USDOT Region V Regional University Transportation Center Final Report

NEXTRANS Project No. 053PY03

Estimating the Economic Impacts of Disruptions to Intermodal Freight Systems Traffic

By

Rodrigo Mesa-Arango
Ph. D. Student
School of Civil Engineering, Purdue University, West Lafayette
rmesaa@gmail.com

Xianyuan Zhan
Ph.D. Student
School of Civil Engineering, Purdue University, West Lafayette
zhanxianyuan@gmail.com

Satish V. Ukkusuri, Ph.D.
Associate Professor
School of Civil Engineering, Purdue University, West Lafayette
sukkusur@purdue.edu

Amlan Mitra, Ph.D.
Professor in Department of Finance and Economics
School of Management, Purdue University, Calumet
mitra@purduecal.edu

Fred Mannering, Ph.D.
Charles Pankow Professor of Civil Engineering
School of Civil Engineering, Purdue University, West Lafayette
flm@purdue.edu

DISCLAIMER

Funding for this research was provided by the NEXTRANS Center, Purdue University under Grant No. DTRT07-G-005 of the U.S. Department of Transportation, Research and Innovative Technology Administration (RITA), University Transportation Centers Program. The contents of this report reflect the views of the authors, who are responsible for the facts and the accuracy of the information presented herein. This document is disseminated under the sponsorship of the Department of Transportation, University Transportation Centers Program, in the interest of information exchange. The U.S. Government assumes no liability for the contents or use thereof.

USDOT Region V Regional University Transportation Center Final Report

TECHNICAL SUMMARY

NEXTRANS Project No. 053PY03 Final Report, Date

Estimating the Economic Impacts of Disruptions to Intermodal Freight Systems Traffic

Introduction

The identification and quantification of the economic and social impacts of disruptions is fundamental for sound transportation policy decisions. The impacts due to disruptions on goods movement are significant. Disruptions in their various forms cause direct short/long term impacts that include fatalities, infrastructure destruction and economic loss. Immediate economic impacts result from the inability of travelers and businesses to adapt to changed circumstances after a disruption. Quantifying the economic impact of different facilities on the transportation network has the potential to dramatically strengthen transportation systems and develop sound policies for network recovery and mitigation. To quantify the economic impacts, one has to clearly capture the consequences of a disruption which is usually a challenging task (Rose, 2009). More recently, these issues have surfaced to the forefront with the increasing realization about the interdependence of the national and global transportation supply chains, where one transportation network is an integral part of a "flat" global transportation network. Various completed and ongoing studies explored this topic from different perspectives (e.g. Series of reports NCHRP 525); however these studies fail to arrive at comprehensive modeling approaches that quantify the complex relationship between goods movement and economic activity. While few models have quantified the "direct" impacts such as infrastructure damage and loss of travel time (Ukkusuri and Yushimito, 2008) there is relatively little understanding of "indirect" impacts which cause the multiplier effect due to reduction in jobs, property values etc in the long term. The ability to estimate the short/long term economic impacts using quantitative methodologies and simulation tools requires the integration of engineering, economic and policy frameworks. Since transportation disruptions have medium and long-run impacts on local, regional and national economies, there is a significant need that warrants their quantification using state of the art tools.

The development of methodologies to quantify the impact of disruptions in goods movement is further crucial because of the significant economic value of the cargo. Globally, the United States imported $1.95 trillion and exported $1.16 trillion of goods in 2007. Of the $3.1 trillion in total U.S. trade, 45 percent moved by vessel, 25 percent by air, and 30 percent by surface and other modes (BTS, 2008). According to preliminary estimates (Commodity Flow Survey in 2007), American businesses produced shipments valuing $11.8 trillion, totaling 13.0 billion tons, and contributing 3.5 trillion ton-miles on the nation's transportation infrastructure. Trucking continues to dominate as the modal choice for freight shipments, accounting for 71 percent of the value and 76 percent of the tons of all commodity shipments. It is easy to imagine the significant impact that a disruption of even a small fraction of the shipments can have on the economy.

The disruption to the goods whether it is due to increased security screening post 9/11 of goods via air, sea and land or due to disruption of critical links in disasters (e.g. earthquake, hurricane etc.) leads to direct and indirect economic impacts. The losses vary from macro level (relocation of jobs, changes in imports and exports, land use changes etc) to micro level (changes in production, sales and prices) impacts on the economy. Depending on the duration of disruption, availability of alternatives, and resilience of the system, the extent of economic impacts can be measured. The challenge lies in developing appropriate performance metrics and modeling tools that arrive at holistic measures of economic impacts. Previous studies fail to address two important characterizations of disruptions: (1) the resilience of the system and (2) the extended linkages of disruptions (Rose, 2009). The resilience depends on the property of systems to overcome the potential disruption by either adjusting to the situation or by rescheduling the delivery of goods when possible. The extended linkages are related to the behavioral response of whole system to failure which may lead to extended periods to rebuild and bring the system back to functionality. In addition, most of the previous studies on measuring economic impacts for goods movement do not consider the intermodal nature of the transportation system. Short term strategies to overcome the deleterious effects of the disruptions typically include the use of alternative transportation modes and detours to efficiently ship the goods. Typically these strategies maximize the cost-benefit ratio of the shipping/trucking firm.

The goal of this work is to develop and apply a methodology to identify and estimate the economic impacts due to disruption of goods movement. The developed model is based on state of the art economic concepts that will allow the quantification of system wide impacts at the regional level. This advanced research contributes to the NEXTRANS theme of vehicle-infrastructure interactions (Pillar 2) and in integration of various modes and methods. The developed research is beneficial to government agencies such as departments of transportation (DOTs) and metropolitan transportation organizations (MPOs).

Findings

- There are limited secondary data sources appropriate for freight transportation modeling and analysis.
- The best available data source for freight transportation modeling and analysis, the Freight Analysis Framework version 3, can be used for regional freight modeling under a set of assumptions developed in this project in order to overcome limitations associated to data aggregation.
- The framework presented in this paper can be used as a good approximation for the analysis of economic impacts due to freight disruptions.

Recommendations

- Public agencies must improve the way in which secondary data for freight modeling and analysis is presented to the researchers and general public.
- Availability of more data will improve the calibration of the model and, hence, its accuracy.
- Regional planning agencies require to develop freight plans that integrate appropriate data sources and models.

USDOT Region V Regional University Transportation Center Final Report

TECHNICAL SUMMARY

Contacts

For more information:

Satish V. Ukkusuri, Ph.D.
School of Civil Engineering, Purdue University
550 Stadium Mall Drive, West Lafayette, IN 47907, USA
Phone : (765)-494-2296
Fax : (765)-496-7996
Email: sukkusur@purdue.edu

NEXTRANS Center
Purdue University - Discovery Park
3000 Kent Ave.
West Lafayette, IN 47906
nextrans@purdue.edu
(765) 496-9729
(765) 807-3123 Fax
www.purdue.edu/dp/nextrans