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**Behavioral Paradigms for Modeling Freight Travel Decision-Making**

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1. **Introduction**

The workshop titled “Behavioral Paradigms for Modeling Freight Travel Decision-Making”, designated as Workshop W4, was a half-day workshop that took place at the International Association for Travel Behavior (IATBR) conference on December 15, 2010 in Jaipur, India. The purpose of the workshop was to assess the state-of-the-art and state-of practice in freight analysis and modeling, to identify emerging research issues and to set a research path forward. The workshop was co-chaired by Agostino Nuzzolo from University of Rome, Italy and Matthew Roorda from University of Toronto, Canada. Nazneen Ferdous was the rapporteur for the workshop.

In total, 19 people attended the workshop. The participants of the workshop represented eight countries on four continents, held different research interests, and represented distinct academic disciplines and the private sector. The workshop opened with a welcome from the co-chairs and introductions. The first resource paper (Puckett, 2012) was then presented. Participants were then divided into three groups to discuss major issues and behavioral paradigms for freight transportation, after which, key conclusions were presented to the larger group. After a short break, a second resource paper (Samimi, *et al*, 2012) was presented. Participants broke into three groups to discuss modeling and data issues, and then summarized their discussions back to the larger group. The workshop was wrapped up by synthesizing the thoughts and issues discussed throughout the workshop session and by identifying areas for future research. The format worked well to address focused questions efficiently, to allow individuals ideas and opinions to be expressed and debated, and to develop consensus where possible. Of course, given the short time available for discussion, the findings of the workshop cannot be considered to be a comprehensive assessment of the field of freight modeling nor does it provide an exhaustive list of potential future research. However, a good variety of useful insights did ensue and are presented here.

The rest of this report is structured as follows. In the next section, we present an overview of behavioral issues in modeling freight travel. Section 3 summarizes the findings from the discussion dedicated to modeling and data issues. Section 4 provides a brief conclusion.

1. **Behavioral Paradigms**

The first half of the workshop was dedicated to identifying major research issues and behavioral paradigms for freight transportation. The first resource paper, titled “Improving our understanding of freight travel decision making: motivations, constraints, incentives and interactions” was presented by Sean Puckett from the University of Sydney in order to provide a focus for this part of the workshop. The paper summarizes some of the key developments that have been made towards understanding the decision making process of freight movement and presents some empirical challenges, issues and opportunities, and areas for future research.

Relative to passenger transportation, there are complexities in the organization of freight systems that have prevented the research community from adequately understanding or representing those systems in behavioral models. From the resource paper by Puckett, and in the ensuing discussions in the workshop, it is clear that complexities in the freight system are now well-recognized in the research community. There was general agreement that the community has only scratched the surface when it comes to understanding freight behavior.

Much of the discussion focused on three particular deficiencies. First, it was noted that a great deal of the complexity in freight systems lies in the interactions between agents. Some of the particular interactions that were noted by participants included interactions between:

* Firms of different scales and power levels
* Firms with different motivations or business objectives
* Firms with different roles in the system (e.g., shippers, carriers and receivers)
* Firms and end consumers

Second, the workshop participants noted a deficiency in our understanding of the constraints and external influences that are faced by freight system agents. For example, the shipper carrier interaction is influenced by time windows on deliveries imposed by receivers (see for example Holguin-Veras, 2007)<<citation does not have a reference in the reference section>>. While both the shipper and carrier may agree that off-peak transportation of goods would add efficiency, external influences imposed by receivers prevent those efficiencies. Critical external influences include:

* Market structure
* Government policy (regulation, incentives and disincentives)
* Economy
* City structure
* Business processes
* Technology
* Traffic management

Participants noted that such external influences on freight transportation and logistics are less well understood and less researched than the reciprocal impacts of freight transportation and logistics on prices, land use, environment and congestion. Given that some of these external influences (perhaps with the exception of city structure) can shift dramatically over short periods of time, important questions arise about the responsiveness and resiliency of the freight system to the shifts. Only through an improved understanding of interactions and constraints inherent in the supply chain, can this question be answered. An opportunity was identified for the travel behaviour research community to interact more proactively with the supply chain community (particularly with regards to freight market interactions and contracts), and operations research community (on questions of logistics) to jointly grapple with these questions.

Third, the question arose of how we can develop integrated understanding of freight systems at very different geographic scales. There has been considerable progress in understanding international trade, goods movement across nations/states/provinces, and goods movement within urban areas. A major gap was identified in integrating that knowledge, given that freight systems that operate at these different scales are not independent, but are part of integrated supply chains that cross political and geographic boundaries and simultaneously operate at different scales.

1. **Modeling and Data**

The second half of the workshop was dedicated to a discussion of freight transportation modeling and data issues. The second resource paper presented by Kouros Mohammadian, entitled “Behavioral freight movement modeling” provided background for this discussion. The paper proposes a nationwide freight microsimulation framework for the United States and discusses data needs and available data sources for the proposed model framework.

**Modeling**

The paper presentation led to discussion surrounding the key modeling decisions that precede any modeling effort. Those decisions, which should generally be made based on the policy analysis requirements or research goals in mind, include questions of scope, unit of analysis, resolution of units of time, space and actors.

The following questions were considered to be of primary importance:

* What scope is most appropriate for freight activity models? A variety of elements were identified to be important directions for improving/expanding the scope of models. These included: consideration of the transportation land-use interaction, incorporation of technological developments, inclusion of the influence of demographic shifts on freight transportation, representation of economic indicators and economic development programs.
* What units of analysis are most relevant for the next generation of freight applications and under what conditions might a diversity of units be considered? Some of the options that are available were identified as follows, although this is recognized to be only a partial list.
  + Commodity flows vs. shipments vs. vehicle trips vs. vehicle tours?
  + Commodity weights vs. commodity values?
  + Single transactions between firms vs. longer term relationships?

Given the nature of the resource papers and other papers presented at the conference, the focus of the modeling discussion gravitated toward the implications of freight system microsimulation. The general consensus in the workshop was that it is not yet possible to credibly microsimulate the entire freight system. In fact, there was a diversity of opinion as to whether it was even necessary to adopt microsimulation methods for representing the entire freight system. While there was a common view that microsimulating the logistics side of freight systems would lead to significantly improved models, not all agreed that microsimulation of the demand side was always worthwhile. Depending on the application, only parts of the freight system may require disaggregate representation, and different levels of disaggregation might be appropriate depending on the application.

Despite the variety of opinions about some aspects of microsimulation modeling, and the issues that were identified, all participants considered that research in microsimulation modeling should be actively pursued because of the many remaining unanswered questions, and its strong potential to address many of the behavioral concerns associated with more aggregate models

The following suggestions were considered to be fruitful directions for continued research in freight system microsimulation.

* Interfaces between different scales of freight such as international, national, and urban freight traffic should be further developed.
* Interactions between agents should be represented, as should the external influences that constrain agent behavior
* Supply chains need to be built into the model, possibly with explicit representation of collaboration and/or competition between agents in markets. Promising methods for representing collaboration include the explicit representation of contracts, and the distribution channel approach.
* Statistical methods should be explored to address the dimensionality of microsimulation.
* In addition to model calibration, rigorous validation techniques should be developed and applied to test forecasting capabilities.
* When developing microsimulation models, feasibility for practical application in terms of computation and application times, should be considered.

**Data**

Data acquisition is a major on-going challenge for freight modeling. In most nations only a patchwork of data are available for modeling, with the most pervasive data deficiencies at the urban level. To address this situation, and to collectively move beyond the “lack of freight data”, there is a need for the research community to engage governments to coordinate, collect, and share consistent and extensive freight datasets.

Concerns about the security of proprietary data is a frequently cited factor that deters businesses from sharing data with government, or other organizations conducting surveys. For this reason, it is imperative that the research community build a “trust interface” with the private sector. This trust interface is founded on at least two notions.

* Data security must be taken seriously, particularly in situations where data may be sensitive (e.g., financial data, customer names and locations). This does not mean that data should not be shared for research purposes (in fact the workshop participants suggested that some disaggregate business data should be made publically available, similar to the Public Use Microdata Sample files from the Census or American Community Survey). Rather, it means that a culture of confidentiality is maintained in the research environment so that breaches of privacy do not occur and that the perception of confidentiality is preserved. New technologies for archiving and disseminating data appropriately and in a secure manner have been developed in the field of computer science are one avenue that could be exploited towards achieving this culture of confidentiality.
* “Win-win” situations need to be generated in which private sector firms perceive tangible benefits in return for data sharing. These benefits do not necessarily need to come in the form of financial incentive (such incentives can sometimes cause conflicts of interest), but can be donations to charity, provision of results of the final project report, or preferably some benefits to their customers.

New advances in freight survey methods are also needed to improve the quality of data that are collected, to further our understanding of freight systems and to support model building. For example, from the perspective of behavioral understanding, we need to develop instruments that can be sensitive to situations in which more than one decision-maker negotiate decisions jointly. Although not much time was spent on the topic, it was acknowledged that a great deal of potential for fruitful research would arise from the development of new survey techniques.

The manner in which data are collected, methodology employed, sample size, and selection bias are, of course, also continuing concerns and need to be addressed to ensure adequate data quality. In particular, methods for improving low response rates are in great need.

1. **Conclusion**

Overall, workshop W4 was a stimulating and productive discussion that assessed the state of research in freight behavior, modeling and data. Although the workshop generated far more questions than answers, a range of new ideas for analysis and modeling of freight transportation did arise. This report summarizes the essence of the many discussions that took place, with the aim of providing guidance for future research in the freight transportation research community.

**Acknowledgement**

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