DESIGN OF A SHIPPER-BASED SURVEY OF FREIGHT MOVEMENTS IN THE GREATER GOLDEN HORSESHOE

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INTRODUCTION

Canada has a well-developed transportation system for moving people and freight. Yet the use of that transportation system is not well understood, particularly in urban areas such as the Greater Golden Horseshoe (GGH) (which includes the Greater Toronto Area, and extends through Niagara Region to the US border). There is a need to build a *balanced* freight and personal transport analysis capability to assess "sustainability" impacts of urban land use and economic policies and to guide investment in transportation infrastructure such as highways and intermodal facilities. *Places to Grow*, the draft growth plan for the GGH, emphasizes the need for strategic improvements in transportation infrastructure to facilitate goods movement, and the development of economic corridors designed to link to inter-modal transport infrastructure and to avoid impacts on natural systems (Ontario, 2005). The plan recognizes that: (a) a prosperous urban economy requires the efficient movement of goods and is sensitive to the time and energy costs associated with traffic congestion, and (b) within urban areas, freight transport must also be controlled to improve road safety, air quality, noise and other impacts on city residents. Currently, models available for urban freight transport are not sufficient to assess impacts of transport investments and land development toward meeting these goals. One of the key reasons for this is the lack of data describing urban freight movements and firm behaviour. Furthermore, there is insufficient literature describing how such data can be collected most cost effectively and with the highest quality results.

RESEARCH OBJECTIVES

Our research goal is to undertake a data collection effort that compares four techniques for collecting commodity and commercial vehicle movement data from shippers and their drivers. The proposed study is designed to:

a) Provide shipment, trip, and tour generation data for Peel Region,
b) Provide information describing the behavioural and economic processes that lead to the shipment of goods and services, and the choice of mode, ultimately resulting in the movement of commercial vehicles,
c) Be of sufficient scale to provide enough observations for the preliminary estimation of a microsimulation model of the urban freight system for a study area within the GGH,
d) Allow for a formal statistical comparison of the response rate, respondent burden, cost, and data quality associated with web-based, telephone interview, mailout-mailback and GPS surveys.
e) Act as the pilot for a large-scale shipper-based survey of commercial vehicle movements envisioned for the GGH.

REVIEW OF DATA COLLECTION EFFORTS

In the GGH, the best and most comprehensive sources of freight data are the Commercial Vehicle Survey (CVS) (MTO 1999-2001), and the Cordon Count program undertaken by the Data Management Group (DMG 2002). These data sources are inadequate to model freight movement and firm behaviour in the GGH on municipal roads for a number of reasons. The CVS is a province-wide road-side vehicle survey, conducted at over 150 road-side directional sites in Ontario, 37 sites in the GGH, in which drivers are asked to report on truck activity characteristics related to the: trip, driver, carrier, commodity and vehicle. This survey is successful in the collection of long-haul intercity freight movements to/from and through Ontario, however, the lack of consistent detailed address-level trip information drastically reduces the accuracy of simulation on municipal facilities. It also only captures goods movements by the "truck/highway" mode, so no observations of the mode choice decision are made. Furthermore, in terms of "tour-making" behaviour, the CVS captures

a maximum of 2 intermediate points and fails to capture the weight of goods picked up or dropped off at these points.

The Greater Toronto Area Cordon Count program provides counts of truck movements across a series of screenlines every 2-3 years. While geographically more comprehensive than the CVS, it only counts trucks in broad categories, with no observation of origin, destination, load characteristics or trip purpose and lacks 24 hour coverage plus is limited to one work day in one season. Thus it can act as a fair validation tool of an urban freight model, but cannot be used in the development of a behavioural / economic model of urban freight movement.

A *shipper-based* survey of goods movement is the preferred method to complement the data sources currently available in the GGH, for at least two reasons. First, most decisions that result in goods and service movements, including the number, timing and value of shipments, the destination location of shipments, and the choice of mode (or combination of modes, as in intermodal freight transport) are made, at least in part, by the provider (shipper) of those goods and services. To understand how those decisions are made, and how they are affected by economic, logistical, regulatory and transportation considerations it is necessary to survey the shipper, who is the player most closely associated with those decisions. The second reason is a practical one. Commodities that are consumed by a large population of households and firms are often produced in a small number of firms. To capture the flow of specific commodities, it is more efficient to survey the small number of producing firms than the large, diverse set of households and firms that consume the goods.

Shipper-based goods movement surveys have been conducted in a number of jurisdictions as shown in Table 1. The largest of these is the Commodity Flow Survey, undertaken in the US, in which commodity origins and destinations are obtained for approximately 50,000 domestic shippers across the United States. In Calgary (Stefan, 2005) and Edmonton (2003), business establishments were contacted to obtain the value and weight of goods shipped and the tour-based trip-diaries of commercial vehicles

leaving those firms. Establishment surveys were conducted in Hamburg and in Dresden,

Table 1- Recent Shipper-based Freight Surveys

Survey Name/location	Survey year(s)	Res-ponses	Method: Survey type	Response rate
Calgary – Commodity Flow Survey	2000	3,000	Mail-out mail-back: commodity flow/tour based trip diary	not given
Edmonton Commodity Flow Survey	2001	4,300	Mail-out mail-back: commodity flow/tour based trip diary	not given
Hamburg mail-out mail-back	2001	537	Mail-out mail-back: Establishment survey and trip diary	36%
Hamburg face-to-face interview	2001	220	Face-to-face: Establishment survey and trip diary	40%
Dresden	2001	856	Face-to-face: Establishment survey and trip diary	42%
USA Commodity Flow Survey	1993, 1997, 2002	50,000	Mail-out mail-back with commodity flow	Census response required by law
Baltimore	2001	14	Telephone with mail-out/mail-back: Investigation of freight issues for specific industries	50%
Oregon DOT	2001	1,872	Telephone survey: Infrastructure-related problems	61%

Germany, each of which included two elements: a trip diary survey and a business survey that included information about the business, its employees and its vehicle fleet (Wermuth *et al*., 2004). Shipper-

based surveys have also been conducted to obtain opinions from the freight community with regard to freight issues and the need for infrastructure improvements. Such studies have been completed in Baltimore (Louis Berger Group, 2001) and Oregon (Lawson and Strathman, 2002). Response rates of these shipper-based surveys have varied from 36% to over 60% depending on the nature and length of the survey, the method of contact with the respondent, and the quality of execution of the survey.

Yet it is recognized that shippers alone do not have information about all aspects of the movement of goods from their firm. To obtain a more complete picture of the nature of deliveries from a business establishment, it is useful to also obtain information from the drivers of delivery vehicles about the particulars of the truck tours that are undertaken, including stop sequence, stop location, reason for the stop and arrival/departure times. The commodity flow surveys recently undertaken in Calgary (Stefan, 2005) and Edmonton (2003) have successfully utilized the joint approach of surveying both the shipper and drivers of commercial vehicles leaving the establishment to obtain both commodity and vehicle movement information. The survey described in this paper builds upon the methods developed in Calgary and Edmonton, by capturing additional behavioural information and by assessing different methods for jointly obtaining information from both actors.

METHOD

Four survey techniques will be used to capture different aspects of commercial vehicle movements and firm behaviour, from the perspective of the shippers of goods and services.

Mail-out / mail-back survey – Mail-out/mail-back surveys are the most widely utilized instruments for collecting shipper based information. The method is reasonably cost effective, requiring a modest amount of survey staff time for administration of the survey. Response rates for this technique can be low, however, unless significant time is allocated to calling firms to encourage them to return completed surveys.

Web-based survey – The main advantages of this survey technique are that it is convenient, provided the respondents are computer

literate and have computer access, it can be the most cost effective technique requiring few supplies or staff, it can feature interactive maps and other graphical tools, and it can allow questions to be customized depending on previous answers in the survey. However, this method can result in low and potentially biased response rates, use of the internet can be a barrier for non-computer literate respondents, and data quality issues can arise.

Computer-aided telephone interview – This technique is more resource intensive, and hence expensive. However, it is expected that improved levels of response can be obtained. Furthermore, the quality of the data can be better, since interviewers can clarify vague or problematic data during the interview.

Mail-out / mail-back survey with GPS supplement – This is the most resource intensive technique, because of the equipment required, the expense to courier the equipment to and from responding firms, and the technical support required to install and configure the equipment. However, the technique provides the most detailed and accurate information about route choice, travel time, stop location and duration.

A target of 200 responses for each survey technique is envisioned. Each survey technique will collect a core set of data, including:

- Attributes of the firm, (including the number of employees, industry type, etc)
- Attributes of the vehicle fleet owned and/or operated by the firm
- Information about all goods shipments over the course of one day
- Information about the mode of transportation chosen for each shipment, and the potential for use of intermodal transport
- Information about all trips made by vehicles owned or hired by the firm over the course of one day

These core data will be compared for each survey instrument, to detect biases, to evaluate data quality and to assess response rates. The core data from the four surveys are to be pooled and used to estimate a microsimulation model of freight travel demand.

MAIL-OUT/MAIL-BACK SURVEY

The core data, common to each of the four survey instruments is best demonstrated by describing the mail-out/mail-back survey in detail. The mail-out/mail-back survey includes five forms. Three are completed by the shipper and two are completed by the driver.

Form A: Firm Information (shipper)

The target respondent for completion of the shipper component of the survey will be person in charge of the shipping/receiving department or the manager of logistics for the firm. Form A includes:

Respondent information: the role of the respondent in the company

Establishment information: number of employees working at the business establishment classified by occupation group, industry classification (NAICS), square footage and age of the establishment.

Annual shipping information: the estimated number and total value of annual shipments, estimated proportions of shipments that are local, inter-regional or international, the existence and frequency of routine delivery schedules, seasonal variation, and whether the firm ships dangerous goods.

Modes used for shipments: approximate annual frequency of shipments by mode, number of shipments made on the survey day by each mode, number of commercial vehicles that arrived and left the establishment on the survey day.

Carriers: use of 3rd party logistics, freight forwarding, for-hire carriers, supply chain management.

Vehicle fleet: number of vehicles owned or leased by the establishment (passenger cars, cube vans/ pickups, single unit trucks, road tractors, 2 axle trailers, 3+ axle trailers, multi-unit trailers) and number outfitted with GPS/satellite tracking devices.

Transportation in the Region of Peel: various open ended questions asking the shipper about their greatest logistical/shipping challenges and how the Region of Peel's transportation infrastructure/policy could be best improved to address these challenges.

Form B: Outbound Commodity Information (shipper)
Form B collects information about every commodity shipped by the business establishment over the course of the study day. A portion of Form B is show in Figure 1a.

Form C: Inbound Commodity Information (shipper)
Form C collects information about every commodity shipment received by the business establishment over the course of the study day. A portion of Form C is show in Figure 1b.

Form D: Stop Information (driver)
Form D collects factual information from the driver describing vehicle and the pick-ups and deliveries that are made over the course of the study day, including stop descriptions, locations, purposes, arrival and departure times, and odometer readings. A portion of Form D is shown in Figure 2.

Form E: Tour Information (driver)
Form E obtains from the driver of the vehicle more behavioural information describing the characteristics of the tour as a whole. It includes the following open-ended questions, for which response categories will developed in the pretesting stage:

a) Were there any shipments you planned, but could not be made on this tour? If so, why not?
b) What affected the number of stops on the tour?
c) What affected the order of the stops on the tour?
d) What affected the route and how your route was determined?
e) What affected the timing of the stops?

Form E also asks whether the tour is done routinely, and whether the timing of stops is typical compared to stops made in the past week. Finally, Form E provides an opportunity for the driver to express his or her opinions about their greatest pickup/delivery/driving challenges and how the Region of Peel's transportation infrastructure/policy could be best improved to address these challenges

Shipment ID	Destination	Final Destination *If different than Destination*	Mode(s) of Transportation *Please check all mode(s) used in transporting this commodity*	Commodity *Commodity that best describes the shipment*					
				Time Sensitive?	Value $CAN	Weight *Specify Unit*	Commodity Name	Commodity Code *Use code provided on the ORANGE SHEET*	Dangerous Good?
	Description Address/Closest Intersection City	Description Address/Closest Intersection City	☐ Truck ☐ Air ☐ Marine ☐ Rail ☐ Other *Please Specify*	☐ Yes ☐ No If Yes: Earliest Latest					☐ Yes ☐ No If Yes, please describe the good

Shipment ID	Origin	Initial Origin *If different than Origin*	Mode(s) of Transportation *Please check all mode(s) used in transporting this commodity*	Commodity *Commodity that best describes the shipment*					
				Time Sensitive?	Value $CAN	Weight *Specify Unit*	Commodity Name	Commodity Code *Use code provided on the ORANGE SHEET*	Dangerous Good?
	Description Address/Closest Intersection City	Description Address/Closest Intersection City	☐ Truck ☐ Air ☐ Marine ☐ Rail ☐ Other *Please Specify*	☐ Yes ☐ No If Yes: Earliest Latest					☐ Yes ☐ No If Yes, please describe the good

Figure 1 – Commodity / Shipment Information (shipper)

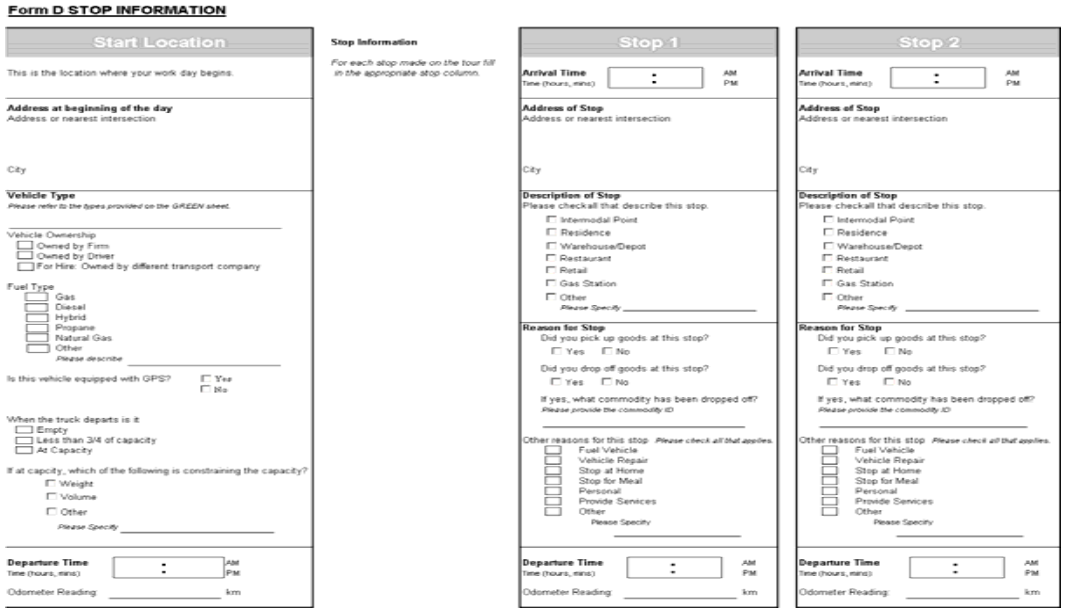

Figure 2 – Form D: Stop Information (driver)

WEB-BASED SURVEY

The web-based survey is designed to collect the same data from the shipper and the driver as collected in the mail-out/mail-back survey. Thus all internet forms have as similar a format as possible to that of the mail-out/mail-back forms described above. However, drop boxes are provided for such fields as industry classification, commodity type, etc. to replace the printed lookup tables necessary for the mail-out/mail-back survey. On-line error and consistency checking are included in the web-based survey design. The key additional design feature of the web-based survey is the use of interactive maps for route choice / stop destination. Drivers will be asked to outline the route that was chosen on a map similar to that shown in Figure 3.

Figure 3 – Interactive map for route entry

COMPUTER AIDED TELEPHONE INTERVIEW

The computer-aided telephone interview (CATI) will also collect the same data from the shipper and the driver as collected in the mail-out/mail-back survey. This survey will include a mail-out with a letter of introduction to the study, instructions to the respondent about the information to be accumulated in preparation for the interview, and lists of industry classifications and commodity descriptions that are too cumbersome to describe over the telephone. Attempts will be made to contact both the manager of shipping/ receiving for the firm, and at least one driver to complete the two sections of the survey.

MAIL-OUT/MAIL-BACK WITH GPS SUPPLEMENT

The GPS survey will be undertaken using RouteTracker technology provided by Turnpike Global Technologies, Ltd. For 200 responding firms, the driver will be asked to install a small, durable RouteTracker device, shown in Figure 4, on the dash of the vehicle. For those respondents that participate in the GPS component of the survey, a modified version of the driver questionnaire will be provided, with less written information required about the arrival and departure times, odometer readings and stop locations.

Figure 4 – RouteTracker Device for the GPS Supplement

STUDY AREA AND PERIOD

The Region of Peel is proposed as the study area for this data collection effort because it includes a large manufacturing/ warehousing base with an estimated 240 sq. ft. of industrial floorspace per capita (more than double that of the Greater Toronto Area (GTA), Chicago, and other major industrial centres in North America). Peel is also a major Canadian transportation hub, which is served by three rail/truck intermodal terminals, Pearson Airport and the densest expressway network in the GTA. The survey is planned for September to November of 2006. These dates are chosen to correspond to the survey period of the Transportation Tomorrow Survey, a passenger travel survey of 5% of Greater Golden Horseshoe households.

SAMPLE DESIGN

The survey sample involves a multi-stage design. First, a sample frame representing the population of all business establishments in

Peel Region will be obtained. Business establishments in the sample frame will be assigned to strata based on industry classification and establishment size. A stratified sampling strategy will be employed to ensure that all classes of establishment are well represented, and that each of the four survey instruments is applied equally to each class of establishment. The random selection of business establishments will then be made as shown in Figure 5.

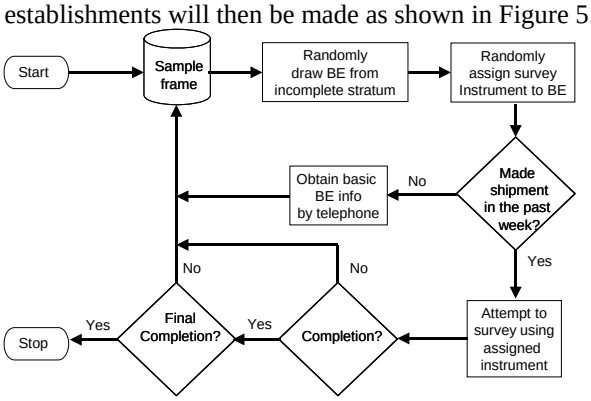

Figure 5 – Sampling flowchart

EXPECTED OUTCOMES

Empirical contribution – Analysis of the data collected in the research will represent a long-needed contribution to understanding urban freight movements in the GGH. The data collection we propose for the GGH will build upon the methods used in other shipper-based surveys, collecting not only a description of the *vehicle movements*, but the *shipments of commodities* and insights into the *behavioural process* underlying shipments.

Methodological contribution – Very few methodological studies of freight data collection have been undertaken. Those studies that have been done (e.g. Lawson and Riis, 2001) have not included the range of instruments including internet and GPS technologies proposed for this study. This study will therefore provide unprecedented information describing the effectiveness of a broad range of survey methods when applied to firm representatives, and will act as a guide

to the profession in developing survey techniques for future freight data collection efforts in the GGH and world-wide.

Contribution to the development of urban freight microsimulation models - The survey is being designed to provide a significant portion of the necessary data for the development of an agent-based microsimulation model of freight movements and firm behaviour. Microsimulation has been used to model the freight transport system successfully only in very few urban centres in North America (e.g. Stefan *et al.*, 2005; Maoh & Kanaroglou, 2005; Khan *et al*, 2002) and these applications don't exploit the full capability of microsimulation.

Support for "Places to Grow – Draft Growth Plan for the Greater Golden Horseshoe" - The survey will provide critical information to for analysis of the Places to Grow draft growth plan for the Greater Golden Horseshoe. The plan notes that "the GGH economy is an economy in transition, with economic activity and wealth increasingly generated by service and knowledge industries" (p.5). Understanding the impact of this economic transition on the flow of commodities and vehicles within the GGH and to/from other regions and nations requires a dataset that describes both the quantity/size/destination of shipments and the means by which those shipments are transported from to those destinations. The collected data will link a firm's economic output to their vehicle movements, allowing for an economic/behavioural understanding of commercial vehicle movements and a better chance of successful modelling of the transportation impact of economic trends.

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