins Year 2
Alix Traver, administrative coordinator, CITT, CSULB	Administration, INUF	Yes, admin support, 5%
Masters student, CSULB	Graduate assistant	Yes, 30% spring semester

*Kristen Monaco left CSULB, and Seiji Steimetz will take her place. Steimetz is a transport economist specializing in road pricing and the trucking industry.

IFSSTAR Team

Name and affiliation	Role in MF	MF Funding
Laetitia Dablanc, Director of Research, IFSTTAR	Theme leader, team leader	No, support via graduate student support, funding for other expenses
Francoise Bahoken, Project Engineer (geography), IFSTTAR	Cartographer	No, research task begins Year 2
Adrien Beziat, PhD student, IFSTTAR	PhD student, graduate research assistant, urban freight survey	Yes, Paris survey research; 75 days
Emilie Gaubert, project engineer (statistics), IFSTTAR	Statistician	No, contribution as cost share, 10 days
Adeline Heitz, PhD student, IFSTTAR	PhD student, graduate research assistant, land use and planning	Yes, 75 days
Martin Koning, Senior researcher (economics), IFSTTAR	Researcher, Paris survey	No, contribution as cost share, 15 days
Antoine Montenon, research engineer, IFSTTAR	Junior researcher	No, research task begins Year 2
Eleanora Morganti, Post-doctoral researcher (urban planning), IFSTTAR	Researcher	No, contribution as cost share, 8 days
Petronille Reme-Harnay, Senior Researcher (economics), IFSTTAR	Researcher	No, contribution as cost share, 4 days

UTRC Team

Name and affiliation	Role in MF	MF Funding
Alison Conway, Asst. Professor, Civil Engineering, CCNY	Theme leader	No, research task begins Year 3
Penny Eichemeyer, Assoc. Director for Research, UTRC, CCNY	Research manager	No, contribution as cost share
Camille Kanga, Asst. Prof. and Director, UTRC, Civil Engineering, CCNY	Researcher	No, research task begins Year 3
David King, Asst. Prof., Urban Planning, Columbia U	Researcher	No, research task begins Year 2
Benjamin Miller, Sr. Research Associate, URTC, CCNY	Researcher	No, research task begins Year 2
Jean-Paul Rodrigue, Prof, Global Studies and Geography, Hofstra U	Theme leader, team leader	No, research task begins Year 2
Zachary Silverman, GIS Technician, UTRC, CCNY	GIS/Geo-database specialist	Yes, 25 days
Qian Wang, Asst. Prof., Civil Engineering, U Buffalo	Researcher	No, research task begins Year 3

KOTI Team

Name and affiliation	Role in MF	MF Funding
Sung Ju Jeong, Senior Research Fellow, Logisitics Policy and Technology, KOTI	Team leader	No, research task begins Year 2
Sang Bam Seo, Division Director, Logistics Policy and Technology, KOTI	Researcher (new team member)*	No, contribution as cost share
Jee-Sun Lee, Assoc. Research Fellow, Logistics Policy and Technology, KOTI	Researcher	No, contribution as cost share
Chang-Jin Ahn, Researcher, Logistics Policy and Technology, KOTI	Researcher, data collection and geo-statistical analysis	Yes, 5.5 months
Hong-Seung Roh, Director, Logistics Policy and Technology, KOTI	Researcher	No, research task begins Year 2
Tai-Hyeong Lee, Division Director, Logistics Policy and Technology	Researcher	No, research task begins Year 3

* Sang Bam Seo is an expert in city logistics and has extensive ties with the logistics industry. He will lead the KOTI research on last-mile strategies.

Future Plans

Planned project activities

Plans to further develop the CoE

As discussed in the Year 1 section, we decided that at least one in-person team meeting should take place each year in order to further establish collaboration across the teams. One of these meetings will take place at one of the partner locations. The meeting will serve to both manage Center activities, as well as provide a comprehensive field visit to observe first-hand the urban freight system in the host location. This should help us to gain a better understanding of the similarities and differences across these very diverse metro areas. We will meet in Paris in April 2014, in conjunction with the Transportation Research Arena conference. Team members from each partner institution have submitted papers and will participate in the conference. In addition we will meet during the TRB Annual Conference in January 2014, and are targeting other conferences that provide an appropriate venue for sharing our research results, including WCTR (World Congress of Transport Research) and the Institute for City Logistics. In 2015 we plan to meet and conduct a site visit in Seoul and meet in October 2015 for the next INUF conference. We will be requesting additional travel funding for these meetings.

Research

For Year 2 we plan to conduct the various research projects presented in the proposal while completing the Phase 1 work. As described above, we are at approximately 60% completion for the data collection, and we have sufficient data to begin the comparative analysis. We plan to have Phase 1 completed by March 31, 2014.

The research program begins in Year 2 for our five thematic areas. Our proposal identified specific projects to be conducted in Years 2 and 3. We propose only minor changes to the proposed Year 2 work.

Theme 1: Role of policy from industry perspective

Lead: LA/Giuliano

Project 1.1 Local government policies and freight operations (LA, NY, Paris, Seoul): This project conducts an analysis of the impacts of local regulations and policies on freight operations and shippers. It will focus on 1) parking, loading, zoning; and 2) vehicle performance standards (emissions, alternative fuels, vehicle size). Year 2 research activities are as follows:

- **LA team** (O'Brien)[1] An examination of the different zoning regulations in municipalities in the Southern California region and their impact on the location and operation of freight-related facilities. This includes any potential adjustments made in the aftermath of changes in operating hours at the ports.
- **NY team** (King) Road Pricing and Port Freight Activity: Examination of the frequency of truck trips, toll costs and trip distance, and how these characteristics may affect port freight costs and operations by location, focusing on the Ports of New York and New Jersey.

[1]Change from proposed: replaces Giuliano with O'Brien to better coordinate with ongoing research activities

- **Paris team** (Dablanc, Koning, Béziat): Dablanc, Koning and Béziat will start working on Beziat's PhD research on size and weight restrictions, delivery time windows and congestion caused by trucks and vans in Paris urban streets.
- **Seoul team** (Jeong and Roh): Analysis of impacts of truck and parking regulations on parcel deliveries in the Seoul region A Pilot freight O-D for Seoul Metropolitan Area's parcel service industry will be carried out based on the freight volume for 2012. The project explores what unique characteristics the Seoul's city logistics possesses in terms of land use pattern. It also examines how the public policies may affect the characteristics of SMA's city logistics mainly through reviewing existing research papers and government reports.

Project 1.2 Modeling for local impact analysis (**LA, Ioannou**): We will develop a traffic simulation model for the Los Angeles region that will allow us to estimate impacts of existing freight flows as well as impacts of policy interventions or of land use changes. The model will have two parts: a macro-simulation model for the region, and a micro-simulation model for a small area that can be used to examine local policies such as route restrictions or parking rules. The focus of Year 2 will be the micro-simulation model.

Theme 2: Last mile strategies

Lead: Paris/Dablanc

Project 2.1 Central city logistics strategies (NY, Paris, Seoul): This project will examine a) the feasibility of consolidating freight deliveries in cities; and b) alternatives for more efficient use of road and parking space in cities. Specific Year 2 research activities are as follows:

- **NY team** (Rodrigue, Conway, Miller and Wang). Conway will work on freight delivery patterns to examine vehicle configurations, temporal patterns, parking behavior, load factors, operating costs, and route choices of freight delivery vehicles in Manhattan. Miller will investigate pneumatic tubes for first mile municipal solid waste, particularly the implementation phase of prior feasibility studies: attempt to develop pneumatic installations to collect waste, recyclables, and organics in dense urban locations. Wang will provide an assessment of freight bottlenecks in NYC by analysing the multi-modal freight network.
- **Paris team** (Heitz). Heitz will assess the results of two small scale consolidation schemes implemented in Paris: Vert chez Vous and the Green Link.
- **Seoul team** (J-S lee). This project develops the advanced city logistics strategies in Seoul Metropolitan Area's CBDs, in the example of *Dongdaemun* Fashion Cluster. Comprehensive strategies including parking, loading/unloading and zoning strategies will be developed. Site visits and interviews with government/municipal officers and private partners will be conducted.

Project 2.2 Reducing vehicle emissions (LA, NY, **Paris**) Although project 2.2 was scheduled to start in Year 3, the Paris team will start in Year 2 thanks to the availability of A. Montenon, hired for Metrofreight and for another project. We will evaluate low emission zones and truck access restrictions on Paris urban truck companies' behavior. Montenon and Dablanc will interview freight stakeholders, administrate a questionnaire survey and do a lit review (A. Montenon, L. Dablanc). Montenon will spend two one-month visits in London and Berlin to assess LEZ impacts there.

Project 2.3 Paris freight survey analysis(**Paris, Dablanc**): This is an ongoing project to analyze the Paris freight survey data in partnership with LET, APUR, and IAU. Specific Year 2 research activities (Dablanc, Koning, Béziat): an operational database will be made available to IFSTTAR and IAU by LET on January 2014. Béziat will get familiar with data and data analysis software. He will participate in the first analyses with LET and IAU teams. Objective is to provide general results and main indicators. Results to be compared with former urban freight surveys' data (1995-1997)

Theme 3: Improving freight/passenger interactions

Lead: LA/Dessouky

Project 3.1 Integrating management of truck and rail systems in Los Angeles (**LA, dessouky**): This project will develop models to optimize the balance of freight demand across rail and truck modes. The Year 2 research will use the year 1 data collected on rail operations in Southern California to perform a detailed simulation analysis to determine the capacity of the rail network. Given this capacity we will determine the amount of freight flow that can be shifted from truck to rail. We will also build a model to estimate the increase in freight flow that can be accommodated for a given rail capacity expansion.

Project 3.2 Improving efficiency of truck flows (LA, NY, Paris, Seoul): This research examines freight bottlenecks associated with trade nodes (ports, airports, intermodal facilities) and develops strategies for addressing bottleneck problems, including 1) improving drayage route efficiency; and 2) increasing rail share. Specific Year 2 research activities are as follows:[2]

- **NY team** (Conway). Conway will continue ongoing NY on truck-bicycle interactions that identified land use, infrastructure, and regulatory factors influencing the frequency of conflicts between bicycles and motorized modes in New York City
- **Paris team** (Koning). Koning will participate in the City of Paris light rail transit goods delivery study. He will contribute to the cost assessment of the project.
- **Seoul team** (Roh): Seoul team will examine freight bottlenecks in Seoul Metropolitan Area, for instance Gunpo-Euiwang Intermodal Logistics Park, Hinterland Logistics Complexes of Incheon International Airport and Incheon Port. Currently, in Korea, freight transportation policy is focused on increasing rail share and enhancing competitiveness in terms of its service time and cost. Seoul team is to plan several improvement alternatives for the intermodal traffic network between main trade nodes and the rest of city areas in SMA.

Theme 4: Land use dynamics

Lead: NY/Rodrigue

Project 4.1 More efficient siting of warehouse and distribution center activity (LA, NY, Paris): This project analyzes 1) spatial trends in logistics activities; 2) factors that explain logistics decentralization; 3) associated impacts on truck VMT and traffic flow; 4) develops a model for estimating impacts of alternative facility locations; and 5) assesses the potential for locating new activities in closer proximity to trade nodes. Specific Year 2 research activities are as follows:

[2] Change from proposed: LA Team Monaco project deleted due to her departure from CSULB and unavailability of Steimetz until year 3.

- **LA team** (Giuliano)[3] Giuliano and PhD students will examine the spatial organization of freight-related activities using employment and transport system data for the LA metro area.
- **NY team** (Rodrigue). Rodrigue and Conway will develop a general city logistics map of the New York metropolitan area. This map will display the main freight functions by land uses and the level of city logistics activity. Urban classification and cartographic methods will be used to effectively represent the logistics system. Rodrigue and Behrens (University of Gothenburg) will develop the concept of suburban logistics; the patterns and characteristics of freight distribution in a suburban setting.
- **Paris team** (Dablanc, Bahoken, Heitz). Heitz, Dablanc and Bahoken will map spatial trends in logistics/warehousing activities for the Paris region (1980-today) for all industries and for selected ones (parcel/big box retailing/wholesale).

Education

For year 2, we will focus our efforts on the development of an interdisciplinary module-based graduate level course on urban freight to be offered in distance format. We will test the course within consortium universities and then modify so that it can be offered more broadly beginning in year 3. Because of the different requirements for developing courses for credit in consortium universities, the course will be offered as a graduate-level seminar during the test period.

During year 2, we will also develop two short courses in urban freight, one targeted at industry, the other designed for policy makers. The courses will be developed locally in Los Angeles and Paris to incorporate issues that professionals in each metropolitan area face and to make them more aware of current trends. The courses will propose possible solutions to urban freight problems. Over the course of the grant period, the course materials will be tested in Seoul and New York and made available more broadly for local adaptation.

We have two educational exchanges scheduled for year 2. Felipe Aros, from RPI/SUFS, will come and stay at IFSTTAR for a two week academic visit in Februay 2014 in the framework of the VREF program for PhD students visits between different CoEs. He will look at the Paris urban freight survey. Martin Koning, from IFSTTAR Metrofreight team, will visit City College of New York for one month in summer 2014, partially with Metrofreight (IFSTTAR), to work with Alison Conway on congestion issues related to urban freight.

Outreach

IFSTTAR is organizing a MF team meeting on April 17-18, 2014, to be held in conjunction with the TRA meeting. There will be three technical visits of city logistics projects, organized by Interface Transport (Franprix barges; Vert chez vous barge+cargo-cycles; Chronopost Beaugrenelle+electric vehicles). There will be an afternoon academic session involving 1) presentation of Phase 1 results (Metrofreight researchers) and 2) a debate with Paris practitioners and planners. This session will take place during TRA 2014 (Transport Research Arena) at CNIT La Defense. The second day will be devoted to an internal Metrofreight meeting with all academic partners.

The Seoul team is planning to hold a joint seminar or a workshop with the topic of “Improving last mile strategies and policies in Seoul Metropolitan Area” tentatively in June, 2014. Seoul team’s academic

[3] Changed from proposed: New LA Team project added to build on existing research and complement NY and Paris studies.

and private partners will be joined as hosts. The main target audience of this seminar is logistics companies in SMA and students and scholars in any logistics-related academies.

METRANS will launch the MF website, produce MF news columns for the *METRANS News,* conduct a seminar series, produce various media communications, and begin publishing research reports as the research projects begin to generate results. The entire MF team will publish research results in scholarly journal and professional/practitioner venues.

Attachment 1: Data Collection Document

METROFREIGHT

Data Strategy

Purpose:

1. Create a comprehensive data base for each metro area that will:
- support local research initiatives
- allow comparative studies of various urban freight topics over the life of the VREF grant
- identify urban freight data gaps among all four metro areas

2. Propose the framework for a Global City Logistics Index: The logistical performance of urban freight distribution requires a comparative framework and key performance indicators. Our work will include a basic dataset about city logistics in several cities around the world in an attempt to set a “Global City Logistics Index.”

Phase 1: Freight flows and their impacts (from VREF proposal)

Phase 1 will develop the information base for the following years. We will describe urban freight dynamics and conduct a comparative analysis across the four metro areas. We benefit from a unique and comprehensive urban freight survey currently being conducted in Paris, and freight data collected for regional planning in Los Angeles. New York has access to shipper and freight facility surveys. Seoul has freight and transport system data from the KOTI Transport Database. The purpose is to develop an empirical base for addressing the research themes in Phase 2. Consistent with our vision of METROFREIGHT becoming a leading urban freight center, we will make our data available online to other researchers.

Understanding the urban freight problem

Year 1 will be devoted to documenting the characteristics of freight flows in each of our case study cities and the impacts freight generates. The following issues will be addressed:

1. Characteristics of freight flows across metro locations by type (trade, commodity, vehicular), mode (truck, rail, water, air, other), time of day, industry sector
2. Interactions between passenger and freight transportation flow (truck traffic share, freight rail traffic share; congestion impacts; hot spots, bottlenecks)
3. Characteristics of the freight vehicle fleet (mix of vans, small trucks, large trucks; age distribution)
4. Environmental impacts: air pollution, CO2 emissions, noise, environmental justice aspects
5. Public policy environment: regulations and policies that affect freight operations
6. Emerging technologies, including new modes, IT, terminals and distribution strategies that may impact city logistics

Organization of the research:

Because a lot of freight information is proprietary, data on the nature of freight flows (what is shipped where and by what means) at the sub-metropolitan level is very limited. Our partners are providing access to freight surveys and other unique data sources, which will be supplemented with other more widely available data sources. Table 1-1 summarizes personnel and data sources for the Phase 1 research.

Results from the Year 1 analysis will be combined to produce a comparative analysis of freight flow characteristics and their impacts across the four cities.

TABLE 1: DELIVERABLE

Team	Lead	Resources	Data Sources
LA	Giuliano	1 graduate student	Region level freight survey data, employment and industry data from SCAG, truck traffic data from Caltrans, public data sources
Paris	Dablanc and Koning	1 Ph.D. student 1 research assistant in cartography 1 research assistant in statistics	Paris comprehensive freight survey (2014) Smaller freight surveys (ECHO, 2004) Vehicle traffic data from DRIEA/city of Paris Industry data from nat. stat agency (INSEE)
NY	Rodrigue	1 graduate student	Regional freight survey data (e.g. NYMTC, PANYNJ, NYCDOT), public data sources
Seoul	Jeong and Seo	1 graduate research assistant	Korea Transport Database (KTDB), KOTI trucking market freight survey data, freight regulation and vehicle registration data from Korea Ministry of Land, Infrastructure and Transportation (MOLIT), region level socioeconomic data(eg. Employment and industry data from SeoulStat), and other public data sources

Data Collection Plan

Metropolitan Areas

Boundaries

The metropolitan area will be the macro unit of analysis:

- LA and NY: Metropolitan Statistical Area (MSA), part of Combined Statistical Areas (CSA)
- Paris: Paris region (Region Ile-de-France)
- Seoul: Seoul Metropolitan Area

We will also consider another level of data analysis: the central area, for its specific issues related to urban freight and deliveries. In all cases we use the central city: Los Angeles, New York City, Paris, and Seoul.

Granularity/spatial units

Our goal is to collect data at the smallest spatial unit possible. The metropolitan areas have the following granularity:

- Los Angeles and New York: Year 2010 US Census tracts
- Paris: municipalities (there are 1281 municipalities in the Paris region and 20 districts within Paris) and possibly "IRIS", a sub-municipal tract for national statistics (b/w 2000 to 5000 people in each IRIS).
- Seoul: Gu (quite equivalent to borough or district), and Dong/Eup/Myeon (smallest unit for Census).

Data format

All spatial data is to be geo-coded in GIS format4 using the ArcMap package by ESRI. All matrix data files in Excel (when possible geotagging identifier will be provided to link the data tables into a GIS) or other files compatible across mac/windows platforms; all files stored in group Dropbox.

Types of data

City logistics data falls into five categories of information: jurisdictions, infrastructure, land use, flows, and policy.
Table 2: Types of Data

Jurisdictional	Political boundaries: municipal, counties or equivalent, transportation districts, air quality districts, port authorities, airport authorities.
Infrastructure	Street network. Highway network. Public transport network. Freight Rail transport network. Airport terminals. Rail terminals. Port terminals. Distribution centers and container depots.

[4] Shapefile is the common format that is easy to export and readable by the great majority of GIS packages.

Land Use	Features (rivers, topography, green space / parks). Zoning. Distribution of socioeconomic attributes (population, employment, number of firms, economic activity-distribution of establishments by industry type).
Flows	Vehicle fleet data. Vehicle flows. Commodity flows. Freight companies.
Policy	Parking regulations; truck operations regulations; fuel and emissions regulations; zoning codes; building codes

Jurisdictional

1. Cities, counties, other government units
2. Special authority districts (e.g. public transit service areas, port authorities, air quality districts)

Infrastructure

1. Freeway/highway /Arterial system – geocoded highway network with basic characteristics (number of lanes; ramp and interchange locations, intersection locations, presence/absence of traffic controls; toll costs/road pricing, parking availability).
2. Public transportation – subway, rail and bus routes, stops (peripheral to this endeavor but could be relevant to help assess interaction and conflicts between public transit and city logistics).
3. Rail system – rail routes and characteristics (number of tracks, switch locations, yards, stations)
4. Waterway system -- rivers and canals (number and location of goods handling points, small and large ports).
5. Transport terminals – ports and terminals (container terminals, bulk and break-bulk terminals, ro-ro facilities), airports, intermodal hub rail yards, including some measure of size (tonnage, TEU, number of lifts, value, enplanements, train number of calls, train services, etc.)

Land use

1. Population characteristics – number, households, income, workers, median house price, race/ethnicity (most recent census data), housing units by type.
2. Densities (both for population and establishments, retail density, warehouse density, etc.).
3. Employment characteristics – jobs, establishments by industry sector by spatial unit(note – many different sector codes; micro data in US is inconsistent across sources and time).
4. Topographic features (mountains, rivers, etc.)

Flows

Vehicle fleet data:

1. Number of registered vehicles by type, size, age, fuel type (diesel, CNG, electric; non-motorized).
2. Number of circulating vehicles by type, size, age, fuel type

Transport flows:

1. Regional flows: Origin/Destination matrices for total flow, passenger flow, truck flow.

2. Freeways/highways/Arterials -- daily average traffic volumes (AM peak, day, PM peak, night); truck/van volumes by truck size/weight/axle number; measures of delay
3. Accidents: number of accidents, number of truck involved accidents
4. Railroads: number of trains per day, tonnage/cars or some other volume estimate; measures of freight rail system delays
5. Commodity flows: to/from region; within region, in tons, dollars, by industry sector
6. Local truck flows: number, frequency, characteristics of deliveries/pickups.
7. Urban trucking industry: number and size of operating companies, business relationships (sub-contracting)

Paris urban freight survey

Additional types of data will be provided by the Paris survey (January 2014 on)

- delivery peak hours, global and by industry sector
- average time for deliveries, global and by industry sector
- type/place of parking for deliveries
- sectorial logistics profiles

Policies and regulations

Traffic regulations (central city only):

1. Parking restrictions (city level)
2. Truck routes (county level), weight restrictions, vehicle restrictions
3. Loading zones and restrictions
4. Off-street loading zones requirements (city level building codes).

Fuel and emissions regulations:

1. National truck fuel economy standards, by fuel type, engine size or vehicle weight
2. Locomotive fuel economy standards (include annual data if standards change over time)
3. National truck emissions standards, by fuel type, engine size or vehicle weight
4. Locomotive fuel emissions standards (include annual data if standards change over time)
5. State or local fuel or emissions standards

Operator regulations

1. Operator hours of service

Land use regulations

1. Land Use/Zoning (residential, commercial, industrial, open space, unzoned, public)
2. Pickup and delivery regulations (service hours)
3. Building code on site level pickup/delivery facilities

Thematic Maps

The data collected can be displayed as thematic maps depicting the nature and configuration of city logistics of the main metropolitan areas. This will enable to build a “City Logistics Atlas” for each city. Among the basic maps that will be created for each metropolitan area:

- City reference map with jurisdictions and features.
- Population and employment distributions (general land uses).

- Road transport system with main bottlenecks (congestion).
- Public transit system.
- Freight terminals (ports, rail yards, airports)

Attachment 2: Data collection summary status

Jurisdictional

	Los Angeles				New York				New Jersey			
Data Elements	Data Exists	Available	Collected	Comments	Data Exist	Available	Collected	Comments	Data Exists	Available	Collected	Comments
Political Boundaries (municipal, county, or equivalent)	Yes	Yes	Yes		Yes	Yes	Yes		Yes	Yes	Yes	
Special authority districts	Yes	Yes	Yes	Public transit service to be rectified	yes	yes	no		yes	yes	no	

	Paris				Seoul			
Data Elements	Data Exists	Available	Collected	Comments	Data Exist	Available	Collected	Comments
Political Boundaries (municipal, county, or equivalent)	Yes	Yes	Yes		Yes	Yes	Yes	
Special authority districts	Yes	Yes	Yes		N/A	N/A	N/A	No Special authority districts exist

Infrastructure

	Los Angeles				New York				New Jersey			
Data Elements	Data Exists	Available	Collected	Comments	Data Exist	Available	Collected	Comments	Data Exist	Available	Collected	Comments
Street Network	Yes	Yes		Geocoded ADMS, waiting on other data	Yes	Yes	Yes		Yes	Yes	yes	
Highway Network	Yes	Yes		Geocoded ADMS, waiting on other data	Yes	Yes	Yes		Yes	Yes	Yes	
Public Transport Network	Yes	Yes	Yes	No metrolink stop data	Yes	Yes	Yes		Yes	Yes	Yes	
Rail Transport Network	Yes	Yes			Yes	Yes	yes		Yes	Yes	yes	
Waterway system	N/A	N/A	N/A									
Airport Terminals	Yes	Yes	Yes		Yes	Yes	yes		Yes	Yes	yes	
Rail Terminals	Yes	Yes			Yes	Yes	yes		Yes	Yes	yes	
Port Terminals	Yes	Yes			Yes	Yes	yes		Yes	Yes	yes	
Distribution Centers	Yes				Yes				Yes			
Container Depots	Yes				Yes				Yes			

	Paris				Seoul			
Data Elements	Data Exist	Available	Collected	Comments	Data Exist	Available	Collected	Comments
Street Network	Yes	Yes			Yes			
Highway Network	Yes	Yes	Yes		Yes	Yes	Yes	
Public Transport Network	Yes	Yes			Yes	Yes	Yes	
Rail Transport Network	Yes	Maybe			Yes	Yes	Yes	
Waterway system	Yes	Yes	Yes					
Airport Terminals					Yes	Yes	Yes	
Rail Terminals	Yes	?			Yes	Yes	Yes	
Port Terminals	Yes	Yes	Yes					
Distribution Centers					Yes	Yes	Yes	
Container Depots					Yes	Yes	Yes	

Land Use

	Los Angeles				New York				New Jersey			
Data Elements	Data Exists	Available	Collected	Comments	Data Exist	Available	Collected	Comments	Data Exist	Available	Collected	Comments
Population characteristics	Yes	Yes	Yes	US Census 2010	Yes	Yes	Yes		Yes	Yes	Yes	
Employment	Yes	Yes	Yes	NETS by 2009; LEHD 2012	yes	yes	no		yes	yes	no	
Number of Firms	Yes	YEs	Yes	NETS by 2009	yes	yes	no		yes	yes	no	
Economic Activity/distribution of establishments by industry type	Yes	YEs	Yes	NETS by 2009	yes	yes	no		yes	yes	no	
Features (Rivers, topography, green space/parks)	Yes	Yes	Yes	Checking on parks and open space	Yes	Yes	Yes		Yes	Yes	Yes	

	Paris				Seoul			
Data Elements	Data Exist	Available	Collected	Comments	Data Exist	Available	Collected	Comments
Population characteristics	Yes	Yes		database for median house price too expensive	Yes	Yes	Yes	Korea National Stat, Seoul Metro Stat
Employment	Yes	Yes	Yes		Yes	Yes	Yes	Seoul Metro Stat
Number of Firms	Yes	Yes	Partly		Yes	Yes	Yes	Seoul Metro Stat
Economic Activity/distribution of establishments by industry type	Yes	Yes	Partly		Yes	Yes	Yes	Seoul Metro Stat
Features (Rivers, topography, green space/parks)	Yes	Yes		Everything but open space	Yes	Yes	Yes	Korea National Stat, Seoul Metro Stat

Flows

	Los Angeles				New York				New Jersey			
Data Elements	Data Exists	Available	Collected	Comments	Data Exist	Available	Collected	Comments	Data Exist	Available	Collected	Comments
Vehicle Fleet Data	Yes	only at state level		DMV data for registered vehicles; not for trucks that operate	yes	maybe			yes	maybe		
Vehicle Flows	Yes	Yes	SCAG RTP Yes; ADMS, AVC, WIM not yet	Awaiting AVC and WIM from Caltrans	yes	maybe			yes	maybe		
Truck O-D	yes	yes		SCAG RTP model only								
Accidents												
Railroads												
Commodity Flows	Yes	Yes	Yes	FAF?	yes	maybe			yes	maybe		
Freight Companies	no				unknown				unknown			
Paris Urban Freight Survey	N/A	N/A	N/A		N/A	N/A	N/A		N/A	N/A	N/A	

	Paris				Seoul			
Data Elements	Data Exist	Available	Collected	Comments	Data Exist	Available	Collected	Comments
Vehicle Fleet Data	Partly	?			Yes			MOLIT data for registered vehicles
Vehicle Flows	Yes	Yes		Not yet available	Yes	Yes	Yes	KTDB
Truck O-D	Partly			Not yet available				
Accidents	Yes	Yes						
Railroads	Partly							
Commodity Flows	Yes	Yes			Yes	Yes	Yes	KTDB
Freight Companies	Yes	Yes			Yes	Yes		
Paris Urban Freight Survey	Yes	Yes		Not yet available	N/A	N/A	N/A	

Policy

	Los Angeles				New York				New Jersey			
Data Elements	Data Exists	Available	Collected	Comments	Data	Available	Collected	Comments	Data	Available	Collected	Comments
Traffic regulations (CC only) - pkg and loading	yes			Cannot locate truck route for LA city	yes	maybe			yes	maybe		
truck routes												
Fuel and Emissions Regulations	Yes	Yes	Yes		yes	maybe			yes	maybe		
Operator regulations	yes	yes			yes	maybe			yes	maybe		
Land Use Regulation - zoning	yes	yes	yes	SCAG land use zoning map 2008	yes	yes	no		yes	yes	no	
Service and code restrictions	yes											

	Paris				Seoul			
Data Elements	Data	Available	Collected	Comments	Data	Available	Collected	Comments
Traffic regulations (CC only) - pkg and loading	Yes	Yes	Partly		Yes	Yes	Yes	Seoul Metro Regulation
truck routes	Yes	Yes	Yes					
Fuel and Emissions Regulations	Yes	Yes	Yes		Yes	Yes	Yes	Seoul Metro Regulation
Operator regulations								
Land Use Regulation - zoning	Yes	Yes	Yes					
Service and code restrictions	Yes	Yes	Yes					

Attachment 3: MF Paris Newsletter

Newsletter METROFREIGHT
Paris-Ile-de-France

MF METROFREIGHT Volvo Center of Excellence

N° 1, Novembre 2013

LE PROJET METROFREIGHT
LE FRET URBAIN A PARIS, NEW YORK, LOS ANGELES ET SEOUL (2013-2017)

METROFREIGHT a démarré le 1er juin 2013. Il s'agit d'un consortium de recherche sur le fret urbain mené par USC (*University of Southern California*, prof. Gen Giuliano) avec le KOTI (Korean Transport Institute), the University Transportation Research Center (UTRC, dont Columbia University et City College of New York) et l'IFSTTAR.

Des partenaires locaux institutionnels sont associés à chacune des universités. L'IFSTTAR a la chance de compter parmi ses partenaires les organismes clés que sont la Région IDF, la Ville de Paris, la DRIEA, l'IAU et l'APUR. Ils rejoignent ainsi la ville de New York, la ville de Séoul et le comté de Los Angeles dans les collectivités impliquées.

Le projet est financé par VREF, Volvo Research and Education Foundations. VREF est une fondation financée par (mais indépendante du) groupe Volvo qui a créé à travers le monde une dizaine de centres d'excellence sur le thème du transport urbain du futur.

METROFREIGHT est construit autour du thème des très grandes métropoles et s'intéresse aux enjeux économiques, environnementaux et de gouvernance du fret urbain pour ces territoires. Six axes de recherche sont menés en parallèle et dans une approche comparative :

- Données et statistiques, enquête Transports de marchandises en ville, *leader : UTRC*
- Politiques publiques et impact sur l'offre de transport de marchandises en ville, *leader: USC*
- Les derniers kilomètres, *leader: IFSTTAR*
- Les interactions fret/voyageurs, *leader: USC*
- Dynamiques spatiales, urbanisme logistique, *leader: UTRC*
- Les comportements des consommateurs et producteurs, *leader: UTRC*

Réunion de lancement METROFREIGHT Paris-Ile-de-France le 12 juin 2013 à l'APUR

Participants :

Cédric Aubouin, CR IDF	Pétronille Harnay, IFSTTAR
Jeannie Creismeas, DRIEA	Martin Koning, IFSTTAR
Laetitia Dablanc, IFSTTAR	Jean Pascal Lavielle, DRIEA
Alexandre Frémiot, Ville de Paris	Hervé Levifve, APUR
Elisabeth Gouvernal, IAU	Corinne Ropital, IAU

Lors de cette réunion de lancement, le projet a été présenté et débattu dans son ensemble et dans sa partie francilienne. Plusieurs décisions ont été prises entre les partenaires.

- Un comité de pilotage francilien METROFREIGHT se réunira une à deux fois par an et sera l'occasion, notamment, de présenter l'état d'avancement des thèses et des recherches METROFREIGHT. L'APUR a proposé de continuer à accueillir les réunions

- METROFREIGHT a proposé de participer au CERLOG. Les résultats METROFREIGHT pourraient être mis à l'ordre du jour du CERLOG à la demande de ses membres.

- La phase 1 du projet a été enclenchée : la collecte de données sur le fret urbain. Un budget METROFREIGHT existe pour l'achat éventuel de données. Il faudra solliciter les ressources existantes: partenaires franciliens, Institut Belgrand (Univ Paris-Est), réseau Quetelet. Laetitia Dablanc sollicitera les partenaires franciliens pour l'obtention de certaines données: trafic et réseaux routiers (DRIEA), enquêtes ZAPA, données commerces, étude trame viaire (APUR), etc.

- Le projet tramfret suscite beaucoup d'intérêt de la part des partenaires américains et coréens de METROFREIGHT. Martin Koning pourra assister l'APUR dans des travaux d'évaluation et de suivis, d'analyses de filières si mise en place d'un prototype.

- L'Ifsttar (Pétronille Rème) contribuera à l'analyse de l'enquête sur la sous-traitance dans le transport routier de marchandises/messagerie menée par le LET pour le conseil régional d'Ile-de-France.

- L'IAU accueillera un à deux jours par semaine le nouveau doctorant de l'Ifsttar, Adrien Béziat pour participer à l'exploitation et l'analyse de l'enquête TMV Ile-de-France.

- Pour compléter certaines des recherches prévues par METROFREIGHT, l'IAU, l'APUR et l'Ifsttar ont décidé de répondre ensemble à l'appel à projets de l'Ademe AACT-AIR. Le projet RETMIF a été retenu et démarrera en novembre 2013.

Signature de la Charte en faveur d'une logistique urbaine durable

Le 18 septembre 2013 a été signée la Charte parisienne en faveur d'une logistique urbaine durable. La Ville de Paris, le Conseil Régional et l'APUR sont bien sûr signataires. L'IFSTTAR, au titre notamment de sa participation à METROFREIGHT, fait également partie des signataires.

Attachment 4: Papers from project

Conway, A, J. Cheng, D. Peters, and N. Lownes (2013) "Characteristics of Multimodal Conflicts in Urban On-Street Bicycle Lanes". TRB paper 13-4545, forthcoming in Transportation Research Record.

Dablanc, L. and J-P Rodrigue (2013) "Urban Freight Distribution: A Global Typology", in G. Giuliano and S. Hanson (eds) The Geography of Urban Transportation, 4th Edition, New York: The Guilfold Press. in press.

Dablanc, L., G. Giuliano, K. Holliday, T. O'Brien (2013) "Best practices in urban freight management: Lessons from an international survey," TRB paper 13-2903, presented at the 2013 TRB Annual Meeting and forthcoming, *Transportation Research Record.*

Characteristics of Multi-Modal Conflicts in Urban On-Street Bicycle Lanes

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Abstract

In urban areas, bicycles traveling in bicycle lanes encounter a variety of obstructions, including pedestrians and various types of motor vehicles. While previous studies have focused on identifying the frequency of such events, the goal of this study is to characterize these conflicts. In order to evaluate specific characteristics that may influence the frequency of specific conflict types, including bicycle lane designs, curb regulations, and land uses, field data collection was performed in the Manhattan and Brooklyn boroughs of New York City. This paper describes a method for evaluating the frequency of conflicts between bicycles traveling in on-street bicycle lanes and various other transportation modes, and for identifying factors that may impact these frequencies.

Introduction

In New York City (NYC), like in many urban centers, bicycles are gaining prominence as a commuter transportation mode. In a concerted effort to improve its sustainability, the city has embarked on an unprecedented era of bicycle network expansion. Between 2006 and 2009, more than 200 bicycle lane-miles were installed, and additional implementations have been made in every year since, with a long term goal of 1,800 lane miles by 2030 (1). While these efforts have been very successful in encouraging a mode shift, doubling commuter cycling rates between 2007 and 2011 (2), these bicycle lane improvements have also created new challenges for the city. With very limited space and high multi-modal demands for that space, most bicycle network expansions are installed at-grade with motor vehicle infrastructure. Many implementations require repurposing of space previously used for motor vehicle travel and parking for bicycle use, resulting in reduced travel and parking capacities for motor vehicles. While this outcome may be viewed as a positive step toward achieving sustainability goals, it may also have unintended consequences for safety. Already, New York suffers from severe obstruction of bicycle lanes by pedestrians and motorized traffic. These conditions lead to conflict events between multiple travel modes, and serve as a deterrent to cyclists who are uncomfortable operating outside of a designated lane. As bicycle volumes increase and motor vehicle capacities shrink, it is likely that, at least in the short term, obstructions and resulting conflicts will only increase. In order to prevent deterioration in safety as the bicycle network continues to expand, it will be necessary for planners to identify locations where conflicts are expected, and to implement lane designs, curb regulations, and enforcement policies that will minimize the likelihood of conflict. The goal of this study is to develop a method to characterize the multi-modal conflicts occurring in bicycle lanes in dense commercial districts in Manhattan and Brooklyn, and to identify specific characteristics, including bicycle lane designs, curb regulations, and land uses that may influence the frequency of specific conflict types.

Literature Review

According to Gotschi and Mills, only a multi-modal transportation system allows an optimal use of limited resources, including fuel, land, time, and money (3). However, even in the nation's densest metropolitan areas like New York, sprawling suburban developments have resulted in long travel distances between destinations and commuter dependence on passenger cars (4). In recent years, state departments of transportation (DOTs) and local agencies have turned to bicycle travel, along with public transit and walking, to address concerns about congestion, health, and the environment (5). "Promotion of bicycling" has become a key element of a broader strategy of urban planning, with a goal to reverse urban problems caused by motor vehicle use (6). Pucher, Dill, and Handy found that to promote cycling, a comprehensive strategy, including bicycle infrastructure development, land use policies, road pricing, and education, among other elements, is needed (7).

Over the past decade, there has been significant growth in both political and financial support for cycling projects (8), and in the near future bicycle ridership is expected to continue to grow. In 2007, NYC's Mayor Michael Bloomberg launched a citywide initiative to promote sustainability in the city (9). A key component of this plan was strategic growth of the city's bicycle network to promote bicycle commuting. Monsere, McNeil, and Dill (10) found that commuter shares improve when new on-street bicycle infrastructure is built. So far, results from New York confirm this general finding; between 2006 and 2009, more than 200 miles of new bicycle lanes were installed in NYC (11). In 2008, NYCDOT's Strategic Agency Plan, "Sustainable Streets," included a goal to double bicycle commuting between 2007 and 2012, and to triple 2007 rates by 2017. The former goal was reached in 2011, a year sooner than planned (2). In addition, the city recently announced plans to implement a bike share program (12). The "Citi Bike" program will ultimately include 600 stations and 10,000 bikes strategically placed across Midtown and Downtown Manhattan, Northwest Brooklyn, and a small region of Queens (13).

Despite recent strides, a number of challenges still exist for cycling in NYC. According to Pucher, Buehler, and Seinen, very large cities present special challenges to cycling, including high density of traffic, long trip distances, and noise and air pollution (8). Additional concerns include unprotected signals, lack of enforcement by police, and failure to gain respect from other road users. Despite its massive recent investments, according to Pucher and Buehler, NYC ranked worst of nine major North American cities in commuter mode share and fatality and injury rates (14). These factors are likely influenced by the frequency of bicycle lane obstructions in the city. Although double-parking in a bicycle line is explicitly prohibited in New York City, even in areas where truck double parking is allowed in motor vehicle lanes, vehicular obstruction of bicycle lanes is common. A 2009 study conducted by Tuckel and Milczarski at Hunter College found that in Midtown Manhattan, on a bike lane the length of 5-6 city blocks, the likelihood of a cyclist encountering a lane obstruction during a 10 minute period is about 60 percent (15). The study found that vehicular lane obstructions included, in order of frequency: trucks, passenger cars, taxis, vans, and parcel delivery vehicles. A study conducted in 11 locations over three days in 2010 by the Manhattan Borough President's Office also identified frequent vehicular obstructions; 275 of 353 obstructions observed were vehicles, including 18 percent taxis and 13 percent municipal vehicles (16).

Safety is a crucial factor in bike ridership, as cyclist will choose not to cycle if they do not at least have a perception of safety in a bicycle lane. The 2009 update of NYCDOT's *Sustainable Streets* report prioritized real and perceived bicycle lane safety, with a goal to increase the comfort level of system users (17). Key targets identified included: implementation of traffic calming and control mechanisms; improved collection of and access to data on incident locations and outcomes; increased public safety and awareness programs; and enhanced construction and inspection methods of pedestrian and bicycle facilities. While education efforts and infrastructure improvements have increased bicycle ridership shares and dramatically improved safety for cyclists, existing challenges remain; conflicts with vehicles, pedestrians, and other bicyclists continue to occur, even in designated bicycle lanes.

Cyclist safety is usually measured through evaluation of accident frequencies and outcomes. In 2006, a multi-agency comprehensive report examining cyclist fatalities in NYC between 1996 and 2005 was produced (18). This study identified 225 fatalities and 3,462 serious injuries to cyclists during that period. Close to 90 percent of fatal accidents involved an accident with a motor vehicle, and a disproportionately high share (nearly one third) involved a large vehicle (truck or bus). While the 2006 study did find that from the beginning of the analysis period until the end, severe injury rates fell by 46 percent, a 2011 multi-agency crash report also showed that while improvements to policy, operations and bicycle infrastructure have made the streets safer for cyclists, more improvements are necessary (19). In 2011, nearly 800 bicycle-involved incidents were recorded, including 754 involving a motor vehicle, 27 involving a pedestrian, two involving multiple bicycles, and 14 involving only a single bicycle. For incidents involving two non-motorized travelers, these numbers are likely a gross underestimate, as many incidents are unrecorded.

Improvements in cyclist safety are often achieved through infrastructure enhancement. There are a variety of types of at-grade bicycle infrastructure in use across the United States. In general, the three main types of bicycle lane configuration include: 1) lanes that are physically separated from motorized traffic (by physical objects, buffered zones, or parking); 2) striped lanes that are designated for exclusive bicycle use; and 3) shared routes that are demarcated as bike routes using signage and sharrows, but that do not include a designated bicycle lane. Much recent research had focused on the relationship between cycling and various types of available infrastructure, with a primary focus on cyclist behavior. A bikeability study completed by Lowry et al. used a comprehensive approach to assess the comfort and convenience of bicycling in urban centers by incorporating suitability across a community; their model captured the benefits from capital investments intended to improve bicycle suitability (5). Pucher and Buehler found that cities with a greater supply of bike paths and lanes have higher bike commute levels (14). Caulfield, McCarthy and Brick (20) found cyclist volumes and speeds are related to the type of infrastructure on which they operate. Monsere, McNeil, and Dill also found that factors such as safety and speed improve when new on-street bicycle infrastructure is built (10). A few studies have also focused on specific infrastructure elements. Dill, Monsere, and McNeil examined the influence of bike boxes on cycling safety at signalized intersections (21), while Brady et. al examined the effects of shared lane marking on bicyclist and motorist behavior (22).

Research Methods

The purpose of this study was to develop a method to assess cyclist exposure to multi-modal conflicts as a function of time-of-day, lane configuration, curb regulation, and land use variables. This analysis was performed using an original dataset of directly observed multi-modal conflicts. For the purpose of this study, conflicts were defined as obstructions parked in or crossing the bicycle lane that required a cyclist, in order to avoid a collision, to 1) exit the bicycle lane, or 2) stop. Conflict frequencies were then evaluated for the purpose of identifying variables that are significant predictors of exposure. The study was completed in four primary steps:

1) Identify expected high-conflict locations using GIS suitability analysis of infrastructure and zoning data.
2) Perform field data collection through direct observation of conflict events.
3) Perform data mining and direct observation to identify lane designs, curb regulations, and land use characteristics in data collection locations.

4) Perform statistical tests to identify variables that can be used to predict multi-modal conflict frequencies.

Step 1: Location Suitability Analysis

The first step in this study was to identify locations in NYC where a high frequency of conflicts between bicycles and other transportation modes, including freight vehicles (trucks and vans), passenger cars, cabs, and pedestrians, were expected. In order to identify these locations, a geographic analysis was performed in ArcGIS using a number of existing datasets. The city bicycle map from NYCDOT was used to identify the locations of on-street bicycle lanes (23). American Community Survey Journey-to-Work data was then employed to identify neighborhood tabulations areas(NTAs) with relatively high commuter bike shares (24); bicycle routes located in these NTAs or connecting these NTAs to Midtown Manhattan were identified as expected high bicycle volume routes. MapPluto data from the NYC Department of City Planning was then mapped to identify concentrations of commercial and mixed commercial/residential land uses adjacent to the bicycle lanes on expected high-volume routes (25) (26); these land use types are expected to produce a large number of trips by all modes.

The suitability analysis identified several areas in Manhattan where frequent conflicts are expected (FIGURE 1). These included locations in Uptown Manhattan (1st Avenue on the East Side and Columbus Avenue on the West Side, Midtown Manhattan (Broadway and its cross streets (20th, 21st, 29th, and 30th) in central midtown), and Downtown Manhattan (Hudson Street through the West Village and 2nd Avenue and Grand Street on the Lower East). Three locations in Brooklyn were also identified as potential high-conflict areas: 5th Avenue in Prospect Park, Grand Street in southern Williamsburg, and the Jay Street/Smith Street Corridor through the neighborhoods of Cobble Hill and Downtown Brooklyn.

Step 2: Field Data Collection

Field data was collected through manual observation. Groups of two and three researchers were dispatched to specific data collection locations, where they collected data on individual street blocks in one- and two-hour increments. Observers collected bicycle volume counts, including in-lane and out-of-lane, and street-direction and opposite-direction counts. Four primary types of conflicts were also observed: freight (truck and van), passenger car, cab, and pedestrian. In total, nearly 50 hours of field data were collected on 35 distinct blocks during 43 observation periods. Counts were conducted between the hours of 7 AM and 7 PM. Counts beginning before 10 AM were classified as "Morning" counts, while counts beginning after 4:00 PM were classified as "Evening" counts. Counts beginning between 10 AM and 4 PM were classified as "Mid-Day" counts. TABLE 1 provides a summary of the field data collected in each area.

Step 3: Static Data Collection

TABLE 2 provides the static characteristics for each specific block within these areas where data was collected. These static characteristics were identified by a number of data collection methods. Bicycle lane configurations were identified through visual inspection. Lanes were classified as one of three lane types: Type A - a standard bicycle lane located adjacent to a travel lane and separated from the curb by vehicle parking; Type B - a buffered bicycle lane separated from the curb by parking and from the vehicle travel lanes by a striped buffer: or Type C - a curbside bicycle lane protected by parked vehicles (FIGURE 2). Curb regulations and block lengths for each block were identified using NYCDOT's Parking Regulation database (27); when errors in the database were identified, corrected curb regulations were obtained by visual inspection in Google Streetview (28), and corrected block lengths were digitally measured from aerial images in Google Earth (29). Each block location and time period was categorized by its dominant curb regulation into one of five categories: Metered, Commercial Loading, Commercial Metered, Open, and No Parking. Additionally, for each block location, specific business types adjacent to the bicycle lanes on each block were counted using Google Streetview images and by manual counting in the field. These values are subject to some error, as 1) businesses may have changed since Streetview imagery was obtained and 2) particularly in Midtown, multiple retail establishments may share a single storefront.

The resulting best available estimates of business counts were standardized to a "Business Density" comparable across varying block lengths. This density was estimated using the following formula:

$$Business\ Density = Total\ \#\ Businesses \times \frac{Standard\ NYC\ Block\ Length\ (264\ ft)}{Observation\ Block\ Length} \quad \textbf{(1)}$$

Step 4: Data Analysis

In order to identify variables indicative of high conflict areas, bivariate correlation analyses were performed between each conflict type and individual time-of-day, bicycle lane configuration, curb regulation, and land use variables. For each conflict type, an adjusted frequency of conflict variable was estimated to account for differing block lengths. For each data collection location and time period, and each conflict type, the following equation was applied:

$$Adj\ Conflict\ Freq = \frac{Observed\ Conflict\ Freq \times \frac{Standard\ NYC\ Block\ Length\ (264\ ft)}{Observation\ Block\ Length}}{Total\ Observed\ Bicycles\ in\ Lane} \times 100 \quad (\mathbf{2})$$

The resulting variable represents the expected percentage of bicycles traveling over a standard 264 ft of a bicycle lane that will encounter a specific type of conflict.

In order to evaluate the specific characteristics of these locations that influence the likelihood of each conflict type, three types of tests were performed. First, for all continuous variables, a Pearson product-moment correlation coefficient (r) was calculated, and the two-tailed significance was identified using a t-test. Three continuous land use variables - business density, percent of businesses that are retail, and percent of businesses that are bars/restaurants - were evaluated. Next, for all multi-category categorical variables, a one-way analysis of variance (ANOVA) was conducted to determine the F statistic for each variable. For those variables found to demonstrate significantly different variances between categories, an additional ad-hoc test, a Bonferroni test, was performed to identify statistically significant differences in means between categories. Finally, for the binary categorical variable, a comparison t-test was performed to compare means. TABLE 3 summarizes the categories and observed frequencies for each categorical variable.

RESULTS

As seen in TABLE 2, a total of 201 multimodal bicycle conflicts were observed, including 114 conflicts with passenger cars, 39 conflicts with pedestrians, 25 conflicts with freight vehicles, and 23 conflicts with cabs. As is clear in TABLE 4, these conflicts are not evenly distributed across all areas. While passenger car conflicts occurred everywhere, bicycles were nearly four times as likely to encounter this type of conflict in Uptown Manhattan compared to Midtown. Alternatively, freight conflicts were more likely to occur in Midtown than in any other area, and were non-existent or nearly non-existent Downtown and in Brooklyn. Pedestrian conflicts were much more likely Downtown that in other locations. Cab conflicts were less frequent than all other conflict types, but were more likely Uptown and Downtown than in the other areas.

TABLE 5 presents the results of the statistical tests performed for each variable. Results with a p less than .10 indicate a strong relationship between conflict frequency and an individual variable. A p value between .10 and .20 indicates an existing but weaker relationship. Because of the very small sample size of some curb regulation types (TABLE 3), only observations of Metered, Commercial Metered, and Commercial Loading curb regulations were evaluated to determine curb regulation impacts.

Freight Conflicts

Most of the observed freight conflicts occurred in Midtown and Uptown Manhattan (TABLE 1). Overall, 25 freight conflicts were observed, including 15 truck conflicts and 10 van conflicts. All of the observed freight conflicts in Brooklyn involved a van, not a truck. Analysis results suggest that several variables can be used to identify areas with a high likelihood of bicycle conflicts with freight vehicles (TABLE 5). A strong positive correlation was identified between the likelihood of a freight conflict and the share of retail businesses. This result is expected, as retail land uses are likely indicative of high freight demand. Results also suggest that bicycle lane configuration will impact conflict frequency, with a Type C lane likely to be associated with fewer conflicts than Type B bicycle lanes. This result confirms field observations indicating that freight vehicles (including trucks and vans delivering goods and performing services) are unlikely to park in a bicycle lane separated from vehicle traffic by vehicle parking. Type B bicycle lanes may also provide an attractive parking space for double-parked trucks, since trucks parked partially in the bicycle lane and partially in the striped buffer are somewhat sheltered from the adjacent travel lane. Results also indicate a negative relationship between likelihood of a freight conflict and business density; this value is more difficult to interpret, since high density of business would seem to indicate a high demand for trucks. One explanation may be that trucks delivering to very dense areas may schedule deliveries during off-peak hours to avoid extreme demands for curb space. Another explanation may be that fewer large businesses (e.g. major drug stores, large grocery stores) may actually produce more freight trips than multiple smaller businesses. In addition to parked and parking vehicles, a number of potential types of freight-bicycle conflicts were also observed in the field, but are not explicitly recognized as "freight conflicts" in this dataset. Observed types of conflicts included: delivery persons crossing from a parked vehicle outside of the bicycle lane; delivery persons using the bike lane to transport goods by hand cart; and unloaded goods piled in the bicycle lane for delivery.

Passenger Car Conflicts

Passenger car conflicts occurred throughout Manhattan and Brooklyn, with the highest concentration of conflicts occurring Uptown, and the lowest in Midtown. During two data collection periods with high bicycle volumes, passenger cars were observed parking in a bicycle lane for a very long duration, leading to extremely high passenger car conflict values. Since these values caused an inflated variance within the categories applicable to the observed block, these data points were excluded from the analysis of variables impacting passenger car conflict frequency. Tests results did not identify any strong relationships between individual variables and passenger car conflict frequencies; however, the power of the tests applied is limited by the small size of the dataset. For time-of-day and lane configuration variables, p values of .216 and .256 do not meet the threshold of .20 used in this study to identify a weak relationship; however, these values do indicate that there is more than a 75% likelihood of a significant difference in variance between categories. Lane configuration impacts were expected to differ for passenger cars; like truck drivers, passenger car drivers would prefer to double park in a Type B lane to be sheltered from oncoming traffic, and are unlikely to park in a lane separated from vehicular traffic by parking. Passenger car conflicts were also expected to differ between time-periods, such as the evening peak, when high volumes of passenger cars are traveling, particularly for non-work purposes such as errands and meal pick-up.

Cab Conflicts

Although observed in all four areas, cab conflicts were the least observed conflict type, with only 23 total observations. However, despite the small number of observations, three significant variables could be identified. Increases of about two conflicts per hour in mean adjusted cab conflict frequency for a Type B lane design compared to both Type A and Type C were found to be statistically significant; as discussed above, this type of lane configuration allows a vehicle to double park while remaining somewhat protected from the vehicle travel lane. Significant correlations were also identified with the Percent Retail and Percent Bar/Restaurant variables. This result suggests that cab demand is higher in locations with a greater share of dining establishments and fewer retail stores. While neither variable meets the threshold p value of .20, p values of .230 and .203 for time-of-day and curb regulation variables also suggests that some relationship does exist between these variables and cab conflict frequency.

Pedestrian Conflicts

Based on the statistical test results, it appears that conflicts between pedestrians and bicycles are much less predictable than cab conflicts. In total, 39 pedestrian conflicts were observed; these included pedestrians stepping into the lane to cross during the wrong signal phase; pedestrians crossing mid-block to access vehicles or the other side of the street; and pedestrians hailing cabs. This number also includes pedestrians, particularly those with hand carts, strollers, and in wheelchairs, using the bicycle lane as an extension of the sidewalk; this condition was especially noted in Type C lane configurations. Of all of the time-of-day, bicycle lane configuration, curb regulation, and commercial land use variables, only the time-of-day variable is a significant predictor of pedestrian conflict frequency. Pedestrian conflict frequency increases significantly in the evening compared to both the morning and the mid-day. This likely reflects the fact that during the evening peak, individuals may be more likely to make personal trips for food and retail.

Error, Bias, and Future Improvements

The dataset evaluated in this study includes targeted observations of expected high-conflict areas during random hours. Due to limited resources, only sporadic counts were taken on individual blocks during morning, mid-day, and evening periods, leading to few observations of some lane configurations and curb regulations during different periods of the day. The small size of the resulting dataset limited the power of the statistical tests applied to identify significant variable interactions. Some specific challenges with the existing dataset can be identified from TABLE 3. First, for some variable categories, especially curb regulation types, the number of observations is extremely small. An examination of the cross-tabulation between variables also reveals close relationships between some variable categories. For example, of the 10 blocks identified to include a major generator, nine were regulated by metered parking. Similarly, on nine of the 10 blocks observed with Type B bicycle lanes, the curb is regulated with metered parking. Also, of the 10 observations on blacks with major generators, none includes a Type C lane. These observed correlations may reflect intentional design differences; for example, Type C lanes may be less likely to be implemented near major generators since these types of lanes may require reductions in parking availability to accommodate turning movements at intersections. However these relationships may also reflect a biased dataset. Study results could be greatly improved through collection and evaluation of a larger and more complete dataset. In order to obtain an improved dataset, future experimental design should explicitly consider lane configuration and curb regulation differences in scheduling of data collection times and locations. While this study does identify some significant predictors of multi-modal conflicts, a much larger dataset with a greater number of observations for all combinations of categorical variables would enable multivariate regression analysis to isolate the impacts of individual variables.

Future Applications and Research

Ultimately, with a sufficiently large dataset, a multivariate regression model could be developed and directly applied to predict the likelihood of multimodal conflicts during specific periods in specific locations using infrastructure and land use data. Already, the results of this study can be applied to develop education materials for cyclists and to provide decision support for cyclists making route choices. By examining lane designs and land uses along their route, cyclists can anticipate the exposure risk that they are likely to encounter on specific routes. For example, cyclists traveling in the evening can anticipate intrusion in the bicycle lane by pedestrians. Cyclists traveling through areas with a high percentage of bars and restaurants will know to look out for cabs, as they are likely to obstruct the lane in these locations. Additionally, cyclists traveling in a Type B bicycle lane will know to anticipate parking in the lane by both cabs and freight vehicles. Risk-averse cyclists can use this information to choose a route that minimizes the potential for conflicts or specific conflict types.

Development of a multivariate regression model would also enable planners to anticipate potential conflicts resulting from proposed bicycle lane installations, and to compare conflict exposure between various proposed routes or various proposed lane configurations. By providing a quantitative measure of specific risks to a cyclist, such a model could enhance consideration of cyclist safety in a cost-benefit analysis of alternatives. For example, a Type C bicycle lane installation will generally require more reconfiguration of a curbside than other lane types and will have a greater impact on parking due a to a need for mixing zones at intersections; however, these costs might be justified by savings due to reduced conflicts between bicycles and motorized vehicles. Results might also be used to determine locations for signage warning pedestrians and drivers of potential bicycle interactions.

Finally, an ability to predict high-conflict locations would also be useful to enforcement agencies with limited resources. These agencies could target enforcement activities to locations and hours when cyclists may be exposed to the greatest risk. For example, ticketing for jaywalking could be performed during evening hours when pedestrian conflicts are expected to be highest. Similarly, parking enforcement could be targeted to locations with Type B bicycle lanes, where vehicles are more likely to park in and obstruct the lane. Specific enforcement locations could be prioritized using expected conflict frequencies.

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References

1. *Sustainable Streets Index.* New York : NYCDOT, 2010.
2. NYCDOT. *Bicyclists*, 2012. http://www.nyc.gov/html/dot/html/bicyclists/bikestats.shtml. Accessed July. 15, 2012.

3. Gotschi, Thomas and Mills, Kevin. *Active Transportation for America.* Rails-to-Trails Conservancy, 2008.
4. Bannister, D. J. Pucher, and M. Lee-Gosselin. Making Sustainable Transport Politically and Publicly Acceptable: Lessons from the EU, USA, and Canada. I*nstitutions and Sustainable Transport: Regulatory Reform in Advanced Economies*, e.d. P. Rietveld and R. Stough, Edward Elgar Publishers, 2007. p. 17-50
5.. Lowry, M., D. Callister,, M. Gresham, and B. Moore. Using Bicycle Level of Service to Assess Community-Wide Bikeability. Presented at the 91st Annual Meeting of the Transportation Research Board, Washington, DC, 2012.
6. Providelo, J. Kirner and S.d. Sanches. Roadway and Traffic Characteristics for Bicycling. *Transportation: Planning, Policy, Research, and Practice*, Vol. 38, No. 5, 2011. p. 765-777.
7. Pucher, J. J. DIll, and S. Handy. Infrastructure, Programs, and Policies to Increase Bicycling: An International Review. Preventative Medicine, Vol. 50, Supplement 1, 2010. p. S106-125.
8. Pucher, J., R. Buehler, and M. Seinen. Bicycling Renaissance in North America? An Update and Re-appraisal of Cycling Trends and Policies. *Transportation Research Part A: Policy and Practice*, Vol. 45, 2011. p. 451-475.
9. City of New York. *PlaNYC*, 2007.
10. Monsere, C. N. McNeil, and J. Dill. *Multi-User Perspectives on Separated, On-Street Bicycle Infrastructure.* Presented at the 91st Annual Meeting of the Transportation Research Board, Washington, DC, 2012.
11. NYCDOT. *Bicyclists: Network and Statistics*, 2011. http://www.nyc.gov/html/dot/html/bicyclists/bikestats.shtml#network. Accessed July. 15, 2011.
12. Citi Bike. *About Citi Bike.* http://citibikenyc.com/. Accessed July 16, 2012.
13. Flegenheimer, M. City Unveils Locations of Bike-Share Stations. *New York Times. May 12,* 2012 p. A14.
14. Pucher, J. and R. Buehler**.** *Analysis of Bicycling Trends and Policies in Large North American Cities: Lessons for New York.* UTRC2, Report No. 49111-13-21, 2011.
15. Milczarski, W., and P. Tuckel. Bike Lanes or Blocked Lanes? *Hunter College, CUNY*. 2009.
16. Office of Manhattan Borough President. Borough President Stringer Releases Unprecedented Report on Bike Lane Infractions, 2006. http://www.mbpo.org/release_details.asp?id=1681. Accesssed June. 7, 2012.
17. NYCDOT. *Sustainable Streets.* New York City Department of Transportation 2009.
18. Nicaj, L., J. Mandel-Ricci, S. Assefa, K. Grasso, P. McCarthy, A. Caffarelli, W. McKelvey, C. Stayton, and L. Thorpe. *Bicyclist Fatalities and Serious Injuries in New York City: 1996-2005.* New York City Department of Health and Mental Hygiene, New York City Department of Parks and Recreation, New York City Department of Transportation, and New York City Police Department, 2006.
19. NYCDOT. *Bicycle Crash Data Report*, 2011.

20. Caulfield, B., E. Brick, and O. McCarthy. *Determining Bicycle Infrastructure Preferences – A Case Study of Dublin***.** Transportation Research Part D:Transport and Environment , Vol. 17, 2012. p. 413-417.
21. Dill, J. C. Monsere, and N. McNeil. Evaluation of Bike Boxes at Signalized Intersections. *Accident Analysis and Prevention*, Vol. 44, No. 1, 2012. p. 126-134.
22. Brady, J, J. Loskorn, A. Mills, J. Duthie, and R. Machemehl. Effects of Shared Lane Marking on Bicyclist amd Motorist Behavior. *ITE Journal*, Vol. 81, No. 8, 2011. p. 33-38.
23. NYCDOT. *Bicycle Maps*, 2012. http://www.nyc.gov/html/dot/html/bicyclists/bikemaps.shtml.
24. United States Census Bureau. *American Commuter Survey*, 2012. http://www.census.gov/acs/www/.
25. MapPluto Data - Manhattan Borough. NYCDCP, 2011.
26. MapPluto Data - Brooklyn Borough. NYCDCP, 2012.
27. NYCDOT. *Parking Regulations.* http://a841-dotvweb01.nyc.gov/ParkingRegs/ViewController/LocationValidation.aspx.
28. Google Inc. *Google Earth.* Available from http://www.google.com/earth/index.html.

29. Google Inc. *Google Maps.* https://www.google.com/maps.

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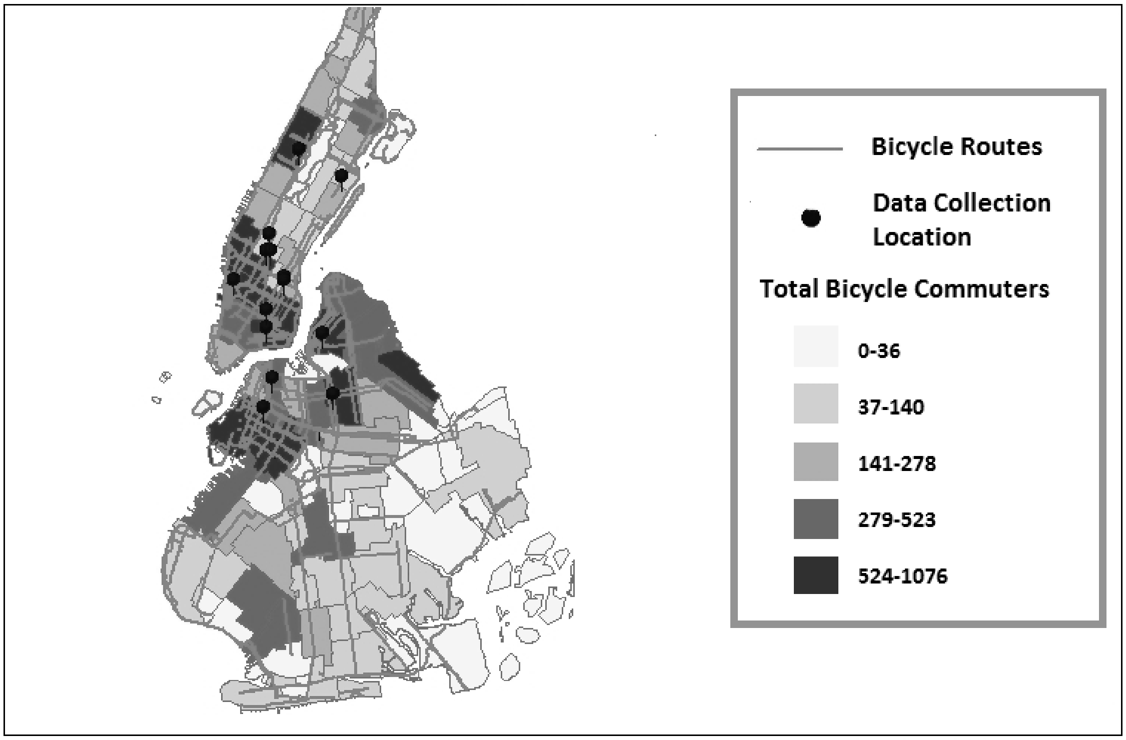

FIGURE 3 DATA COLLECTION LOCATIONS

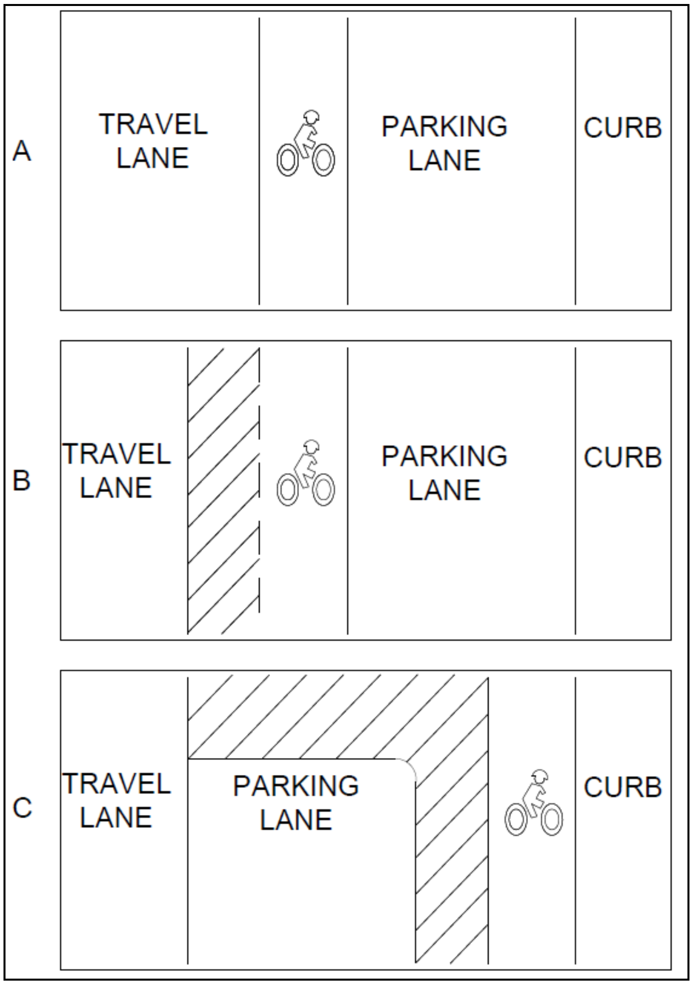

FIGURE 4 BICYCLE LANE CONFIGURATIONS

TABLE 1 Summary of Field Observations

	Brooklyn	Midtown Manhattan	Uptown Manhattan	Downtown Manhattan	New York City
Total Observed Block-Hours	**17**	**10**	**12**	**10.67**	**49.67**
Morning	*7*	*5*	*3*	*1*	***16***
Mid-Day	*8*	*5*	*6*	*6.67*	***25.67***
Evening	*2*	*0*	*3*	*3*	***8***
Total Bicycle Volume	**1009**	**527**	**777**	**821**	**3134**
Percent in Lane	*84.3*	*81.4*	*70.9*	*79.5*	***79.3***
Percent in Street Direction	*76.1*	*65.8*	*62.5*	*69.4*	***69.3***
Avg. Hourly Volume	*59*	*53*	*65*	*77*	
Max. Hourly Volume	*105*	*98*	*121*	*108*	
Min. Hourly Volume	*20*	*18*	*21*	*58*	
Total Observed Conflicts	**46**	**38**	**65**	**52**	**201**
Freight	*2*	*14*	*9*	*0*	***25***
Passenger Car	*35*	*13*	*41*	*25*	***114***
Cab	*3*	*4*	*9*	*7*	***23***
Ped	*6*	*7*	*6*	*20*	***39***

TABLE 2 Specific Data Collection Blocks

Block				Bicycle Lane Config.	Curb Regulation	Business			
Street	From	To	Length (ft)			Density	Pct. Retail	Pct. Bar/ Restaurant	Major Generat-or
Brooklyn									
Jay	Willoughby	Fulton Mall	270	A	Comm. Load.	14.7	53	13	No
Smith	Douglass	Degraw	231	A	Meter	14.9	15	54	No
5th	11th	12th	236	A	Meter	13.4	0	33	No
5th	12th	13th	233	A	Meter	10.2	22	22	Yes
5th	13th	14th	233	A	Meter	10.2	22	22	Yes
5th	14th	15th	231	A	Meter	12.6	18	9	No
Grand	Graham	Manhattan	436	A	Meter	7.9	31	23	Yes
Grand	Humboldt	Graham	437	A	Meter	6.6	9	18	No
Grand	Humboldt	Bushwick	403	A	Meter	11.1	29	18	Yes
Manhattan									
Midtown									
20th	Broadway	Park	601	A	Comm. Met.	7.5	35	24	Yes
21st	Broadway	Park	675	A	Comm. Met.	6.6	24	12	No
29th	Broadway	5th	425	A	Comm. Met.	12.5	71	4	No
29th	Broadway	6th	592	A	Comm. Met.	9.9	88	0	No
30th	Broadway	6th	513	A	Open	7.7	53	0	No
Broadway	27th	28th	238	C	Comm. Met.	12.2	82	0	No
Broadway	28th	29th	241	C	Comm. Met.	12.0	45	0	No
Broadway	29th	30th	238	C	Comm. Met.	15.5	93	0	No
Broadway	30th	31st	242	C	Comm. Met.	14.2	92	0	No

Uptown									
1st	72nd	73rd	247	B	Meter	3.2	0	33	No
1st	73rd	74th	238	B	Meter	11.1	20	50	No
1st	74th	75th	232	B	Meter	13.7	8	33	No
1st	75th	76th	234	B	Meter	4.5	50	25	Yes
1st	76th	77th	237	B	Meter	7.8	29	0	Yes
1st	78th	79th	245	B	Meter	7.5	0	29	Yes
Columbus	81st	82nd	178	C	Comm. Load.	1.5	0	0	No
Columbus	82nd	83rd	240	C	Comm. Load.	9.9	56	0	No
Columbus	83rd	84th	240	C	Meter	9.9	11	33	No
Columbus	87th	88th	234	C	Meter	9.0	13	0	No
Downtown									
2nd	7th	8th	225	C	Meter	10.6	11	22	No
2nd	10th	11th	221	C	Meter	11.9	30	20	No
2nd	11th	12th	237	C	Meter	11.1	10	60	No
Grand	Chrystie	Bowery	238	C	Open	11.1	10	40	No
Hudson	Charles	10th	231	A	Meter	12.6	18	45	No
Hudson	11th	Perry	233	A	Meter	10.2	11	56	No
Hudson	10th	Christopher	223	A	No Parking	4.7	50	0	No

TABLE 3 FREQUENCIES OF VARIABLE OBSERVATIONS

		Frequency of Observations												
	Variable	**Time of Day**			**Lane Configurations**			**Curb Regulations**					**Major Generator**	
		AM	MID	PM	A	B	C	O	NP	CL	M	CM	Yes	No
Variable	**Total Observations**	**14**	**21**	**8**	**18**	**10**	**15**	**3**	**1**	**5**	**25**	**9**	**10**	**33**
Time of Day														
Morning (AM)	**14**				9	1	4	1	0	1	8	4	3	11
Mid-day (MID)	**21**				7	5	9	1	1	3	11	5	5	16
Evening (PM)	**8**				2	4	2	1	0	1	6	0	2	6
Lane Configurations														
A	**18**	9	7	2				1	0	2	10	5	7	11
B	**10**	1	5	4				0	1	0	9	0	3	7
C	**15**	4	9	2				2	0	3	6	4	0	15
Curb Regulations														
Open (O)	**3**	1	1	1	1	0	2						0	3
NoPark (NP)	**1**	0	1	0	0	1	0						0	1
Commercial Loading (CL)	**5**	1	3	1	2	0	3						0	5
Meter (M)	**25**	8	11	6	10	9	6						9	16
Commercial Meter (CM)	**9**	4	5	0	5	0	4						1	8
Major Generator?														
Yes	**10**	3	5	2	7	3	0	0	0	0	9	1		
No	**33**	11	16	6	11	7	15	3	1	5	16	8		

TABLE 4 ADJUSTED FREQUENCIES OF MULTIMODAL CONFLICTS

	Adjusted Observed Frequency of Conflicts (Conflicts per Hour)											
Mode	Brooklyn			Midtown Manhattan			Uptown Manhattan			Downtown Manhattan		
	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min
Freight	0.22	2.63	0.00	2.94	16.10	0.00	2.01	6.16	0.00	0.00	0.00	0.00
Passenger Car	3.93	14.38	0.00	2.20	11.65	0.00	8.05	43.59	0.00	2.68	15.64	0.00
Cab	0.57	3.12	0.00	0.45	2.75	0.00	1.90	8.53	0.00	1.14	5.12	0.00
Pedestrian	0.84	9.44	0.00	1.39	4.76	0.00	0.98	8.83	0.00	3.57	12.86	0.00

TABLE 5 Variable Analysis Results

Initial Test

	Variables	Statistic Value	p
Continuous Variables: Pearson's r	**Adjusted Cab Conflicts**		
	Business Density	0.029	0.853
	Percent Retail	-0.277	0.072
	Percent Bar/Restaurant	0.260	0.093
	Adjusted Freight Conflicts		
	Business Density	-0.236	0.127
	Percent Retail	0.282	0.067
	Percent Bar/Restaurant	-0.162	0.300
	Adjusted Passenger Car Conflicts		
	Business Density	0.105	0.514
	Percent Retail	-0.032	0.841
	Percent Bar/Restaurant	-0.033	0.838
	Adjusted Pedestrian Conflicts		
	Business Density	-0.003	0.985
	Percent Retail	-0.177	0.256
	Percent Bar/Restaurant	0.118	0.449
Categorical Variables: Analysis of Variance (F)	**Adjusted Cab Conflicts**		
	Time of Day	1.524	0.230
	Curb Regulation	1.666	0.203
	Lane Configuration	4.335	0.020
	Adjusted Freight Conflicts		
	Time of Day	1.047	0.360

Post-Hoc Test

	Variables	Difference of Means	p
Categorical Variables, Significant F: Bonferroni Test	**Adjusted Cab Conflicts**		
	Lane Configuration		
	A vs. B	-1.903	0.037
	A vs. C	0.116	1.000
	B vs. C	2.019	0.032
	Adjusted Freight Conflicts		

	Curb Regulation	0.755	0.477		Lane Configuration		
	Lane Configuration	2.399	0.104		*A vs. B*	-0.631	1.000
	Adjusted Passenger Car Conflicts				*A vs. C*	1.777	0.277
	Time of Day	1.595	0.216		*B vs. C*	2.409	0.157
	Curb Regulation	0.046	0.955		**Adjusted Pedestrian Conflicts**		
	Lane Configuration	1.411	0.256		Time of Day		
	Adjusted Pedestrian Conflicts				*Morning vs. Mid-Day*	-0.293	1.000
	Time of Day	3.079	0.057		*Morning vs. Evening*	-3.095	0.078
	Curb Regulation	1.665	0.203		*Mid-day vs. Evening*	-2.802	0.094
	Lane Configuration	0.774	0.468				
Binary Categorical Variable: Comparison of Means (t)	**Adjusted Cab Conflicts**						
	Major Generator	1.101	0.277				
	Adjusted Freight Conflicts						
	Major Generator	0.370	0.713				
	Adjusted Passenger Car Conflicts						
	Major Generator	-0.627	0.534				
	Adjusted Pedestrian Conflicts						
	Major Generator	-0.607	0.547				

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1. ABSTRACT

Freight movement is essential to the function of metropolitan areas, yet it generates many externalities, including congestion, air pollution, noise, and greenhouse gas emissions. Metropolitan areas around the world are seeking ways to manage urban freight and its impacts. This paper presents results from a comprehensive international survey of urban freight management strategies. Our purpose was to examine the effectiveness of alternative strategies and assess their transferability for broad US implementation. We use three categories to describe urban freight strategies: last mile/first mile deliveries and pickups, environmental mitigation, and trade node strategies. We find that there are many possibilities for better managing urban freight and its impacts including labeling and certification programs, incentive-based voluntary emissions reductions programs, local land use and parking policies, and more stringent national fuel efficiency and emissions standards for heavy duty trucks. More research is needed on intra-metropolitan freight movements and on the effectiveness of existing policies and strategies.

2. INTRODUCTION

Commercial transport is crucial for the functioning of metropolitan areas. Trucks and vans provide local "last mile" deliveries and pickups, as well as most medium haul freight transport. In metro areas that serve as trade hubs, trucks are a major part of wholesaling, distribution, logistics and intermodal operations. Commercial traffic generates significant externalities in metro areas, including congestion, air pollution (small particulates, NOx, greenhouse gas emissions), noise, and traffic incidents. In addition, heavy duty vehicles affect pavements and generate additional demands for increased road capacity.

Metro areas are seeking ways to better manage goods movements. Researchers and local stakeholders have explored a range of strategies, such as better routing algorithms, smaller or newer trucks, consolidated local delivery stations, alternative modes, off-peak deliveries, low emission zones and freight partnerships. The purpose of this paper is to consider the state of research and practice in the US context. There are many interesting and innovative strategies being developed in Europe and other parts of the world. The extent to which these strategies are transferable to the US context depends on the complex governance arrangements in which urban freight policy takes place in the US.

This paper is organized as follows. We begin with a brief review of the urban freight literature. We then describe the sources of our research synthesis. We summarize the key findings of our study and lessons learned from our investigation of experiments with various policy measures. We consider whether these experiments are transferable in the US and may be identified as best practices. We close with some recommendations and suggestions for future research.

3. BACKGROUND AND LITERATURE REVIEW

Although there is increasing experimentation in solving urban freight problems, the relevant literature is limited and fragmented. A major challenge for research is the lack of appropriate data; studies have addressed data availability and promote more comprehensive data collection (*1*-*3*). Data on truck and van movements in US urban areas is almost non-existent; consequently the extent of the urban freight problem remains unknown. There is an extensive literature in logistics, with studies on truck routing, network optimization, and related topics (*4*-*6*). This literature is not "urban" in the sense of considering the urban context (freight/passenger conflicts, externalities), but rather addresses routing and allocation problems that are common in the urban environment. Transport economists have examined the economic structure of the drayage trucking industry, shipper behavior, and responsiveness to pricing policies (*7*-*9*). City logistics is an emerging field of study; it seeks to improve freight efficiency while minimizing both economic costs and social externalities, looking at city logistics in a broader sense than transportation (*10*). This is also the conclusion achieved by (*3*) in a recent review of city logistics in the academic literature. Researchers have examined spatial dynamics in freight activities, the transport geography of industry networks, and urban freight distribution systems (*11*-*16*).

There is a growing literature on the externalities associated with urban freight. The truck (*17*) and rail congestion (*18*) studies sponsored by USDOT show that freight bottlenecks are most prevalent in metropolitan areas, particularly where trade flows are concentrated, as in Los Angeles, Atlanta, Chicago and New York. Case studies document local congestion associated with truck parking and loading (*19*). There is a growing number of studies of the health impacts of small particulates associated with diesel truck emissions, notably the longitudinal children's health study in Los Angeles (*20*). Ports and intermodal terminals tend to be air pollution "hot spots" due the concentration of truck traffic and the prevalence of older, more polluting trucks in local delivery fleets. Trucks are also significant contributors to GHG emissions, accounting for about two-thirds of emissions from freight sources (*21*).

There is an emerging literature on urban freight policy, much of it focused on environmental impacts and regulation (*22*). Studies of specific policy examples include off-hours deliveries in New York (*7*), low emission zones (*23*), and the container fee program in Los Angeles (*24*). These studies have not reached a point of synthesis or general understanding of what policies are effective, and what conditions are required for effective implementation (*25*).

4. METHOD

Our synthesis is based on a review of the domestic and international literature (*25*). Our review includes journal publications, government reports, consultant reports, and unpublished papers and materials, resulting in 261 references of which 108 are academic papers and scientific books. We believe this review to be fairly comprehensive regarding academic publications in English, as it results from a search in the main publication databases covering transport engineering, transport geography, transport economics and logistics as well as transport planning. It matches the recent literature review on city logistics by (*3*). Our review is focused more on local sources, such as freight data collection in specific cities or national reports from ministries and institutions. These sources were identified from various contacts or previous work. Our literature review was supplemented with communications from project sponsors and data collected from secondary sources. A full list of references is available in Giuliano et al, 2013 (*25*) and only the most significant ones have been referenced here. Our synthesis included: 1) an assessment of current knowledge on the impacts of freight in metropolitan areas; 2) a survey of mitigation strategies proposed, planned or implemented in metropolitan areas; 3) a discussion of the US governance and regulatory context; and 4) our evaluation of freight management strategies and their potential for implementation. In this paper we present an overview of mitigation strategies. We selected 63 practices based on their recurrence in the literature and, when available, their reported positive results. Half of them are from North America. The paper finally provides our assessment of the most promising strategies for broad implementation in the US.

5. RESULTS: BEST PRACTICES AND POLICY INITIATIVES

In response to growing urban freight problems, cities around the world have engaged in extensive experimentation. In this section we summarize findings, discuss effectiveness, and consider transferability to widespread implementation in the US.

We organize our discussion around three general categories of urban freight management problems: local last-mile/first-mile delivery and pick-up, environmental impacts, and trade node problems. Last mile strategies address local deliveries and pick-ups to or from urban businesses or residences (home deliveries). They aim towards making these trips more efficient. Strategies that reduce environmental impacts focus on reducing emissions and noise by regulation or offering incentives to use less polluting vehicles. Finally, we consider strategies related to trade nodes (i.e., cities that are hubs for national and international trade) where there are larges flows to and from ports, airports, or intermodal facilities.

5.1. Last mile strategies

One-third of urban truck traffic is goods pick-ups. The last mile (or rather miles) represents the final haul of a shipment to its end receiver, be it a shop, a business, a facility or a residence in case of home deliveries. (Collectively we will refer to these trips as the “last mile.”) Serving local businesses and residences in cities is inefficient for several reasons. First, product is often delivered from vendor to establishment, so a given establishment (say department store) may receive multiple deliveries each day. Small deliveries across many destinations generate complex routing problems. If deliveries could be consolidated across vendors, more efficient routing and fewer trips would be possible (*26*). Second, deliveries may be restricted to certain routes or time periods, adding additional constraints on routing and scheduling. Restrictions on night deliveries, or the reluctance of urban business owners, force more trips to take place during peak hours, adding to congestion. Third, home delivery is inefficient due to the small size of products, the spatial dispersion of residences, competition within the local delivery industry, and the frequency of failed deliveries (*27*).

European cities face more serious local delivery problems than US cities because of their older built form, higher average density, and greater share of small and independent businesses. European cities also have the apparent advantage of more regulatory control over truck access and roads. It is therefore not surprising that the majority of last mile experiments have come from overseas - Europe in particular. In the US, the few domestic policy experiments that do exist (like clean truck programs and off-peak deliveries) come from either of the two largest trade node cities: New York and Los Angeles. Other North American cities' freight initiatives tend to center on new or improved infrastructure (such as grade separations, added highway capacity, or logistics parks) rather than operational changes

The main types of last miles strategies and some examples of each are presented in Table 1. The main sources of information are (*7, 23, 28-30*). Table 1 clearly illustrates the preponderance of examples coming from outside the US.

[TABLE 1]

5.1.1 Labeling or other certification programs

Certification and labeling programs are examples of voluntary regulation. The public sector negotiates with private industry to develop a set of voluntary targets or operating rules that confer either recognition or special benefits like flexible delivery hours. Certification and labeling programs include the various "green" certification programs that promote use of cleaner vehicles, cleaner fuels, or operations during less congested periods of the day. Effectiveness depends on how much 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 including public and private stakeholders. Two well-known Freight Forums, in London and Paris, resulted in detailed Freight Plans.

The certification programs we reviewed 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 the large shippers are more capable of negotiating program conditions with public sponsors, and hence programs may be designed to the advantage of larger shippers. 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, as more clients place value 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.

Voluntary regulation is a good fit with the US context of decentralized governance and dispersed regulatory authority. In cases where direct regulation is either impossible (due to lack of authority) or infeasible, voluntary regulation may be the best available alternative.

5.1.2 Traffic and parking regulations

City efforts to manage last mile problems have 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 are limited tools for managing last mile problems. 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 supply of loading and parking areas, enforcement becomes costly and increasingly difficult, as the risk of being cited becomes less costly than the delays incurred in waiting for a parking spot.

Traffic and parking regulations have a mixed record of success. Restrictions on truck access or the limit of 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 both US and international examples is that local freight demand must be accommodated, hence strategies that *manage* rather than *restrict* freight deliveries tend to be more effective.

5.1.3 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. With increased development in city cores and more frequent deliveries for each business, freight demand has increased, while the scarcity of road and curb space, as well as ever higher land values, increase the cost of managing demand. New development or redevelopment offers the opportunity to implement planning standards for on-site freight facilities. 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. 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 the US context, where the authority of local governments to develop and implement planning and building guidelines is clearly established. The ability to negotiate through the zoning and approval process allows for flexibility in enforcement and is widely accepted.

5.1.4 City logistics and consolidation programs

Consolidation programs seek to reduce truck traffic by finding ways to combine pickups and deliveries of different shippers or difference receivers. They 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, e.g. on the end of the chain, such as pick-up centers for online purchases. These common pick-up points reduce home deliveries (truck trips) but their impact on private vehicle trips is unknown and depends on how consumers access these 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 pick-ups). 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. Although shippers may benefit from the lower costs of consolidated deliveries, whether these benefits would offset the rental and added labor costs of trans-loading is unclear. In the many European experiments, consolidation centers were not feasible without public subsidies and many have since closed.

The transferability of consolidation schemes to the US context is limited. The required subsidies to freight operators would be politically difficult, even if local jurisdictions had the funding to provide. Any effort to force consolidation in the US via regulation (as in several European cities) would be very difficult due to interstate commerce laws.

5.1.5 Off-hours deliveries

Off-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. Constraints on the trucking side include federal hours of service requirements, shift premium pay for unionized drivers, and possible efficiency losses associated with spreading shipments out across more hours of the day. Constraints on receivers include having to open receiving facilities early and to operate loading terminals more hours of the day, shift premium pay for terminal workers, and local zoning codes that prohibit after hours truck activities in residential neighborhoods.

There is only one permanent off-hours program in the US, the PierPass program at the Los Angeles/Long Beach ports. It was implemented due to unique circumstances that do not exist in other US 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. Off-hours delivery may have potential as a voluntary regulation. Shippers might be incentivized to purchase and use quieter trucks and handling equipment in exchange for being able to deliver off-hours.

5.1.6 Intelligent Transport Systems (ITS)

The use of ITS for monitoring or managing urban freight include technologies for providing real-time traffic (and parking) information, automated enforcement of parking or traffic regulations, toll collection, or automated access control. Use of ITS for monitoring truck traffic via license plate readers and other devices is extensive outside the US. Automated monitoring systems involve high upfront costs, and tend to be used either as part of road pricing systems or limited access zones. Once implemented, automated systems make possible continuous, low cost enforcement of tolls or access zones, and thus can be very effective.

Transferability in the US depends on the perceived acceptability of the policies to be implemented. So far, security at limited access facilities has proven to be an acceptable justification for semi-automated monitoring. The use of tolls to manage congestion in metropolitan areas is not yet widely accepted. The New York City congestion pricing proposal is illustrative; it included truck tolls that could be discounted by using clean trucks, and studies indicated that congestion and emissions reductions would be substantial. However, we expect that tolls will become more acceptable as congestion increases and funding from traditional sources to support capacity expansion declines.

A second implementation challenge in the US is the general resistance to automated monitoring by public authorities. An illustrative case is the conflict surrounding cameras used to enforce red light violations at intersections. Monitoring could provide comprehensive data on truck movements, which is greatly needed for better analysis of urban freight problems. However, these data may be perceived as proprietary and resisted by trucking companies and shippers. Use of ITS for truck tolls or automated monitoring outside limited access facilities appears to have limited transferability to the US context.

5.2 Strategies to reduce environmental impacts

Strategies to reduce environmental impacts seek to reduce truck emissions and energy consumption by improving engine performance, shifting to cleaner (and quieter) conventional diesel trucks or alternative fuel trucks, or shifting freight to more energy efficient modes. Our review makes clear that strategies that address the entire commercial fleet have the most impact, even if the impact is small on a per vehicle basis. Strategies that impose substantial costs on private industry will not be adopted unless industry is forced to do so, and strategies that seek to shift freight from trucks to slower modes are not attractive to industry without large subsidies, and may have little impact on emissions or energy consumption. Strategies to reduce environmental impacts are summarized in Table 2. The main sources of information are (*21, 23, 32-36*).

[TABLE 2]

5.2.1 Truck fuel efficiency and emissions standards

Truck fuel and efficiency standards have been demonstrated to be one of the most effective tools for reducing emissions. The recent changes in light truck CAFÉ 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. The Los Angeles/Long Beach ports' Clean Truck Program is by far the most ambitious emissions reduction program in the US, and in four years led to large reductions in diesel truck emissions. We expect fuel efficiency and emissions regulations to continue to be one of the most effective tools for reducing air pollution and CO_2 emissions in metro areas.

5.2.2 Alternative fuels and vehicles

Alternative fuel vehicles (AFVs) have been widely promoted in the US, but have achieved little market penetration due to higher capital and operating costs, the complexities of operating diverse fleets, limited range, and lack of fueling infrastructure. 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 we noted experiments with smaller AFVs, such as small vans and "cargo-cycles" for local deliveries. Niche markets may exist in the most dense US city centers (New York, Chicago, Boston), depending on the costs (labor, new vehicles) relative to conventional vans or small trucks. Lack of a potentially large market suggests that these strategies would have little impact on emissions reductions.

5.2.3 Low Emission Zones (LEZs)

Low emissions 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 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 re-organization of the local trucking industry into larger and hence more efficient operations (we note that whether LEZs generate net benefits is uncertain, as the elimination of small operators would eliminate jobs and small businesses.).

Although a potentially effective strategy, the transferability of LEZs to the US context is low. In the absence of jurisdictional authority, a LEZ would have to be established as a voluntary program.

5.2.4 Alternative modes

Efforts to shift truck freight to slower but more energy efficient and cleaner modes have not been successful. Experiments in Europe using 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. Waterborne freight in the US continues to lose market share.

Mode shifting has large impacts on the supply chain. In order 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. In addition, mixing modes adds to the number of times shipments must be handled, further increasing labor and facility costs. The most promising segments for mode shifting are through freight traffic (port or airport imports/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.

5.2.5 Community environmental mitigation

The US has taken the lead in the incorporation of environmental justice as a performance measure for new freight projects. In part this is due to the socio-geography of US 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 of 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 SCAG's Toolkit for Goods Movement, New York City's truck impact study, and Baltimore's industrial overlay zone study.

US 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.

5.3 Trade node strategies

Trade hubs and gateways – places with large ports or airports, intermodal transfer points, or border crossings – are the focus of freight flow associated with national and international trade. Trade hubs share the same "last mile" issues addressed in previous sections such as truck and van delivery and access issues, evening and weekend vehicle movements, and incompatible land uses. However, trade 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 have pushed distribution centers (DCs) and warehouses to the periphery of metropolitan areas. These facilities generate freight-related activity that may pass through the urban core on their way from ports and airports to markets outside the region.

Unlike the last mile and environmental strategies outlined above, the majority of trade node strategies have been developed and tested in the US context. The largest trade nodes – in particular Southern California – have had the greatest influence in the development of strategies to address environmental problems. In the Southern California gateway, the threat of legislative mandates and rising trade volumes created a unique set of conditions that favored an industry-driven response to environmental pressures. The question is whether the same conditions exist in other places in the US. Both political pressure and competitive pressures exist in other parts of the world, but it is apparent from the research that the two in combination drive the environmental agenda in trade gateways. In the US, where good intermodal connections encourage the development of pass-through traffic transited through transload centers, the gateway plays a pivotal role in framing the debate surrounding the environmental impacts of trade. Trade node strategies are summarized in Table 3. The main sources of information are (*7*, *24*, *37*-*45*).

[TABLE 3]

5.3.1 Appointments and pricing strategies at ports

These strategies attempt to spread the flow of truck traffic passing through terminal gates across more hours of the day. Appointments have been implemented at several ports. They have the potential to increase the efficiency of port operations and therefore reduce truck turn times (hence reducing truck idling), but 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 was intended to reduce road congestion and it proved successful at shifting a significant amount of eligible cargo to the evening (approximately 40%). No other US metro 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, including distribution centers and retail establishments which presumably also operate on more traditional work schedules. The net benefits at the system level are not yet proven.

5.3.2 Road pricing and dedicated truck lanes

Despite the demonstrated effectiveness of congestion pricing in the few places where it has been implemented, pricing strategies in the US continue to be difficult to implement. There is more use of pricing strategies in Europe and Asia compared to the US, and at least a few examples of truck pricing, notably the weight-distance fees in Switzerland, Austria and Germany, and the cordon pricing scheme in London. There are numerous proposals for truck tolls in the US, including the New York bridge toll plan, and proposed tolled truck lanes in Atlanta, and in 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. The trucking industry argues that they already pay their "fair share" for using the roadways, and additional charges would reduce their competitiveness with rail. From an environmental perspective, if trucking generates more emissions per ton of freight carried, this shift would be socially beneficial despite the negative impact on the trucking industry. Despite their promise for managing congestion, implementation of pricing strategies will require extensive education and political leadership.

A second strategy (often linked with tolls to offer a funding mechanism) is truck-only lanes. They have been proposed in major metropolitan areas (most notably Atlanta) and included in regional transportation plans. They have failed due to lack of funding as well as a scarcity of land. Truck lanes are costly to build due to pavement and geometry requirements, and can rarely be justified on the basis of truck volumes. Given the fiscal constraints facing the US highway system, truck-only facilities do not appear to be a promising option for dealing with truck traffic.

5.3.3 Accelerated truck emissions reduction programs

Given the success in the US of national regulation to increase fuel efficiency and decrease emissions, a logical extension is to accelerate the introduction and use of cleaner vehicle at trade nodes. Several US ports have "clean truck" programs, which are intended to accelerate the use of cleaner diesel and alternative fuel vehicles in drayage trucking. The most aggressive effort is the Clean Truck Program (CTP) at the Los Angeles/Long Beach ports (*45*). 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. As voluntary, negotiated programs, they are a good fit in the US context.

5.3.4 Equipment management

Another potential source of reducing truck VMT is to use port-related freight equipment – chassis and containers – more efficiently. Ownership practices result in many extra trips for truckers, because they are required to match containers with the same owner's chassis. If management practices are modified by the owners, it becomes possible to share containers and chassis, reducing VMT associated with these movements. Equipment owners are motivated to experiment with different models due to the growing standardization of equipment characteristics (and therefore the declining value of branding one's own equipment), the costs of owning equipment that is idle much of the time, and the costs of storing equipment at land facilities. Public sector assistance may be necessary to assist with land assemblage for shared equipment facilities, and to sponsor studies.

Shared equipment offers a promising way to reduce truck trips while increasing the efficiency of port-related freight operations. Since it is industry motivated, it is a good fit in the US context.

5.3.5 Rail strategies

Efficient rail and intermodal facilities are critical to international trade. High volume rail corridors conflict with surface road traffic at at-grade rail crossings, and conflict with passenger commuter rail traffic. The main trade node city strategy to address these problems is capital investment to increase rail capacity and to eliminate at-grade rail crossings.

The major challenge to capital investment strategies is the lack of an obvious funding source. Railroads have little incentive to incur costs to solve a problem for road transport, and hence are typically unwilling to pay. Local jurisdictions have no authority to force railroads to incur these costs. They also have little incentive to pay, as they view the rail traffic as a national responsibility. At the national level there is no specific funding source for such projects.

5.3.6 Border crossings

Border crossing regions are a unique subset of trade nodes. Like port regions, border crossings generate truck traffic destined for local distribution or transfer facilities as well as markets beyond the immediate metropolitan area. This means "last mile" impacts as well as the pass-through impacts previously discussed. Border crossings provide a unique challenge with regard to managing regional freight capacity however because of the international context.

The US-Canadian border has provided a useful test bed for researchers investigating both the institutional and technological framework for freight flows across borders. In Washington State, the FAST Corridor was designed and supported by the USDOT, the state of Washington, the Puget Sound Regional Council, the three ports, three private freight carriers, 12 local cities and three counties. The FAST Corridor members identified highway/rail crossings as the most pressing concern, and proposed as a first phase, 15 projects: 12 grade separations and three truck access projects totaling $470 million.

US-Mexico border crossings, in many ways, operate in a more complex and uncertain environment. While the North American Free Trade Agreement (NAFTA) and other institutional and regulatory reforms have been designed to improve cross-border freight flows for the US, Canada, and Mexico, the lack of a truly open border results in further delays at crossings as goods are unloaded and reloaded on different vehicles on opposite sides of the gate. This has created a demand for technology-based solutions.

6. RECOMMENDATIONS

6.1 Urban freight management strategies

Our review and assessment suggests some promising options for better management of freight in US cities and metropolitan areas. Our findings are summarized in Table 4. The second column is our rating of effectiveness based on the literature as discussed in Section 5 above (*25*). The last column is our rating of applicability in the US context: given US institutional and governance structures, to what extent could such a strategy be implemented? The ratings for applicability were based on our judgment. The US context is quite different from that of Europe, and other developed parts of the world. For example, many aspects of urban freight are protected by interstate commerce, limiting the ability of local or state governments to regulate. There are also different perspectives on the extent to which private industry should be subsidized in order to achieve social benefits. Among the last-mile strategies, labeling and certification programs, land use planning (in the longer term), and off-hours deliveries are the most effective strategies. However, off-hours delivery programs are less transferable due to the many changes they require across the supply chain. Traffic and parking regulations are less effective, because they do not have an impact on the underlying demand for freight moves. We rate ITS strategies as medium due to their limited implementation feasibility and the need for more development of some of the most potentially beneficial applications, such as truck parking and loading information systems.

Within the category of environmental strategies, global fuel efficiency and emissions regulations have proven their effectiveness over several decades. Low emissions zones are the most effective to address local hot spots, but do not appear to be feasible under current national and state US policy. Alternative fuel vehicles may prove to be very effective long term, but the technology and market penetration are not sufficient to achieve significant reductions in emissions or energy consumption. Environmental justice efforts are more advanced in the US than in other countries; however environmental justice problems are challenging to solve.

Among the trade node strategies, pricing and accelerated emissions programs are among the most effective strategies. Despite the effectiveness of pricing, we rate it low on applicability because of the continuing strong political opposition from various stakeholder groups. Accelerated emission-reduction programs based on negotiation and voluntary targets have proven to be effective and are a better fit in the US context. Rail strategies can be effective, but involve high costs for which funding sources are not obvious.

[TABLE 4]

6.2 Future research needs

There are many opportunities for further research. First, most cities cannot answer the following questions: How many vehicles (be it a heavy-duty truck, a light-duty truck, a van, a car, or even, a bike) are engaged in freight transport activity? How many deliveries and pick-ups occur in a day, a week? Data accessible to planners and researchers on delivery characteristics is almost non-existent. Without these data it is hard to confirm or refute conventional wisdom such as, the rise of e-commerce means a net increase in commercial VMT.

Additionally, we find there is much research on system optimization, but little on how optimization methods work in practice. We need better data on, for example, real time route optimization that is based on actual fleet movements. Border crossings are a case in point. Similarly, the need for field tests in the area of technology deployment is great.

Second, one of the biggest problems associated with urban freight is truck emissions, and our review showed the many different approaches being taken to address this problem. We have limited information on the relative benefits and costs of certification systems or Low Emissions Zones (LEZs). Research is needed to better understand the effectiveness of these strategies. For example, in the case of LEZs, a) what are the costs associated both in terms of the government and logistics firms, b) what is the impact on trucking industry, c) are LEZs legally possible in the US, and if so, at what level of government?

Finally, there is a need for careful and systematic evaluation of existing policies and experiments. We are lacking 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.

7. ACKNOWLEDGEMENTS

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8. REFERENCES

1. Ambrosini, C. and Routhier, J.L. (2004) “Objectives, Methods and Results of Surveys Carried out in the field of Urban Freight Transport: An International Comparison,” Transport Reviews, 24:1, 57-77.
2. Transportation Research Board (2003) A Concept for a Freight Data Program. Special Report 276. Washington DC: Transportation Research Board.
3. Wolpert, S. and Reuter, C. (2012) Status Quo of City Logistics in Scientific Literature. Systematic Review. Transportation Research Record 2269, 110-116.
4. Chassiakos A., Dessouky, M. and Ioannou, P. (2010) “Selected papers from the second national urban freight conference, Long Beach, California, December 2007”, Transportation Research Part E, 46:4, 481-562.
5. Dessouky M., Giuliano, G. and Moore, J. (2008) “Selected papers from the National Urban Freight conference,” Transportation Research Part E, 44:2, 181-332.

6. Sonntag, H. (1985) "A Computer Model of Urban Commercial Traffic, in Transport", Policy and Decision Making, 3 (2).
7. Holguín-Veras, J., Q. Wang, N. Xu, K. Ozbay and J. Polimeni (2006) "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, 40, 744-766.
8. Wang, Q. and J. Hu (2012) "Behavioral Analysis of Commercial Vehicular Mode Choice Decisions in Urban Areas" Transportation Research Record: (Forthcoming).
9. Kawamura, K. and Lu, Y. (2007) "Evaluation of delivery consolidation in US urban areas using a logistics cost analysis," Transportation Research Record 2008, 34-42.
10. Dablanc, L. (2012) "City Logistics," in Rodrigue, J-P., Notteboom, T. and Shaw, J. eds. The Sage Handbook of Transport Studies, London: Sage.
11. Dablanc, L., C. Ross (2012) "Atlanta: A Mega Logistics Center in the Piedmont Atlantic Megaregion (PAM)," Journal of Transport Geography, 432-442.
12. Rodrigue, J-P. (2012) "The Geography of Global Supply Chains: Evidence from Third Party Logistics," Journal of Supply Chain Management, 48:3, 15-23.
13. Rodrigue, J-P. and Notteboom, T. (2010) "Comparative North American and European Gateway Logistics: The Regionalism of Freight Distribution", Journal of Transport Geography, 18:4, 497-507.
14. Cidell, J. (2010) "Concentration and decentralization: the new geography of freight distribution in US metropolitan areas", Journal of Transport Geography, 18:3, 363-371
15. Hesse, M. (2008) The City as a Terminal: The Urban Context of Logistics and Freight Transport, Ashgate.
16. Hesse, M. and Rodrigue, J-P. (2004) "The transport geography of logistics and freight distribution," Journal of Transport Geography, 12:3, 171-184.
17. Cambridge Systematics (2005) An Initial Assessment of Freight Bottlenecks on Highways. October 2005. Available at: http://www.fhwa.dot.gov/policy/otps/bottlenecks/bottlenecks.pdf.
18. Bryan, J., Weisbrod, G. and Martland, C. (2007) "NCHRP REPORT 586: Rail Freight Solutions to Roadway Congestion-Final Report and Guidebook", Washington D.C.: National Cooperative Freight Research Program. http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_586.pdf.
19. Bomar, M. A., Becker, E. P., and Stollof, E. R. (2009). Urban Freight Case Studies: New York. November 2009. Retrieved September 23, 2011. Available at: http://www.ops.fhwa.dot.gov/publications/fhwahop10019/fhwahop10019.pdf.
20. Peters, J. M. (2004) 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. Retrieved January 23, 2012. Available at: http://www.arb.ca.gov/research/apr/past/94-331a.pdf.
21. Cambridge Systematics (2010) Freight and Climate Change Background Paper for the Oregon Freight Plan. June 2010. Retrieved December 13, 2011. Available at: http://www.oregon.gov/ENERGY/GBLWRM/docs/FR1_ClimateChange.pdf?ga=t.
22. Danielis, R., Rotaris, L. and Marcucci, E. (2010) "Urban freight policies and distribution channels: a discussion based on evidence from Italian cities," European Transport/Trasporti Europei, 46, 14-146; Melo, S. and Macharis, C. (Ed.) (2011) City Distribution and Urban Freight Transport, Multiple Perspectives, NECTAR Series in Transportation and Communication.
23. Dablanc, L. (2008) "Urban Goods Movement and Air Quality, Policy and Regulation Issues in European Cities," Journal of Environmental Law, 20:2, 245-266.

24. Giuliano, G., T. O'Brien (2008) "Extended gate operations at the Ports of Los Angeles and Long Beach: a preliminary assessment," Journal of Maritime Policy and Management, 35:2, 215-235.
25. Giuliano, G., O'Brien, T., Dablanc, L. and Holliday, K. (2013) "NCFRP Project 36(05) Synthesis of Freight Research in Urban Transportation Planning," Washington D.C.: National Cooperative Freight Research Program (forthcoming)
26. OECD (2003) Delivering the Goods, 21st Century Challenges to Urban Goods Transport, OECD Publishing.
27. Xing, Y., Grant, D., McKinnon, A. and Fernie, J. (2010) Physical Distribution Service Quality in Online Retailing, International Journal of Physical Distribution and Logistics Management, 40:5.
28. SUGAR (2011) *City Logistics Best Practices: a Handbook for Authorities*. European Commission, INTERREG Program, SUGAR Project, final publication. 272p.
29. Palmer, A. and Piecyk, M. (2010) Time, cost and CO_2 effects of rescheduling freight deliveries. Presentation at the *15th Annual Logistics Research Network Conference.* http://www.greenlogistics.org/SiteResources/15thLRN/Palmer%20and%20Piecyk.pdf Retrieved April 9, 2012.
30. Ville, S., Gonzalez, J., Dablanc, L. (2012) The limits of public policy intervention in urban logistics: lessons from Vicenza (Italy). *European Planning Studies*, DOI:10.1080/09654313.2012.722954, 1-14. Bestufs (2007) *Good Practice Guide on Urban Freight*. Available at: http://www.bestufs.net/gp_guide.html. Retrieved February 5, 2012.
31. MIG, ICF International, UltraSystems (2009) *Healthy Economies and Healthy Communities: A Toolkit for Goods Movement*. Report for California State Department of Transportation, Los Angeles County Metropolitan Transportation Authority, Riverside County Transportation Commission, San Bernardino Associated Governments. http://www.metro.net/projects/mcgmap/goods_evironmental_justice/ Retrieved April 9, 2012.
32. O'Brien, T. and Giuliano, G. (2012) Contested Trade and Policy Responses in Southern California. Chapter 11 in Hall, P. and Hesse, M. (Ed.) *Cities, Regions and Flows*, Routledge Publishers, U.K.
33. US Department of Energy (USDOE) (2010) *Clean Cities' Guide to Alternative Fuels and Advances Medium- and Heavy-Duty Vehicles*, 40p. Available at http://www.afdc.energy.gov/pdfs/47984.pdf. Retrieved October 26, 2012.
34. Goevaers, R. (2011) PIEK low noise equipment, off peak hours transport. Presentation at the Transportation Research Board Annual Meeting, January, Washington, DC.
35. Maes, J., Vanelslander, T. and Sys, C. (2011) Low emission zones in Europe: their impact on sustainability and logistics, *4th METRANS national urban freight conference*, Long Beach, USA, October.
36. Dablanc, L. (2009). *Freight Transport, A Key for the New Urban Economy, Report for the World Bank as part of the initiative Freight Transport for Development: a Policy Toolkit*, 52p. Retrieved January 20, 2012. Available at: http://siteresources.worldbank.org/INTTRANSPORT/Resources/336291-1239112757744/5997693-1266940498535/urban.pdf.
37. Davies, P. (2009) Container Terminal Reservation Systems (Power Point Presentation) Presented to the 3rd National Urban Freight Conference, Long Beach. Retrieved February 10, 2012 from http://www.metrans.org/documents/2009%20NUF/Presentations/Davies.pdf

38. Goodchild, A., Albrecht, S. and Leung, L. (2010) Free and Secure Trade Commercial Vehicle Crossing Times at the Pacific Highway Port of Entry. Journal of Transportation Engineering, 136, 932.
39. Mu, S., and Dessouky, M. (2011). Scheduling Freight Trains Traveling on Complex Networks. Transportation Research Part B,45, 1103-1123. doi:10.1016/j.trb.2011.05.021
40. Le-Griffin, H.D. and Murphy, M., Container Terminal Productivity: Experiences at the Ports of Los Angeles and Long Beach. Presented to the 1st National Urban Freight Conference, Long Beach, CA. Retrieved February 12, 2012 from http://www.metrans.org/nuf/documents/Le-Murphy.pdf
41. Roorda, M., Woudsma, C., Abdulhai, B., Smith, C. (2007) Exclusive Truckways: Exploring Potential in Canada's Heartland. (Power Point Presentation) Presented to the 2nd National Urban Freight Conference, Long Beach. Retrieved from http://www.metrans.org/nuf/2007/documents/Roorda.pdf
42. Woudsma, C., Hall, P., and O'Brien, T. (2009). Innovation and Stakeholder Collaboration in West Coast Gateways: An Analysis of the Seaport and Freight Movement Industries. Report Prepared for the Asia Pacific Foundation of Canada. Retrieved January 30, 2012, from http://www.asiapacific.ca/sites/default/files/filefield/Innov_repor.pdf
43. Giuliano, G. and O'Brien, T. (2007) "The terminal gate appointment systems at the Ports of Los Angeles and Long Beach: An Assessment", Transportation Research D, 12(7), 453-528.
44. Giuliano, G. and O'Brien, T. (2008) "Extended gate operations at the Ports of Los Angeles and Long Beach: A preliminary assessment." Maritime Policy and Management 35(2), 215-235.
45. Giuliano, G. and Linder, A. (2011) Regulation and response at the San Pedro Bay Ports, METRANS Research Report 08-06, Draft Report. Available at www.metrans.org.

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TABLE 2 Last mile strategies

Strategy	Location	Description
Consultation processes and certification schemes	London	Freight Quality Partnership
	London	Freight Operator Recognition Scheme
	Paris	Delivery Charter
	Netherlands, 25 cities	PIEK label program
Traffic and parking regulations	Paris	Daytime hours truck ban (over 29 square meters)
	Sao Paulo	Access two days/week/vehicle
	New York City	Commercial Vehicle Parking Plan
	Barcelona	Off-peak hours use of roadways for unloading/loading
	Los Angeles downtown	Increased enforcement of use of loading bays
	San Francisco	Demand dependent parking charges
Intelligent Transport Systems (ITS)	Several European and Asian cities	Automatic control systems for truck access regulation
	London	Transport for London Freight Website
	Europe	DHL Packstation and USPS Gopost: automated self-service parcel delivery lockers
Planning strategies	Tokyo	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
	Barcelona	Minimum 5 sq. m. storage for new bars, restaurants
	Paris	Technical guide to delivery bays for the City of Paris design guide for on-street loading bays
Consolidation schemes and measures targeted towards urban supply chains	Paris	Urban Logistics Spaces: subsidized rental rates for freight storage in municipal parking garages
	Europe	Kiala network: pick-up points for home deliveries
	Bristol (UK), Motomachi (Japan), Cityporto (Italy)	Urban Consolidation Centers
	London	Construction Consolidation Center
Off-hours deliveries	New York City	2009-2010 experiment, focus on receivers
	Los Angeles/ Long Beach	PierPASS off-peak program

TABLE 3 Strategies to Reduce Environmental Impacts

Strategy	Location	Description
Truck fleet emission standards	California	CARB truck, diesel particulate filter standards
	US	EPA 2011 truck CO2 emissions and fuel efficiency standards
Low Emission Zones (LEZs)	Greater London	Low Emission Zone: access restrictions on old trucks and large vans
	Milan	Historic center truck regulations
	Swedish, Dutch and Danish cities	Regulations based on Euro standards
Alternative fuels, electric delivery vehicles	London, Milan	Congestion charge exemption for AFVs
	US cities	Delivery company use of alternative fuel trucks and vans
	European Cities	Electrically assisted Cargo Cycles
	France	Program to group purchases of electric vans for commercial fleets for public administrations
	Los Angeles/ Long Beach Ports	CAAP Technology Advancement Program (TAP)
Promotion of alternative modes/Cargo diversion	US	USDOT (MARAD) Marine Highways/Short Sea Shipping Grant program
	San Francisco Bay Area	FedEx BART pilot program
	Paris	Cargotram, Monoprix rail, and waterways deliveries projects
	Dresden	CargoTram
Restriction on truck idling	California	Five minute limit on diesel truck idling
	US	Truck-stop electrification
Delivery noise reduction	Netherlands	PIEK research, development and regulation program
	Atlanta	ASTROMAP
Environmental justice, community mitigation measures	Greater Los Angeles	SCAG Toolkit for Goods Movements
	County of Riverside	Truck Routing and Parking Study
	New York City	Truck Route Management and Community Impact Reduction Study
	Baltimore	Maritime Industrial Zone Overlay District
	Europe	Freight villages
	Atlanta	Regional Commission's Freight Studies
	US	EJ Guidelines Publications (NCHRP 320, NCFRP 13, 14)

TABLE 4 Trade node strategies

Strategy	Location	Description
Congestion pricing: Marine terminal gates	Los Angeles/ Long Beach Ports	PierPASS off-peak Program
	Vancouver	Off-peak gate program
	Busan	Evening gate program
Congestion pricing: Road pricing	New York City	Proposed pricing
	Europe	Truck VMT pricing
Truck reservation and appointment system	Ports of LA, Long Beach and Oakland	AB 2650
	Port of Vancouver	Reservation system
Lane separation/ Truck only lanes	Georgia	Statewide truck only lanes (proposed)
	South Boston, Southern CA, Port of New Orleans	Short distance/truck only access roads
Elimination of at-grade crossings	Los Angeles	Alameda Corridor
	Greater Los Angeles	Alameda Corridor East
	Chicago	CREATE
	Seattle	FAST program
Border crossing delays	Washington State	FAST Corridor
	US/Mexico Border Crossing	Pilot Program
Accelerated emissions reduction	Los Angeles/ Long Beach Ports	Clean Air Action Plan Clean Trucks Program
	Port of Vancouver	Truck Licensing Program
	New York and New Jersey, Seattle, Oakland	Voluntary truck emissions programs
Equipment management	New York and New Jersey, Oakland	Virtual Container Yards
	Worldwide	Industry driven Chassis Pools

TABLE 5 Summary of strategies, their effectiveness and applicability to the US

	Strategy	Effectiveness	Applicability to US
Last-mile	Labeling or other certification programs	High	High
	Traffic and parking regulations	Medium	High
	Local planning policy	High	High
	City logistics and consolidation programs	Low	Low
	Off-hours deliveries	High	Medium
	Intelligent Transport Systems (ITS)	Medium	Medium
Environment	Truck fuel efficiency and emissions standards	High	High
	Alternative fuels and vehicles	Low	Medium
	Low Emission Zones (LEZs)	High	Low
	Alternative modes	Low	Low
	Community environmental mitigation	Medium	High
Trade node	Appointments and pricing strategies at ports	Medium	High
	Road pricing and dedicated truck lanes	High	Low
	Accelerated truck emissions reduction programs	High	Medium
	Equipment management	Medium	Medium
	Rail strategies	Medium	Medium
	Border crossings	Medium	High

The Geography of Urban Freight

Geography of Urban Transportation, 4th Edition, Genevieve Giuliano and Susan Hanson (Editors)

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FREIGHT AND THE CITY

Urban freight is a very important but lesser known element of urban transportation. Cities commonly compete to attract economic activities and their logistical performance as well as the environmental impacts associated with urban freight activities are a factor of growing concern for public and private stakeholders.

Urban freight is defined as *the transportation of goods by or for commercial entities (as opposed to households) taking place in an urban area*. This definition includes all goods movements generated by the economic needs of local businesses, warehouses and activities such as deliveries and pick up of supplies, materials, parts, consumables, mail and refuse that a business generates in its operations. It also includes home deliveries to households, as they are generally done by means of a commercial transaction. Through traffic, namely trucks circulating in a city en route to another destination without serving any business or household of the city, is also part of urban freight. This definition does not include private transportation undertaken by people to acquire goods for themselves (shopping trips), although these activities can represent an important element of the transportation of goods. It has been estimated that in large French cities, shopping trips represent about half of the vehicle-miles related to the urban movement of goods (Routhier, 2013). There are no such data for the United States. The main reason why these trips are not considered is that they are combined with personal mobility and are using passenger vehicles.

Urban freight activities represent an important part of urban transportation in many respects. In terms of vehicle flows and traffic, the movement of goods represents 10 to 15% of vehicle equivalent miles travelled in city streets.[5] Freight transportation modes and terminals are important components of urban geography and interact and sometimes conflict with passenger transportation. Three to five percent of urban land is devoted to freight transportation and warehousing, but this figure can go higher in main port cities acting as gateways to large markets or at large inland hubs such as Chicago and Kansas City. Freight generates one delivery or pick-up per job per week and 300 to 400 truck trips per 1000 people per day, but such figures obviously vary according to income and economic function of cities (e.g. cities focusing on manufacturing as opposed to financial centers). Urban freight distribution is prone to a wide array of externalities, namely congestion, pollution and community disruptions. It represents a significant amount of the air and noise emissions that are generated by urban transportation: a quarter of CO2 emissions, a third of NOx emissions and half of particulate matters. This is due to the predominance of road transport (more than 90% of the tonnage) as well as the age of commercial fleets: trucks and vans in cities tend to be older than freight vehicles circulating over long distances.

[5] This data and the following result from a compilation of various sources, mostly European – see Giuliano et al., 2013; Routhier, 2013. Few sources are specifically from North America.

Urban freight is a key element to understand the economic geography of cities. This is all the more important as urban economies are evolving rapidly and with them the related supply chains. A city has always been an entity with concomitant and multiple production, distribution and consumption activities. More recent trends related to globalization and rising standards of living imply a higher intensity and diversity of this consumption (Rodrigue, 2004). To improve productivity, store inventory levels have shrunk and businesses are increasingly supplied on a just-in-time basis. This enables a higher intensity of usage of valuable retail space. The quantity and variety of retail goods have increased considerably and inventories change several times a year. With the rise of the service economy, the demand for express transport and courier services has soared. Additionally, E-commerce has increased the demand for home deliveries and new forms of urban distribution. These factors have made urban economies more dependent on freight transportation systems, with more frequent and customized deliveries. All this incites a greater intensity and frequency of urban freight distribution and correspondingly improved forms, organization and management.

Although urban freight appears to be an issue taking place at the local (urban, metropolitan) level, a comprehensive understanding of its drivers and dynamics requires the following considerations:

- A salient issue relates to urban freight distribution in the context of global supply chains as global processes are imposing local forms of adaptation to insure that freight is delivered in a timely and reliable fashion. Offshoring and outsourcing have also contributed to the setting of supply chains where freight distribution activities taking place within an urban area cannot be effectively explained by the regional economic structure (Hesse, 2008). These supply chains serve entire regions/countries and sometimes more (cities as trade nodes and hubs).
- As the distances involved in supporting global supply chains have increased, global freight distribution has taken a new significance, particularly with the setting of large terminal facilities such as ports, airports, rail yards and distribution centers. These terminals are

handling movements originating from, bound to or simply passing through a metropolitan area. With containerization as a tool supporting a growing share of international trade, intermodal terminals have become a notable element of the urban/suburban landscape. With the growth of valuable cargo carried over long distances, airports are also active nodes interacting with urban freight distribution. Along with their attached freight distribution facilities (e.g. transloading facilities and warehouses) large terminals form a fundamental element of the interface between global distribution and city logistics. This explains the phenomenal increase in the number of warehouses and freight centers in large urban areas in the recent decades (in the Atlanta metropolitan area alone, there are three times as many freight facilities in 2008 than in 1998; Dablanc and Ross, 2012).

- Global urbanization is compounding the challenges of urban freight and logistics since the share and the level of concentration of the global population living in cities is increasing. Cities present a variety of forms and levels of density, each associated with specific urban freight patterns. Socioeconomic factors, such as rising income and consumer preferences are also important drivers of urban consumption.

As a response to the increasing challenges met by the urban freight system, *city logistics* has emerged as a strategy ensuring efficient freight movements and innovative responses to urban customer and business demands (Dablanc, 2009). City logistics is involved in all the means over which freight distribution can take place in urban areas in an optimized manner, as well as in the strategies that can improve its overall efficiency, such as mitigating congestion, energy consumption and environmental externalities (Giuliano et al., 2013; Taniguchi and Thompson, 2008). The first applications of city logistics were dominantly undertaken in Japan and Western Europe. These metropolitan areas share the constraining commonality of the lack of available land as well as a strong tradition pertaining to urban planning.

City logistics is an emerging field of investigation. Up to the 21st century the consideration of freight distribution within the urban planning discipline remained limited. This implies that urban planning generally does not pay much attention to issues related to urban freight distribution (Lindholm and Behrends, 2012). The mobility of urban passengers has been the dominant focus of researchers and practitioners. This is well reflected in comprehensive attempts to build a functional typology of urban transportation that have focused on passengers and public transit and which have largely overlooked freight transportation issues (e.g. Kenworthy and Laube, 2001). Strategies aiming at improving the mobility of passengers such as promoting urban transit, imposing restrictions on driving and developing high land use densities can even be in contradiction with freight distribution strategies in urban areas that rely upon trucking. Freight distribution should thus be considered an important component of urban mobility, but so far has been lacking in such analyses.

This chapter underlines the diversity in which urban freight distribution takes place and provides a review of the current trends in city logistics. Based upon the main challenges that have been identified, the chapter looks at the city logistics strategies and policies that have been implemented with various degrees of success. Since urban freight is dependent on the specific urban land use form, pattern and function in which it takes place, the chapter suggests a typology to classify global cities by their logistics systems and their city logistics initiatives, and underlines the need for performance metrics.

THE DIVERSITY OF URBAN FREIGHT DISTRIBUTION

City Functions and Urban Distribution

The city is jointly a place of production, distribution and consumption of material goods and will thus generate material flows (Figure 1). The role and extent of these functions vary according to the historical and socioeconomic context of each city, commonly involving a specialization (e.g. financial cities, manufacturing cities), with consumption being, nonetheless, an equalizing factor as it is now a dominant activity everywhere.

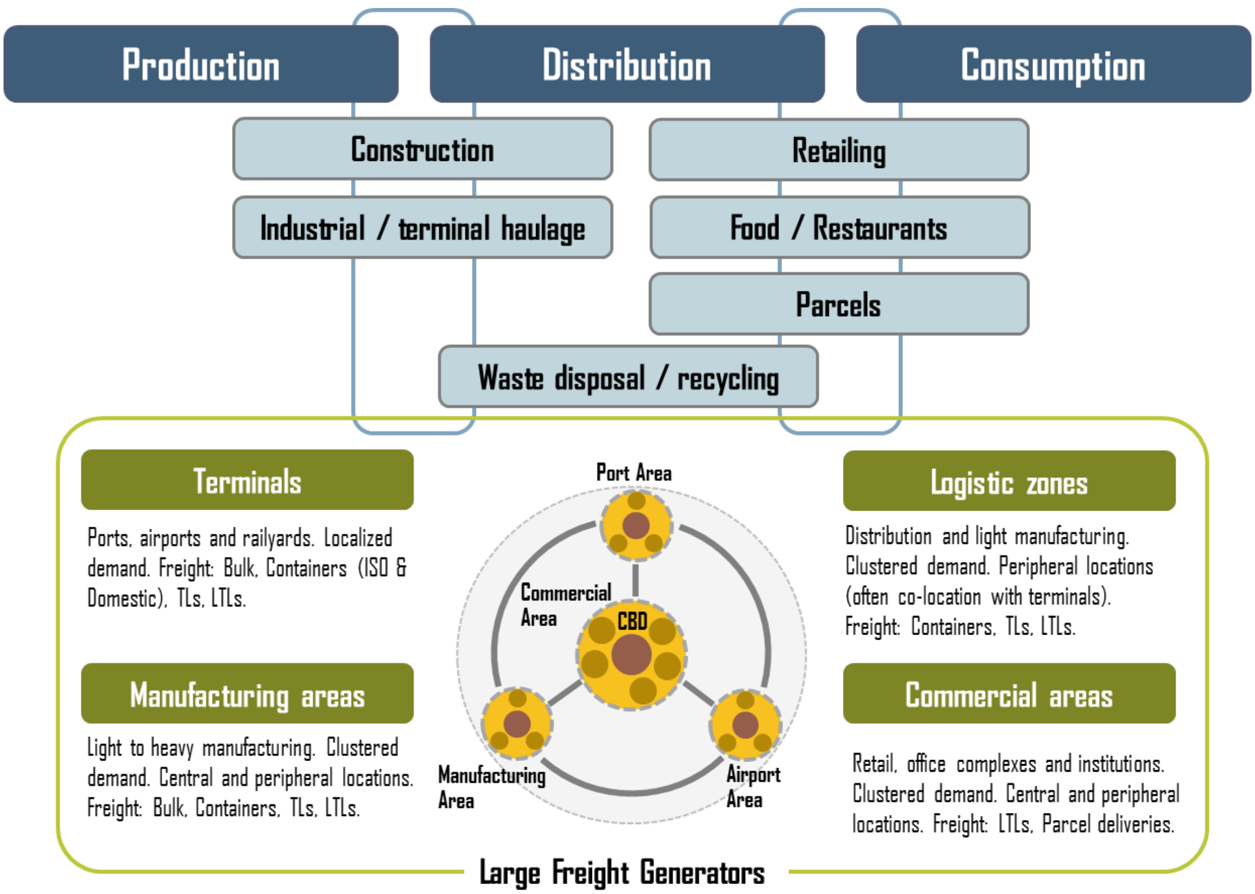

FIGURE 5 - CITY FUNCTIONS AND URBAN DISTRIBUTION

Globalization has changed the functions of production, consumption and particularly distribution by expanding its role with terminals and logistics zones. Some cities, namely global cities, have become prime financial, cultural, transportation and political centers, with production taking a more marginal role, but not logistics. With the growth of long distance trade, many of these cities play an intermediary role with their port and airport facilities articulating the commercial flows of vast markets. For instance, gateway cities are the interface between global and regional freight distribution.

The functions of consumption, production and distribution are associated with various types of material flows, each representing a form of city logistics. For instance, retailing relies on urban deliveries originating from distribution centers, which themselves are likely to have been supplied through terminal haulage. The intensity level of urban freight distribution is usually clustered around large specialized generators, which come in four major types:

- *Terminals*, such as ports, airports and railyards, are highly localized entities with access points often supporting high traffic levels. Since terminals handle a wide variety of freight, it can be expected that it will enter urban areas as bulk, containers, full truckloads (TLs) and less than truckloads (LTLs). The market area of transport terminals is defined as the hinterland, which can involve destinations (logistics zones and manufacturing districts) within the city itself or flows having to transit through urban areas on their way to other destinations. The impact of a transport terminal on city logistics is obviously related to the intensity of the terminal activity, the supply chain it services and the extent of its hinterland.
- *Logistics zones* include warehouses, sometimes associated with clustered distribution and light manufacturing activities. Higher consumption levels and global supply chains have been a driving force in the setting and expansion of logistics zones. Facilities are increasingly co-located, implying more efficient interactions because of proximity; freight has less propensity to enter

urban areas. High land prices near terminals and central areas have also incited the development of logistics zones in peripheral areas, sometimes far away.

- *Manufacturing areas*. In the contemporary setting many production activities are related to global processes and elements of global value chains since they may produce finished goods (requiring parts coming from all over the world), and more likely intermediate goods (e.g. parts). They are generators of producer-related urban freight movement involving all possible forms of road (sometimes rail) transport. Manufacturing districts are commonly found in association with transport terminals, particularly for heavy industry. Manufacturing and logistics activities are often mixed; standard manufacturing activities are common in logistics areas. The distinction between a logistics and a manufacturing zone can thus be blurred. For instance, many logistics zones were developed as industrial zones that attracted distribution centers instead.
- *Commercial areas.* Core component of the urban centralities (city centers and suburban sub-centers) and the destination of the bulk of urban passenger flows. They concern consumer-related freight movements, mostly through retail activities usually supplied through LTLs (e.g. delivery vans and trucks). The clustering of office towers and large institutions (seats of government, universities, museums, etc.) is also a large generator of freight demand such as parcels. Some central business districts also involve adjacent freight intensive activities such as rail yards and even port terminals, particularly in older cities or in cities having an important gateway function.

Urban freight generators are commonly interrelated. For instance, a port district will involve maritime terminals but also nearby distribution centers and industrial activities. The same applies to airport districts that can experience a concentration of distribution centers and commercial activities. Parcel and express deliveries are everywhere, especially since the growth of E-commerce has increased direct goods deliveries to residential areas.

Transportation and Urban Supply Chains

A supply chain involves all the activities necessary to satisfy a demand for goods or services such as raw materials, parts or finished goods. All urban economies involve a wide array of supply chains, each of various importance depending on the activity mix, urban setting and the level of development, but coming into two main functional classes. The first involves consumer-related distribution:

- *Independent retailing*. Urban areas have a notable variety of retailing activities, many of which define the commercial and social character of neighborhoods. There is a decreasing but still significant number of small single owner stores and in developing countries these retailing activities are often complemented by informal street markets and stalls. Supply is often organized by the store-owner (own-account logistics or direct relationship between a specific supplier and the store) and involves mostly small loads and hence small vehicles.
- *Chain retailing*. In the contemporary commercial landscape, especially in the U.S., chain retailing (stores directly affiliated to a common brand or franchised from this brand) have become a dominant element. Like independent retailing, chain retailing covers an extensive array of goods and types of stores. They are supplied by manufacturers that have extensively relied on global sourcing, through a complex chain of warehouses and distribution centers[6] (Figure 2). Chain retail outlets are located in central areas (and being a defining element of urban centrality) as well as in suburban and peri-urban areas (such as "big box" stores). Shopping malls are set on the principle of economies of

[6] A warehouse is a facility where goods are stored for periods of time, while a distribution center tends to store goods for short periods of time as orders are fulfilled, commonly on a daily basis. However, the word "warehouse" often stands for all sorts of logistics terminals, including distribution centers.

agglomeration and the provision of ample parking space. Chain retailing tends to rely on the expertise of third party logistics service providers to mitigate urban freight distribution challenges and to organize complex multinational sourcing strategies for mass retailers. Large stores are commonly accessed through dedicated delivery bays where they are resupplied on a daily basis through their own regional warehousing facilities.

- *Food deliveries*. Since most food products are perishable, a specialized form of urban distribution has been set to supply outlets such as grocery stores and restaurants. In the Paris region, the total daily number of deliveries made to cafés, restaurants and hotels is five times more important than the total number of deliveries made for all large supermarkets. In developing countries, outdoor or enclosed markets also take an important role in supplying urban populations with perishables. This may be linked with informal forms of distribution where food producers deliver their production to urban markets. Limited information is available about urban food consumption levels but high levels of spoilage are observed, in the range of 50% of all the food consumed (World Bank, 1999). Since food deliveries commonly involve perishable goods, the reliable transport of refrigerated goods (often referred as cold chain logistics) is an important component in improving this relatively poor performance.
- *Parcel and home deliveries*. The growth of retail and E-commerce and the setting of advanced services such as insurance, finance or corporate management (head or regional offices) are linked with a growth in the movement of parcels and courier. While some are serviced by local companies, large parcel carriers have established services covering the majority of the world's main commercial cities. They maintain a network of strategically located distribution centers where shipments are consolidated or deconsolidated. International shipments are often taken care of by parent companies, namely air freight integrators. Online shopping (for retail goods but also for groceries) has grown significantly as it represented about 8% of total retail sales in the US in 2013.

This trend is associated with the growth of home deliveries or deliveries within newly implemented networks of pick-up-points (14,000 Hermes drop-boxes in Germany, 19,000 local stores serving as pick-up-points in France in 2013). These deliveries can happen at unusual times (evening, week-ends) and in unusual neighborhoods (residential) for common carriers accustomed to delivering to businesses.

The second functional class of urban supply chains is related to producer-related distribution:

- *Construction sites*. Urban infrastructures, from roads and residences to office and retail spaces, are constantly being constructed, renovated and repaired. Such activities are intensive in material use, heavy equipment and must be supplied on an irregular basis both in terms of the time and location of the deliveries. This makes the planning of such deliveries an ad hoc process that is prone to local disruptions.
- *Waste collection and disposal*. Urban activities generate large quantities of waste, namely paper, paperboard, food, plastics, metals and glass. These materials must be collected and carried to recycling or disposal sites. In particular, recycling has become an important activity taking place in urban areas and involves specialized vehicles and dedicated pick-up tours. This means that this form of urban freight transportation can effectively be organized to minimize disruptions and improve its efficiency. As standards of living are increasing across the world, the amount of waste generated by cities has grown accordingly.
- *Industrial and terminal haulage*. Cities are zones of production as well as gateways for the circulation of goods, implying that significant quantities of truck movements are bound elsewhere. Large transportation terminals such as ports, airports and railyards are dominant elements of the urban landscape. From these facilities an extensive array of cargo is moved (drayed) to warehouses and distribution centers where shipments are processed then redistributed to markets (see Figure 2). Transport terminals and logistics

zones are therefore generators of goods movements that may impact urban circulation. Gate access at large intermodal terminals such as ports can lead to congestion (queuing) and local disruptions.

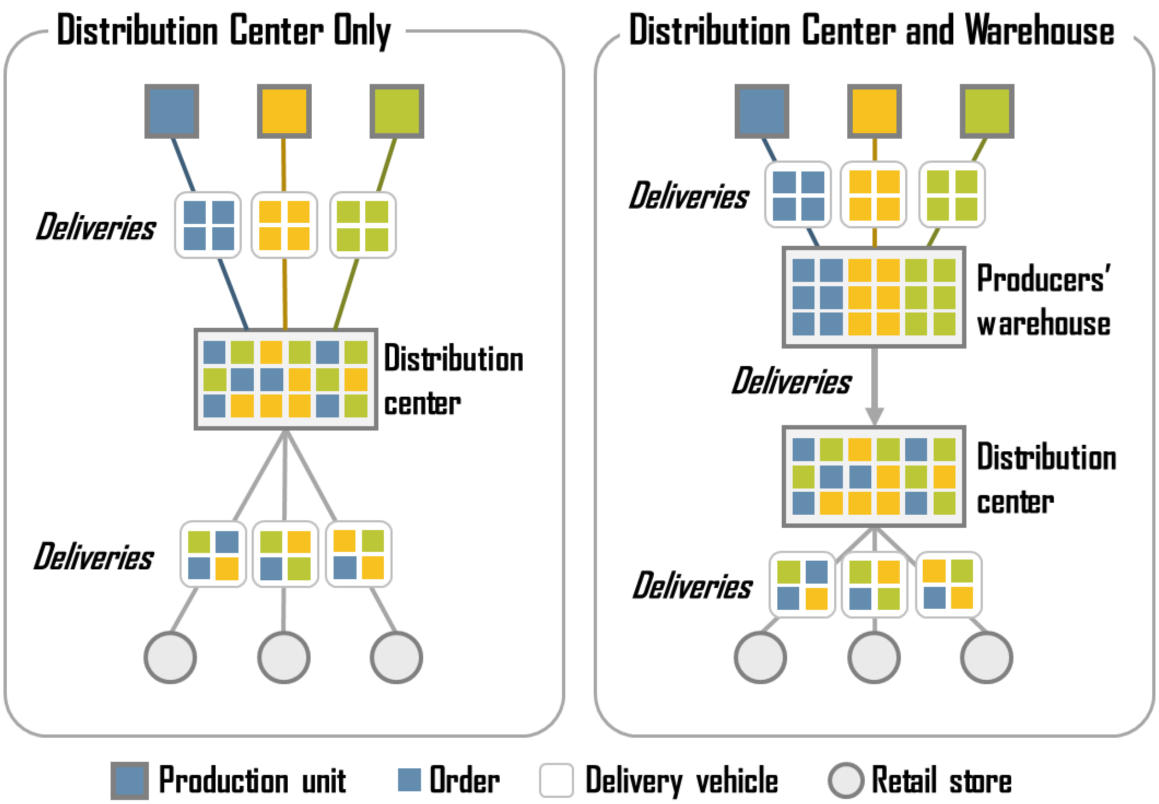

FIGURE 6: THE ROLE OF DISTRIBUTION CENTERS AND WAREHOUSES

Components of City logistics

There are three main components of urban freight and city logistics; the modes that carry the freight, the infrastructures supporting freight flows and the operations related to their organization and management. For instance, transport terminals, roads and distribution centers (including docking bays) are infrastructure components of city logistics. The same applies to scheduling, warehousing, parking and loading / unloading, which are operations components. Trucks remain the dominant mode supporting city logistics. The current dependence on trucks appears to be unsustainable in a growing number of urban areas because of the high level of externalities they impose, although rail and intermodal transportation are also generators of negative impacts in urban areas.

A major challenge for city logistics therefore involves a rebalancing where alternative modes and infrastructure, improved by novel forms of operations, would play a more prominent role:

- Infrastructure load shift. Attempting to shift a share of the infrastructure load away from the road; reducing the footprint of freight on urban roads. This can be done through the consolidation of cargo on trucks (higher load factor) or the use of facilities such as urban distribution centers. Intermodal terminals (ports, rail yards or airports) can also be used in city logistics.
- Operational improvements. Attempting to make urban distribution more productive and flexible, which commonly results in a better utilization level of modal and infrastructural assets.
- Modal shift. Attempting to increase the share of alternative modes. One alternative is the use of cleaner, more energy efficient trucks and vans or non-motorized vehicles such as cargo-cycles.[7] However such a shift is often accompanied with changes in the capacity and operational characteristics of vehicles and thus imposes a change in urban distribution practices. As their driving range is limited, electric vehicles also require nearby freight terminals where delivery tours are prepared. A more radical alternative is the use of waterways and railways for urban goods distribution. A few experiments have been carried out in European cities (London, Paris) involving large retailers. These schemes are expensive, as they involve additional transshipment operations.

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[7] Cargo-cycles are bi- or tricycles carrying a container of up to 1.5 cubic meters for the purpose of freight transportation. Recently developed cargo-cycles are electrically assisted.

Obviously, the nature and extent of this rebalancing is city specific, particularly since each city is supplied by an impressive variety of supply chains servicing a wide array of economic activities such as grocery stores, retail, restaurants, office supplies, raw materials and parts, construction materials and wastes (Routhier, 2013, Rhodes et al., 2012). The level and type of economic development determines the level of urban freight activity as income and consumption levels are interdependent. Because of the divergence in economic mix (and to a lesser extent built environments), each city around the world has different freight transport and logistics activities and level of intensity. This brings the question about the specific size threshold after which urban freight distribution problems, such as delays and congestion, become more prevalent thus requiring a concerted approach. Using the United States as evidence (data from TTI, 2011), it appears that congestion starts to be a serious issue once a threshold of about one million inhabitants is reached. For cities of less than one million, city logistics is less likely to be a problem and may be localized to specific areas such as the downtown or the port or other terminals area.

The unique and often non-replicable conditions of each city are influencing the nature and intensity of congestion in its urban freight distribution system. The share of public transit use, land use pattern and density and income levels in cities are common factors relatively unique to each country and even to some extent to each city.

Cities and Logistical Performance

The logistical performance of urban freight distribution requires a comparative framework and key performance indicators at the city level. However, such a framework does not yet exist. One has been compiled at the national level by the World Bank; the Logistics Performance Index (LPI)[8]. A value of less

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[8] The LPI is a composite measure ranging from 1 (worst) to 5 (best) based on six underlying factors of logistics performance: (1) efficiency of the clearance process by customs and other border agencies; (2) quality of transport and information technology infrastructure for logistics; (3) ease and affordability of

than 3 reflects an array of problems within a nation's freight distribution system causing undue delays and additional costs. While the LPI reflects global trade and supply chains, it can also be reflective, to some extent, of the logistical capabilities of cities. By cross-referencing a dataset composed of the world's 435 cities of more than one million inhabitants (totaling 1,257 million urban dwellers) with their respective national LPI values, it is possible to categorize cities by their nation's LPI (Figure 3). Based on such a classification, 27% of the urban population lived in cities within countries with a low LPI (less than 3) while 47% lived in cities with below average LPI conditions (between 3 and 3.5). Only 26% of the urban population were living in cities with adequate national LPI conditions (more than 3.5). Such an assessment should be interpreted with caution as significant differences exist between cities of the same nation. For instance, port and airport cities tend to have more capabilities for city logistics because of their infrastructure and distribution capabilities.

arranging international shipments; (4) competence and quality of logistics services; (5) ability to track and trace international shipments; and (6) timeliness of shipments in reaching destination.

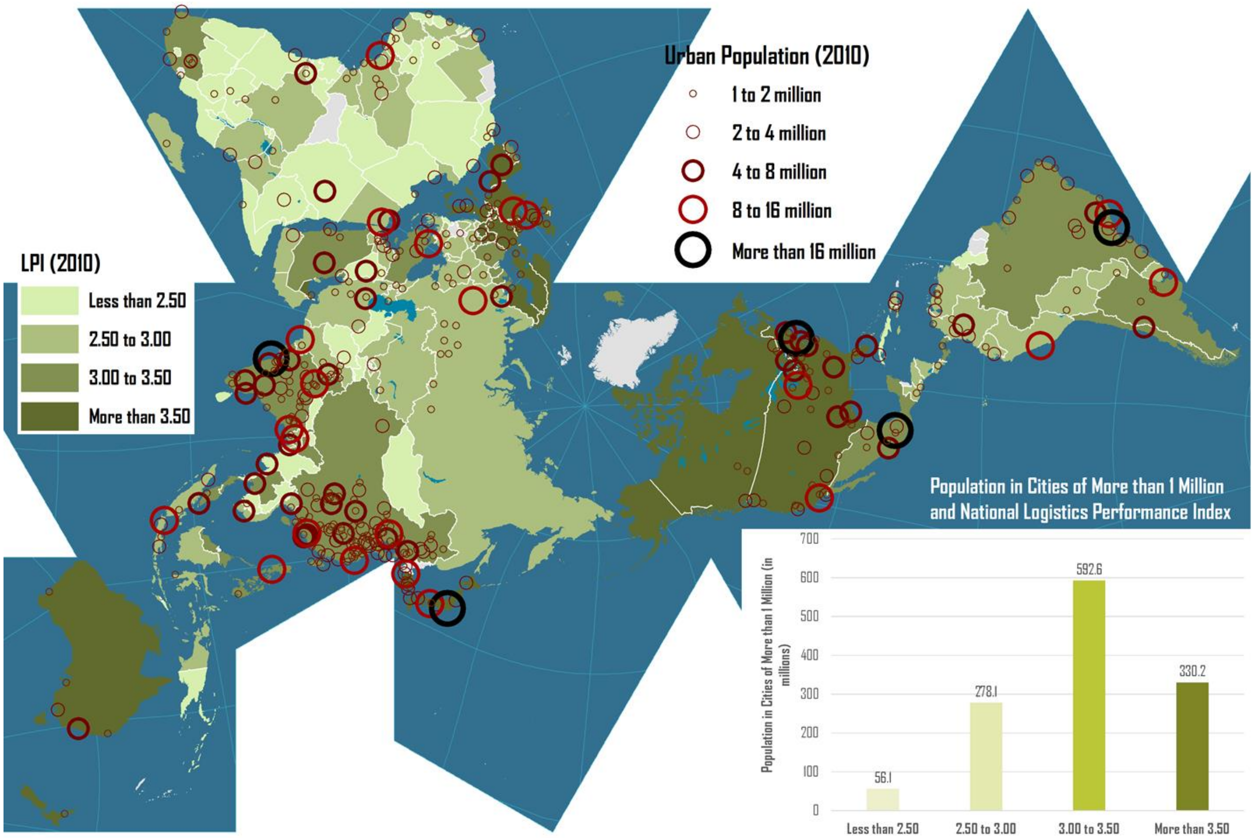

FIGURE 3 - WORLD'S MAJOR CITIES AND THE LOGISTICS PERFORMANCE INDEX, 2010[9]

There is a level of proportionality between the share of the urban population and the Logistics Performance Index (LPI); the higher the share of the urban population, the higher the LPI (Figure 4). The size of each observation is related to the national population living in cities of more than 1 million inhabitants. For instance, China with an urban population standing at 46% of its total population has 224 million inhabitants living in cities of more than 1 million with a national LPI of 3.49. The positive outliers (above the trend line) are countries having a high dependence on international trade and thus well-developed logistical structures (e.g. Germany, Japan, China, South Korea). The negative outliers (below

[9] Sources of data: World Bank, Logistics Performance Index. Urban population data from United Nations, World Urbanization Prospects: The 2007 Revision Population Database.

the trend line) tend to be countries with deficient transport infrastructure and governance issues and a somewhat more limited participation to international trade (e.g. Brazil, Russia, Nigeria).

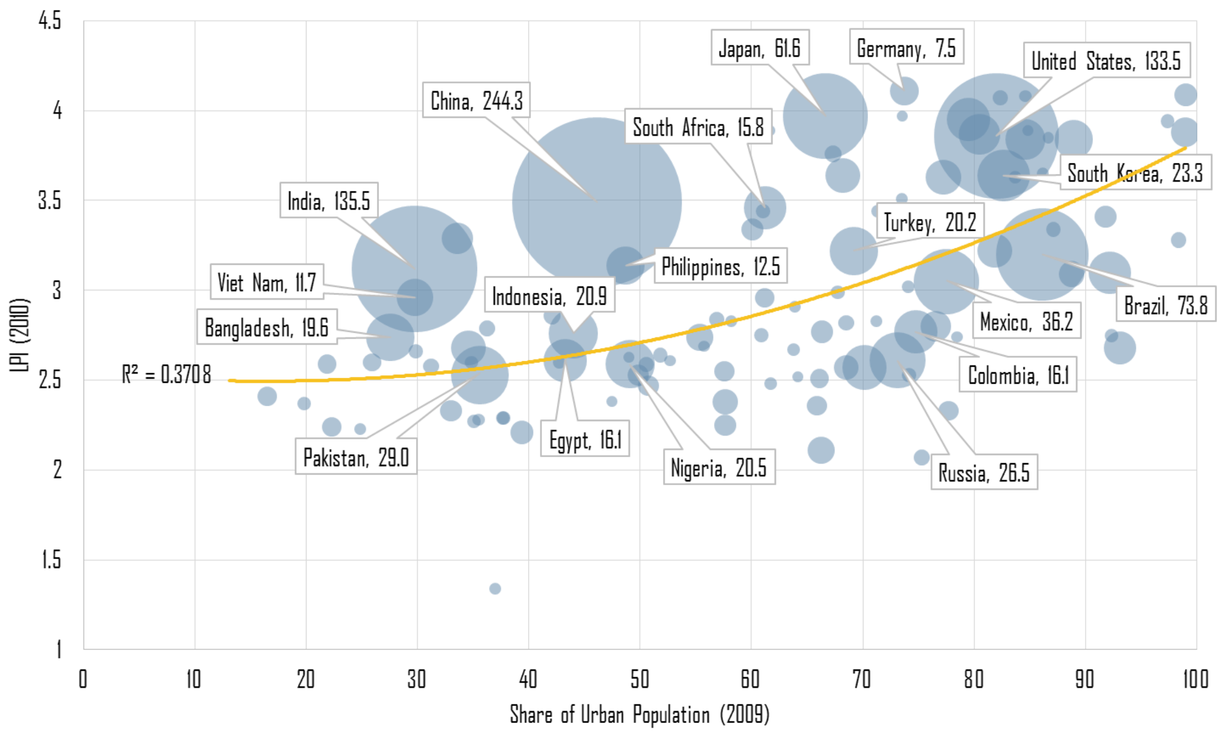

FIGURE 4 - NATIONAL URBAN POPULATIONS AND THE LOGISTICS PERFORMANCE INDEX[10]

The characteristics of urban freight distribution depend upon local economic, geographic, and cultural features, which can lead to different objectives and preoccupations in urban freight distribution. For instance, world cities have each a diverse array of concerns:

- Paris aims to limit the environmental footprint of freight distribution so that the quality of life of its residents can be maintained and improved. The city's status as one of the world's leading cultural and touristic hub has a notable impact on the strategies and priorities accorded to urban freight distribution.

[10] Source of data: World Bank, Logistics Performance Index. Urban population data from United Nations, World Urbanization Prospects: The 2007 Revision Population Database.

- Lima tries to cope with the contradictory demands related to the dual presence of both modern (motorized) and traditional forms of urban distribution in terms of infrastructure provision and regulations. Modern logistics services are as vital to the urban economies of developing and emerging countries as are more basic freight activities serving street vendors or home based manufacturing workshops.
- Chicago aims at maintaining its role as a major rail hub and freight distribution platform for North America with concentration of distribution and manufacturing activities. The metropolitan area is the point of convergence of the rail lines of the Class I carriers, but the different terminal facilities are in separate parts of the city and not well connected. This involves truck congestion as containers need to be carried from one terminal to the other.
- Los Angeles is facing congestion and environmental issues such as noise and air pollution. The city is facing conflicts between its function as a major commercial gateway for the East Asian trade and other functions linked with economic, touristic and cultural activities. Recent initiatives concern trucking associated with the main port facilities.
- Shanghai has become the largest cargo port in the world and acts as the main transport hub supporting China's export-oriented strategies. A significant share of the freight circulating within the city is therefore linked with global distribution processes. Rising standards of living imply growing consumption levels and the setting of city logistics challenges common in advanced economies.
- Istanbul is coping with rapid urbanization and economic growth, along with unique geographical constraints, namely a scarcity of flat land and the division of the city by the strait of Bosporus. Its commercial function is being strengthened by its role as a platform between Middle Eastern, European and Black Sea commercial interactions. The outcome has been severe constraints for freight circulation in an environment of

accelerated economic and urban growth. The city is embarking on large infrastructure projects with a new mega airport and the relocation of manufacturing activities to exurban locations.

THE EXTERNALITIES OF URBAN FREIGHT DISTRIBUTION

Environmental and Social Externalities

Modern freight distribution systems operating on the global urban landscape are generators of environmental and social externalities. In less developed countries, rural migration and population growth have led to very rapid urbanization, while the public supply of infrastructure and transport services has lagged behind, impairing the efficiency of urban deliveries. Road transportation is the most polluting per unit of distance traveled, but there are limited alternatives to provide for urban deliveries. A positive trend has been the decline of air pollution due to better engine designs and the phasing out of leaded fuel in most countries. Diesel trucks still account as significant sources of particulate matter and NOx emissions, an issue compounded by their use as urban delivery vehicles. Urban freight distribution is more polluting than intercity freight transport, particularly because of the following factors.

- *Vehicle age*. On average vehicles used for urban deliveries are older and it is a common practice to use trucks at the end of their service life for short distance drayage. This problem is compounded in developing countries where vehicles are even older and thus more prone to higher emissions and accidents.
- Vehicle size. The size of vehicles used for urban deliveries is on average smaller, particularly in areas that have high density and limited street parking. This implies that the advantages of economies of scale cannot be effectively applied for urban freight distribution as they are for long distance trucking. Smaller delivery vehicles must undertake more travel to deliver a similar volume of freight than a regular truck.

- *Operating speeds and idling*. The conditions pertaining to urban freight distribution in central areas are such that vehicles are forced to have lower driving speeds, regular stops and acceleration (e.g. traffic signals) as well as much more idling than a vehicle operating in an uncongested environment. In some cases delivery trucks, pedestrians and urban transit are impeding one another. The rise in the use of bicycles for passenger mobility in cities such as New York and Paris generates an increase in safety issues because of conflicts between trucks and bikes. Additionally, driving restrictions such as one ways or car-only streets often make the usage of the shortest path unfeasible. The result is more fuel consumption and pollutant emissions. In suburban areas, operating speeds and parking are much less of an issue, but longer trips due to lower densities contribute to higher emissions.

A common characteristic of cities in developing countries is that motorized and non-motorized traffic are sharing the same infrastructures, which leads to congestion and vehicle operation problems. The urban environment of many cities in the developing world is characterized by street vending (petty trade) supplying the urban population a range of basic necessities. This is particularly the case for shantytowns which experience a lesser share of formal supply chains and are serviced by forms of urban freight distribution about which little is known.

The ”Motor Transition”

What can be named the “motor transition” for urban freight is the change from predominantly pedestrian or animal powered transport of goods to motor vehicles, to mostly diesel powered trucks and vans. Figure 5 illustrates conceptually this transition.

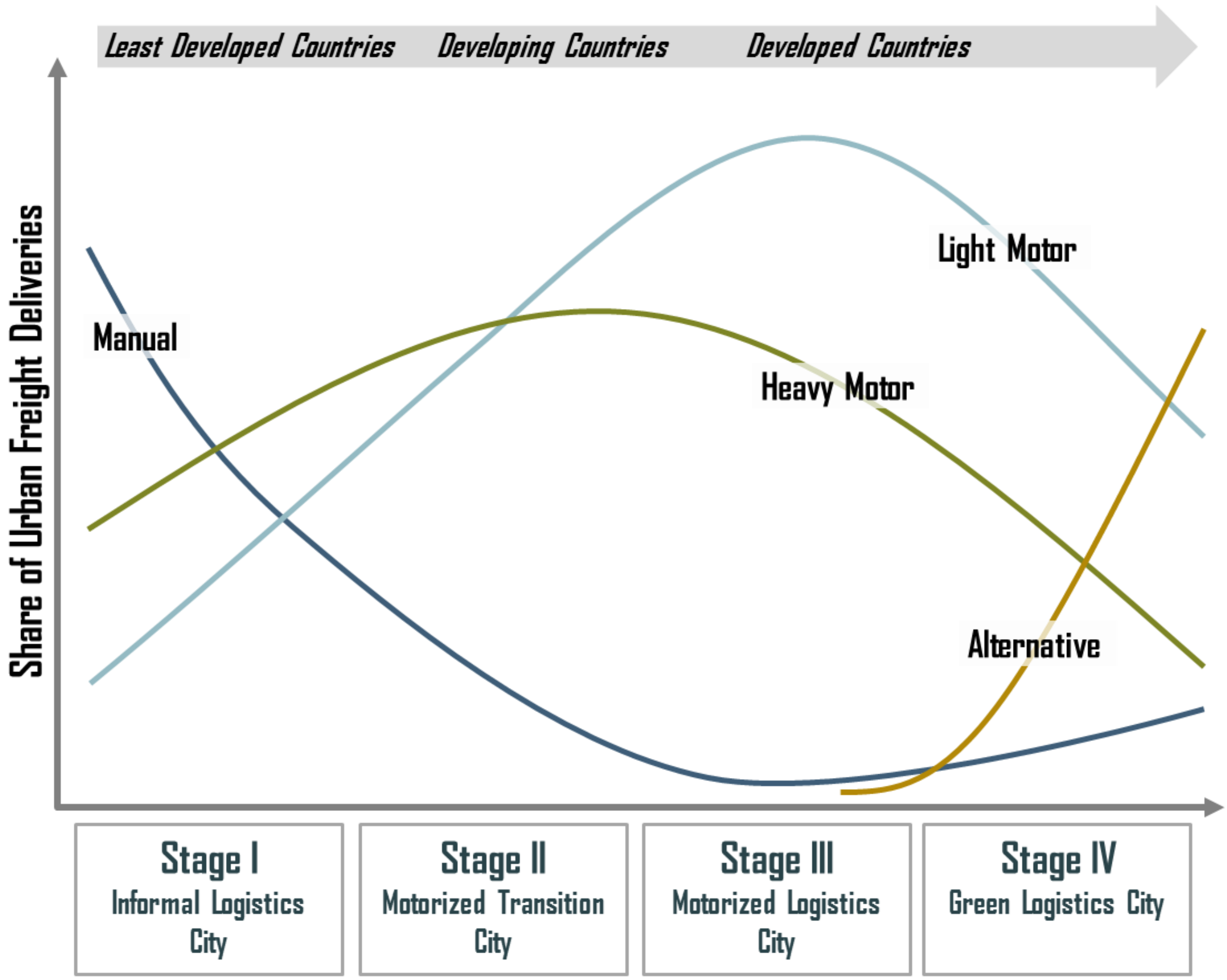

FIGURE 5 - THE "MOTOR TRANSITION" FOR FREIGHT DISTRIBUTION IN CITIES[11]

In stage 1, the situation of some of today's cities in the poorest countries, a significant share of the urban movement of goods comes from non-motorized traditional means of circulating. In stage 2, as in medium income countries with thriving large cities, diesel trucks and vans are dominant, with non-motorized traffic still important. Stage 3 sees vans and motorbikes taking over the streets. A stage 4, where green modes of transport stand out (electric, natural gas or clean diesel vehicles, new cargo-cycles), is the ideal situation envisioned in transport strategies of many large cities in the world. It has been partially implemented in the Greater London area with a ban on lorries and vans not meeting strict

[11] Source: Adapted from Dablanc, 2009.

emission standards. In Mexico City, already many trucks run on natural gas and some electric vehicles are used in the historical center. The urban freight transition from stage 1 to stages 2 and 3 has important impacts, both negative and positive. It makes freight more efficient and provides better service to the urban economy. All the while, pollution and energy consumption are dramatically increased due to the state of urban fleets of trucks and vans, which are generally very old. In Delhi, one of the most polluted cities in the world, general regulations were taken to promote cleaner fuels and the conversion to CNG vehicles. For trucks and vans, a recent incentive scheme to promote the conversion to CNG vehicles did not meet much success. Stage 3 can have a positive impact on congestion as traffic becomes more homogeneous, even though more motorized vehicles are added onto the city streets.

KEY LOGISTICAL CHALLENGES

Addressing city logistics requires an understanding of urban geography as well as supply chain management, which tends to be an uncommon set of skills. Urban freight distribution thus has a unique array of challenges as a multidisciplinary field. It reflects many dimensions of contemporary logistics such as route and delivery sequence selection and also exacerbates its constraints such as on-time deliveries. Among the most salient challenges of city logistics:

- *Commuting and peak hours*. Passengers and truck movements are not interacting efficiently as freight and passenger circulation are a zero-sum game; road capacity taken by freight transportation is usually at the expense of capacity available to passenger transportation. They share the same road infrastructure and peak hours due to commuting exacerbate the difficulties of freight distribution (in most developed economies, 8 to 9 AM is where passenger and freight peak hours cross, with the highest impact on total congestion).
- *Congestion*. City logistics, like logistics in general, depend on consistent and reliable deliveries. The urban environment that tends to have high congestion levels is

challenging. To avoid congestion, deliveries can take place during the night (or off peak hours) if possible. Retail outlets are often reluctant to receive deliveries at off peak hours, as they are lacking staff or do not trust unattended deliveries.

- *Parking*. There is limited parking capacity (both on-street and off-street) to accommodate deliveries in high density areas. Delivery vehicles cope with this challenge by double parking, thus seriously impeding local circulation.
- *Cargo load contradictions*. Urban freight distribution is characterized by smaller volumes and high frequency deliveries. This is not conducive to load consolidation and economies of scale and involves higher delivery costs. This is particularly the case for retail outlets that are restocking their inventories on a continual basis and in proportion to the daily sales.
- *Land use*. Land use patterns determine many features of the urban movement of goods, where the pattern of industrial, commercial and logistics facilities has a direct impact on the flow of commercial goods. Logistics sprawl has been a dominant land use change of the last decades with the relocation of logistics facilities towards peripheral areas at faster rates and greater distances than any other economic activity (Dablanc and Ross, 2012, Cidell, 2010).
- *Reverse (green) logistics*. While cities are major consumers of final goods, there are also reverse logistics activities related to the collection of wastes and recycling. Growing environmental concerns and rising consumption are placing additional pressures to implement urban green logistics strategies.
- *E-commerce*. Related to new forms of demands and new forms of urban distribution with a growth in the home deliveries of parcels. While the concerned volumes are still relatively small, it has necessitated strategies to complement home deliveries with alternate solutions (pick-up-points, automated locker banks) (Augereau and Dablanc,

2008). In Japan, pick-up points located in convenience stores have been commonly used for more than a decade.

The urban space is thus prone to conflicts between different stakeholders, as high population densities are related to a low tolerance for infringements and disturbances. There are also opportunities for collaboration as city logistics opens new realms of engagement for urban planning.

URBAN FREIGHT DISTRIBUTION STRATEGIES

From a freight distribution perspective, a city can be considered as a bottleneck where infrastructure resources (namely road and parking space) are scarce relative to the potential demand and are thus highly valuable. As an optimizing strategy, city logistics can take many forms depending on the concerned supply chains (e.g. retailing, parcels, food deliveries, etc.) as well as the urban setting in which it takes place. City logistics strategies are however difficult to implement as they often imply higher costs and can cause additional delays. The mitigation strategies that are the most considered concern three interrelated realms of engagement.

Rationalization of Deliveries

Rationalization of deliveries relates to adjustments about how freight is delivered (or picked up) in urban areas so that costs and externalities, namely congestion and energy consumption, are minimized. Such a strategy tries to make better use of existing assets, particularly vehicles. One of the simplest strategies is to reduce the time constraint on access to specific parts of the city, such as promoting night-time deliveries in central areas. Distributors can opt for night deliveries or at least extended delivery windows to avoid peak hour traffic, but there are challenges, as discussed earlier. Information technologies are increasingly being used to manage urban freight distribution systems. The most used technologies relate to global positioning systems that improve vehicle tracking and urban navigation as well as load management applications that can assist in building routes and delivery schedules. Under such circumstances it becomes more effective to match trip sequences, such as deliveries and pickups to strive towards forms of collaborative distribution. More sophisticated strategies introduce urban consolidation centers (UCC), specifically providing a bundled and coordinated delivery service for a whole neighborhood. A UCC is a logistics facility located close to areas with a high density of delivery operations (such as a city center) from which consolidated deliveries are carried out, and which provides a range of other value-added logistics services (Bestufs, 2007). Up to 200 such terminals existed in European cities in the 1990s and early 2000s. Due to operating costs, most of them closed down when municipalities could not subsidize them (Dablanc, 2009). Elsewhere, few projects for urban consolidation centers (such as the Motomachi UCC in Japan) (Bossin et al., 2009) have met success. Their operating costs are high since they involve high rents and additional handling before final delivery.

Freight Facilities

Another set of strategies seeks to develop freight distribution infrastructures that are better adapted to the urban context. This can involve logistics parks providing services to tenants (catering for employees, truck stops, security); designated parking areas for deliveries, as well as the use of urban freight distribution centers and local freight stations. If the opportunity arises, such as the availability of an underused area (former railyards, some brownfield sites provided cleanup costs are reasonable) in proximity to the city center, urban logistics zones can be developed which can provide a counterweight to logistics zones that have emerged in the periphery of most large urban agglomerations (Cidell, 2010). However, land prices in dense areas can be high. Also, available urban areas fitted for logistics activities tend to be located in poor neighborhoods, placing an important burden on poor and minorities (environmental justice concern). In some cities such as Tokyo, logistics facilities are still a feature of dense urban areas (Dablanc, 2009) thanks to a great care given to the minimization of negative impacts to neighboring communities. In Paris, recent examples of urban logistics facilities demonstrate that such facilities can be accommodated within populated areas with minimal impact. These developments, however, are costly. Urban freight facilities are a higher value proposition for very large cities, as their contribution to flow optimization can outweigh their costs. In smaller cities, such initiatives would drive up costs and unreliability.

Modal Adaptation, Modal Shift

Relates to using vehicles adapted for urban freight distribution. Smaller vehicles tend to be better suited for urban deliveries because of their ability to maneuver and the small loads typical of urban deliveries. However, all else being equal, for a given amount of freight, using smaller vehicles requires using a greater number of vehicles, possibly generating more truck miles of travel. Regulations can therefore be enforced concerning the permitted size of delivery vehicles (with a chosen limit permitting medium size trucks to operate) and even their age if environmental concerns such as emissions and noise are salient. Innovative strategies such as CNG vehicles and even bicycles and tricycles have been successfully implemented. They underline a good potential for modes to adapt to the diversity of the urban landscape, although they tend to remain a niche market (Giuliano et al., 2013). Vehicle change remains a cost-benefit exercise where the costs are often difficult to assess while the benefits are not readily measurable.

Barge and rail are minor modes of freight transportation for urban deliveries. Barges do play a role in some river cities for the supply and expedition of building materials or in very specific cases. For instance, Dutch cities use their canals for the supply of cafés and restaurants. Many Chinese cities extensively rely on canals as a mode for urban freight distribution, but specific figures are not available. Rail freight requires dedicated logistics facilities (tracks, sidings, yards, terminal) that are space consuming and therefore expensive within central areas. There is often local opposition to railyards and intermodal terminals because of their environmental impacts: old and noisy locomotives, poorly looking industrial areas, increased truck movements. In the U.S., rail freight volumes have increased nationally in recent decades. Major rail hubs such as Los Angeles, Chicago or Atlanta experience busy intermodal terminals often located in urban areas. These terminals only very partially supply the urban markets, they mostly serve as hubs redistributing shipments to other regions. They generate economic benefits to the urban areas (jobs and some tax revenues) but high environmental impacts. In Europe, a growing passenger rail traffic has drastically reduced the available capacity for freight on the rail infrastructure. Recent years have seen new projects for urban rail freight. In Dresden, Germany, a freight light rail is in operation since 2000 for parts supplied to a Volkswagen plant. Another major project based on light rail, called Amsterdam City-Cargo, went bankrupt in early 2009. The Monoprix freight train, in Paris, operates since 2007. Monoprix is a chain of supermarkets with 90 stores in Paris A train enters the city of Paris every evening. Pallets are then transferred to CNG operated trucks for final deliveries early in the morning. The scheme generates a yearly saving of 10,000 diesel trucks and 280 tons of CO_2. This operation, however, is quite expensive, with an additional cost of 25% per pallet compared to the former all road solution. One of Monoprix competitors, Franprix, has been operating barges to supply its Paris stores since the end of 2012.

Advantages and Drawbacks

Although each of these city logistics strategies has its own advantages, there are also drawbacks that are commonly related to higher distribution costs and additional delays. An urban freight distribution center interfacing with a set of distribution centers, each being connected to their respective supply chains, could service dense city areas thus achieving a better distributional efficiency within the central city.

However, most UCC experiments have failed due to high costs resulting from land prices and additional transshipment activities. The usage of waterways, rail and public transit systems has also been considered for urban freight distribution. However, there are no cost and logistically effective strategy to date. Public policies are more interested in urban freight than before, and many intent to promote innovative city logistics to reduce freight externalities and enhance the provision of efficient logistics to urban businesses. However, few strategies have met obvious success (Giuliano et al., 2013), leaving city authorities reluctant to go further.

From the point of view of city and metropolitan authorities, what a city logistics strategy entails is a framework that ensures the best possible management of urban freight distribution, particularly assets such as trucks, logistics terminals and parking space. For instance, incentives, regulations and enforcement should aim at promoting off-peak hour deliveries, available on-site and off-site loading zones and trucks with a higher load factor. Policies should promote voluntary changes in urban distribution practices, such as the provision of labels to businesses demonstrating optimized and environmentally sound delivery practices (Giuliano et al., 2013). Planning provisions that make the development of logistics parks possible are also part of a city logistics strategy, which further underlines the need for collaboration with the freight and logistics industries.

CONCLUSION: RISING CITY LOGISTICS CONCERNS IN THE ERA OF GLOBALIZATION

Urban areas remain congested areas where space utilization comes at a premium and where the presence of many stakeholders imposes concerted efforts to insure that urban markets are serviced in an effective and environmentally friendly fashion. The future is indicative of a transition towards greener forms of city logistics since the current situation appears unsustainable because of rising congestion and environmental externalities. Since each city represents a unique setting with its own supply of transport infrastructure and modal choice, there appears to be no single encompassing strategy to improve urban freight distribution, but a set of strategies reflecting challenges that can be common or unique for each city. As underlined, a salient difference relates to city logistics between developing and developed countries.

A fundamental element behind the scope and extent of city logistics remains a matter of size and density. Large metropolitan areas (a threshold of about one million inhabitants has been suggested) have reached a level of complexity that would warrant a concerted city logistics (freight policy) effort. Large cities tend to have frequent transshipment/transloading operations in suburban distribution centers while for smaller cities direct deliveries are more common. Large cities are also serviced by smaller vehicles and a higher share of vans, have more vehicle-miles, and a predominance of subcontracting to small truck operators. The average age of motor vehicles also tends to be higher in large cities. Additionally, large cities have seen the rapid growth in the number of logistics centers and warehouses, particularly in suburban areas.

Among the large variety of urban supply chains and freight transport systems in cities around the world, four typical models of urban logistics can be suggested (Table 6). They concern large metropolitan areas in developed and developing countries; gateway cities (that can also be major metropolitan areas) handling a substantial interface function between national and global freight distribution; and an array of medium-sized cities in developed economies, particularly in Europe, that have implemented city logistics schemes to deal with specific challenges.

Table 6- Proposed Typology of Global City Logistics

	Large metropolitan areas of developed economies	Large metropolitan areas of emerging economies	Gateway cities	Medium-sized cities in developed economies
OPERATIONS	Chain retailing resulting in more optimized urban	Many independent stores and home and street based businesses requiring specific	Numerous drayage operations from port (airport, intermodal	Higher share of direct deliveries: less transshipment activities in

	deliveries. High share of common carriers, high level of urban delivery sub-contracting (Europe). E-commerce and services activities requiring parcel and express transport.	patterns of deliveries. Dual transport and logistics system, prevalence of own-account operations. Very high diversity of urban supply chains	terminals, large logistics hubs) to region's DCs	local DCs
MODES AND VEHICLES	Prevalence of vans. Many old commercial vehicles in European urban areas. New city logistics schemes (alternative fuel vans, cargocycles, barges)	Huge heterogeneity of modes and types of road uses (from pedestrian carts to two wheelers to trucks), high levels of congestion.	Additional HGV traffic in addition to local freight traffic. Intermodal traffic.	Large and medium size trucks still quite visible
INFRASTRUCTURE AND LAND	Availability of suburban land, generating patterns of logistics sprawl (US, Europe). European attempts at urban consolidation centers. In Japan: scarcity of land, low differentials in prices between urban and suburban lands, maintaining freight facilities and multi-story terminals in dense areas	Land generally available but supporting infrastructure often lacking.	Intermodal terminals, ports, airports, mega distribution centers serving regional markets	Various conditions but land generally available and infrastructures adequate.
POLICIES	European cities involved in new city logistics experiments and environmental zones to reduce the share of old trucks. US cities lacking data, strategies focused on metropolitan truck traffic, port cities (NYC, L.A., Seattle) more involved in freight issues.	Freight not yet a prevalent issue despite recent efforts in some cities.	Issues of infrastructure investments for a better position in global competition (deepening of ports, capacity of airports, renovation of rail infrastructure, dedicated freight corridors, grade crossings, etc.).	Case specific such as access to a congested central area. Many city logistics initiatives in Europe.

In light of this typology, four illustrative cases of city logistics can be brought forward:

- *Land efficient urban logistics* (Japanese cities). The logistics organization in cities such as Tokyo presents several striking features including the integration of freight and logistics facilities in very dense urban settings. Responding to the needs of urban consumers, a widespread network of convenience stores is supplied day and night, and parcel transport companies provide finely tuned home delivery services using information technology tools. These advanced logistics strategies are (or are likely to be) adopted by other high density Asian cities, such as in South Korea, Taiwan and coastal China.
- *The city as a mega distribution center* (large US and European gateways). The recent years have seen a surge in the number and size of warehouses in many large North American and European metropolitan areas, specifically at their fringes. Serving as gateways to import-based consumer oriented economies, these urban regions concentrate the growth of new freight terminals, acting both as distribution facilities for important local markets of urban consumers and businesses, as well as regional hubs for the grouping and redistribution of goods to regional and national markets.
- *Dual urban logistics systems* (metropolises of developing countries). Giant cities of fast growing economies have a two-sided urban freight system; logistics needs of a modern economic sector comparable with the one in any city of developed countries coexist with an informal and largely unrecorded system of pick-ups and deliveries for home-based artisans or street vendors. Poorly maintained roads accommodate a very diverse traffic from push carts to mopeds, vans and lorries. Such cities are prone to the “motor transition” described earlier (Figure 5).
- *Smart city logistics* (historical centers of European cities). Innovative schemes of urban deliveries emerge in many European city centers with an emphasis on cleaner more silent operations, and consolidated deliveries. These experiments still represent a

marginal share of total freight activities in metropolitan areas, but receive a lot of media and decision-makers attention.

City logistics has emerged as an active field of research and application as the last mile in freight distribution commonly takes place in a congested and constrained urban setting. While specific operational strategies remain a salient challenge, there is also the need to develop comparative city logistics performance metrics. Since global cities commonly compete to attract economic activities, let them be related to production (manufacturing), distribution (warehouses) or consumption (major retailers), their logistical performance is a factor of growing concern for public and private actors since directly related to their competitiveness in the global economy.

REFERENCES

Augereau, V. & L. Dablanc (2008). An Evaluation of Recent Pick-up Point Experiments in European Cities: the Rise of two Competing Models? In Taniguchi, E. & R. Thompson (Eds.), *Innovations in City Logistics* (pp. 303-320). New York: Nova Science Publishers.

Bestufs (2007). *Good Practice Guide on Urban Freight*. Brussels: European Commission. Retrieved August 24, 2013 from *www.bestufs.net/gp_guide.html*.

Cidell, J. (2010). Concentration and decentralization: the new geography of freight distribution in US metropolitan areas. *Journal of Transport Geography*, 18, 363-371.

Dablanc L. (2009). Freight Transport, A Key for the New Urban Economy. Report for the World Bank as part of the initiative *Freight Transport for Development: a Policy Toolkit*. Retrieved August 24, 2013 from *siteresources.worldbank.org/INTTRANSPORT/Resources/336291-1239112757744/5997693-1266940498535/urban.pdf*.

Dablanc, L. & C. Ross (2012). Atlanta: A Mega Logistics Center in the Piedmont Atlantic Megaregion (PAM). *Journal of Transport Geography*, 24, 432-442.

Giuliano, G., T. O'Brien, L. Dablanc, K. Holliday (2013). *Synthesis of Freight Research in Urban Transportation Planning*. National Cooperative Freight Research Program (NCFRP) Project 36(05), Washington D.C.. Retrieved August 24, 2013, from *www.trb.org/Publications/Blurbs/168987.aspx.*

Hesse, M. (2008). *The city as a terminal. The urban context of logistics and freight transport*. Farnham: Ashgate.

Kenworthy J, & F. Laube (2001). *The Millennium Cities Database for Sustainable Transport*, International Union of Public Transport (UITP), Brussels and Institute for Sustainability and Technology Policy (ISTP), Perth.

Lindholm, M. and S. Behrends (2012). Challenges in urban freight transport planning – a review in the Baltic Sea Region. *Journal of Transport Geography*, 22, 129-136.

Rhodes, S., M.Berndt, P. Bingham, J. Bryan, T. Cherrett, P. Plumeau and R. Weisbrod (2012). *Guidebook for Understanding Urban Goods Movement*. NCFRP 14, National Academies of Sciences, Transportation Research Board.

Rodrigue, J.P. (2004). Freight, gateways and mega-urban regions: The logistical integration of the BostWash corridor, *Tijdschrift voor economische en sociale geografie*, 95 (2), 147-161.Routhier, J.L. (2013). *Urban Freight Surveys in French Cities*. Presented at the EU-US Transportation Research Symposium No. 1: City Logistics Research: A Trans-Atlantic Perspective, Transportation Research Board, Washington DC.

Taniguchi, E. & R. Thompson (Eds.), *Innovations in City Logistics* (pp. 303-320). New York: Nova Science Publishers.

World Bank (1999). *What a Waste: Solid Waste Management in Asia*. The International Bank for Reconstruction and Development, Washington, D.C.