FREIGHT TRANSPORTATION: WHO IS THE DECISION MAKER?

Stephanie McCabe, Helen Kwan, Matthew J. Roorda
Department of Civil Engineering, University of Toronto Email:
smccabe@gmail.com, helen_kwan1@hotmail.com, roordam@ecf.utoronto.ca

INTRODUCTION

Currently available freight models for public sector decision making do not adequately represent the multitude of actors that participate in the supply chain, and they represent the many decisions that influence the movement of goods very simplistically, if at all. The diverse decision making entities and the many interactions between them (Dedek, 2004) makes an understanding of "bigger picture" of the freight transport system difficult. Ultimately, public sector policy-making and planning suffers, since the impacts of freight transportation improvements on businesses, the transportation industry and the end consumers of products are largely uncertain. Therefore, a better understanding of the relationships of all stakeholders involved and their behaviour in the goods movement system is crucial. This paper characterizes the major actors that influence freight transportation, the interactions between those actors, and the key decisions that each actor is responsible for. Our exploration of the roles and relationships of the decision makers in freight is accomplished through a review of the literature. Based on the results of this review, the major decisions and actors for these decisions are identified,

abstracted and mapped using Unified Modelling Language (UML) notation. Given the diverse and dynamic nature of business and logistics, we recognize that there is no simple "one size fits all" representation of the supply chain that will adequately describe all companies. Therefore, a model structure that emphasizes the decisions made by actors, rather than the actors themselves is provided as the most appropriate abstraction of the supply chain.

DECISION MAKERS AND THEIR INTER-RELATIONSHIPS

This section provides a characterization of the decision makers in the supply chain and the complex relationships between them. The words actor and decision maker are used interchangeably throughout this paper. Actors are people or organizations that can be affected by or influence the freight system. This definition recognizes the fact that many organizations beyond just the shipper or carrier are decision makers in the freight process. This is argued by Regan and Garrido who states:

"Freight demand models should consider not only the two primary actors, that is the shipper and carrier, but also the chain of intermediaries that are more and more involved in the distribution business: freight forwarders, brokers, facilitators, agents, etc. These new actors may have an important impact on the modelling variables such as quality of service and prices." (2002).

Receivers

The receiver receives the goods at a firm. It is important to note that all firms can be shippers, receivers and customers. From the point of view of the receiver, the most important decisions are concerned with level of service, such as shipment speed, reliability, and the resulting ability to maintain a desired level of stock (Ogden,1992). Winston also emphasizes the importance of level of service and states the receiver's main concerns are associated with high service quality (1981). He also states that the receiver can be the decision maker with respect to mode choice (1981).

Shippers

A shipper is a company that distributes goods to other firms or households. Shippers can be from any industry, including manufacturing, wholesale and retail. A shipping company can also act as a receiver in many instances. Shippers have many responsibilities in the supply chain, but there is some disagreement in the literature over the scope and extent of those responsibilities, presumably because the characteristics of shippers are diverse. According to Ogden, the main decisions for shippers in the freight system concern the distribution and mode choice of the good (Ogden, 1992). The shipper is responsible for controlling product availability (Wisetjindawat and Sano, 2003) and the ownership rights of the commodities (Hensher, 2003). In addition, the shipper usually arranges and pays for freight transport. The specific attributes of the transportation such as travel

time and route generally are not of the shipper's interest as long as the goods arrive at an agreed time (Hensher, 2003). Some, but not all, shippers place a premium on low cost freight transportation (Winston, 1981). The shipper primarily makes or outsources mode choice decisions, although the receiver may also be involved (Ogden, 1992).

Shipments may be moved using a private fleet or may be outsourced to a carrier. The shipping company considers transportation cost (including the costs of labour, the difficulty of finding reliable drivers, administrative, repair and fuel costs) against service quality when deciding to own a private fleet. The decision to own a private fleet or hire a carrier is not a simple one, however, when a carrier is hired, the firm is mainly concerned with speed and reliability of the shipment and not solely cost (Regan and Garrido, 2002). Whether or not transportation is outsourced to a carrier, the shipping company provides the infrastructure that allows for the loading, such as a loading dock.

When a private fleet is used, the shipper is the main decision maker with respect to route and mode. Shippers with private fleets also make decisions regarding usage of truck capacity. If a particular shipment is time sensitive, the truck may go out not fully loaded. In addition, the shipper will make decisions regarding the routing of the truck, for example if a single direct delivery is made or a tour is formed with multiple deliveries.

If a shipper does not own a private fleet, then a carrier(s) may be hired directly. Shippers are now deciding between fewer carriers and entering into long-term relationships with these carriers. Larson found that carrier reduction leads to better customer service, less loss and damage, more reliable (on-time) delivery, and lower total logistics costs (Larson 1998 as cited in Regan and Garrido, 2002).

Carriers

Carrier companies move goods using their own vehicles. There are four main types of carrier firms: for-hire, owner-operators, government motor carriers and private fleets (Ogden, 1992). Carriers may provide services using one or more different modes, including air, truck, marine rail and/or intermodal.

One of the main strategic decisions that the carrier makes is the type and number of vehicles to own based on a desired level of service, profit and costs. The carrier will decide how to best move the goods between their origin and destination (Hensher, 2003) by selecting mode and route (Wisetjindawat and Sano, 2003). These decisions can also be made jointly with the shipping firm or may be dictated by the shipping firm. Therefore, the mode and route choice decisions are made by the shipping company, carrier company or both together. This decision making process can change for each shipment which makes the relationship complicated on a multi-shipment level.

Logistics Companies

The decisions made by logistics companies (including freight forwarders, 3PL, 4PL, etc.) tend to vary in depth and scope. Some logistics companies will manage the entire supply chain and others will just help with carrier selection. Some of the services provided by logistics companies include: warehousing operations, freight payments and auditing, carrier selection, rate negotiations, inventory control measures, packing services, product testing, fleet management, and shipment consolidation (Lieb and Randall, 1999). A variety of different actors including shippers and receivers outsource services to logistics firms. In North America in 2005, 73% of companies have some services outsourced to logistics firms (Langley, 2005). This increased delegation of responsibility to logistics firms blurs the distinction between shippers and logistics firms.

Vehicle Operator

The vehicle operator is the representative for the shipping and/or carrier company and is responsible for the safety and security of the load (Ogden, 1992). The operator is the service representative to the receiver of the goods and thus plays an important marketing role for the company. More importantly, the vehicle operator usually selects the route used to drive from origin to destination. Although the carrier firm may designate a route for the driver, the vehicle operator may dynamically change the planned route in response traffic congestion. Furthermore, the operator may stop for personal reasons such as meals.

These additional stops can influence the route, timing and even the order of deliveries.

Other Actors

Some of the other actors that are important in freight transportation but are not discussed in detail in the scope of this paper are listed below.

- Customers- represent the final demand for the product and can be a business or household
- Terminal Operators- the operators at facilities where vehicles drop off or pick up goods when there is a intermodal transfer or a transfer (i.e. consolidation or deconsolidation) between urban trucking operations and line haul trucking operations (Ogden, 1992).
- Government Organizations- Responsible for a variety of decisions including regulations and funding of infrastructure

CONCEPTUAL FRAMEWORK FREIGHT TRANSPORTATION DECISIONS

The challenge in characterizing the decision making process for goods movement is that no single actor necessarily makes all of the decisions for a particular goods shipment. Furthermore, because supply chains are heterogeneous, the type of company that makes each of the different decisions is inconsistent from one supply chain to the next. Therefore a generalized conceptual framework is required to accurately reflect the heterogeneity in responsibility for various decisions

required to move a good. We call it a "decision-oriented" framework.

In the decision-oriented framework, the entity responsible for a particular decision is generalized as a superclass and the specific type of company or individual that is assigned to make that decision is defined as a subclass. Subclasses share all of the features of the superclass; however, each individual subclass has unique features that differentiate it from other subclasses. The unique features that are of importance are those that have potential to influence decisions. These include:

1) Access to resources – Resources open up options for a particular decision. Vehicles, distribution centres, drivers, technology all are tangible examples of resources that can be utilized to improve service and efficiency.

2) Access to information – Better information improves decision making. For example, if a carrier, hired by a shipper is given information about future shipments, they are able to better optimize the usage of their vehicle fleet. A carrier with access to real-time information about traffic conditions can improve their route choice decisions, thus reducing delay.

3) Access to expertise – Expertise can lead to greater efficiency. For example, a shipper may select carriers for their own shipments, however, they may prefer to outsource carrier selection to a logistics firm with greater experience making these decisions, resulting in improved service at lower rates.

4) Access to economies of scale – Because of their size and service to a greater variety of markets, larger

carriers may be able consolidate loads more efficiently, achieving higher load factors than shippers' private fleets moving only their own goods.

The decision of route choice, shown in Figure 1, shows a variety of actors can influence this decision as each actor has unique features as outlined in the decision-oriented framework.

Given that diverse actors may be involved in logistics decisions, a framework is needed to show how decision making is delegated at the strategic logistics planning stage and how that translates into shorter term decision-making for goods movement. The next two sections present example components of such a framework, depicting a sequence of decisions that are based on our review of the literature. However, it is clear from the literature that the sequence of decisions may vary from one firm to the next. We present our "best knowledge" depiction of the decision-making process, recognizing that exceptions to the model exist. In addition, this analysis focuses on physical goods movement process recognizing at the same time that the role of technology, and information exchange also play at part in most points of the process.

Shipping Firm's Strategic Logistics Planning

The shipper firm's planning decision is depicted in Figure 2. A similar activity diagram could be drawn for the carriers and logistics companies as well; but the shipper is used as an example. This activity diagram consists of long

term planning decisions for a shipping firm that ultimately influence the transport of goods from their firm. This set of decisions is crucial, because it assigns decision makers (e.g. carriers or logistics firms) to be responsible for the many decisions that affect day-to-day transport operations.

The activity diagram begins with a **demand forecast**, which is the basis for the firm's anticipated transportation requirements within the supply chain. Transportation demand planning allows the firm (or another firm to which the task is outsourced) to determine optimal stock, the need for warehousing/ distribution centres, and the number of required vehicles. However, this information is usually stored by different firms and is not available to all members of one supply chain (Stadtler and Kilger, 2005). As a result, demand planning can be a difficult step for the firm, resulting in uncertainties that lead to larger levels of required safety stock, larger warehouses, and a fleet size that may be inappropriate.

The decision to **outsource warehousing/distribution centre operations** is made by those companies that wish to focus on their core business and contract all logistics services, including the logistics associated with storage, consolidation, etc. to a logistics firm that is specialized in providing those services. There exists a trend toward the contracting out of such long term logistics services rather than the traditional outsourcing of transportation services on a transaction-by-transaction basis (Murphy and Poist, 1998). Long-term outsourcing arrangements require that

the shipper **negotiate a long-term contract** with the logistics firm.

If warehousing/distribution centre operations are not outsourced, the shipper makes decisions regarding the number, location and capacity of the warehouses/distribution centres.

The decision to **outsource transportation services** involves many considerations for a firm as it has major implications on customer service, capital investment, operating expenses, and managerial responsibilities (Min, 1998). A private fleet offers greater service flexibility; however the firm must carry more financial burden and risk. A private fleet also offers such benefits as more prominent advertising for the firm. However, a major challenge with a private fleet is to minimize empty miles. The use of a common carrier is attractive as they can often offer freight transportation services at lower costs due to competition and economies of scale (Min, 1998).

The outsourcing of transportation services can be arranged through a **long-term contract(s)** with a carrier or a logistics firm, or can involve the selection and hiring of carriers for individual shipments or for short term contracts. If the firm elects to arrange a long-term contract, then the shipping firm **negotiates a contract** for the services. Although price is an important aspect of service, many purchasers value timely pickup and delivery more highly (Milligan, 1999 as cited in Kuo and Soflarsky, 2003). Just-in-time delivery is an example of

strong contractual arrangements in which heavy penalties are introduced for late deliveries.

Shippers that elect to maintain a private fleet are required to **hire vehicle operators**. Some industry experts feel this is the most difficult task in the logistics chain. Recruiting and retention of drivers has become difficult due to new safety standards, drug testing, hours of service records, unchanging driver salaries, an aging driver population and driver's license requirements (Bowman, 1998; Johnson and Wood, 1996 as cited in Min, 1998). These challenges influence the shipping firm's decision to outsource or have a private fleet.

Goods Movement Process

The goods movement process is depicted in the activity diagram shown in Figure 3. The goods movement process begins when the actor responsible for transporting the shipment (i.e. carrier, logistics firm or the shipper themselves) is able to **identify shipment attributes**, such as origin, destination, pick-up time window, delivery time window, volume and/or weight and any special transportation or handling requirements.

The next two steps are **transportation mode/carrier selection**. The sequence of these two decisions and the degree to which they are made jointly are not consistent from firm to firm. Furthermore, in cases where a long-term contract has been established between the carrier and the shipper or logistics firm responsible for the

transportation of the shipment, the carrier selection (and possibly also mode selection) has already been made.

For the truck only mode, **off-site consolidation** decisions are the next step in the process. On a particular day, a carrier may have many orders from many customers to deliver goods with diverse origins and destinations. Consolidation allows for economies of scale to be exploited by the carrier such that greater load factors are achieved, larger more economic vehicles can be utilized, and fewer empty vehicle trips are made. Consolidation is also inherent in the process of intermodal transfer, although at a somewhat different scale than for truck consolidation. For example, at a rail-truck intermodal terminal, containers are transported to the terminal by truck and "consolidated" onto trains with many containers. The same occurs at container ports. Since, conceptually, truck and intermodal consolidation processes are similar (although the physical processes are very different), they are represented together in Figure 3.

In the non-consolidation branch of the decision making process, **vehicle type selection** is then made. Vehicle type choice depends on the attributes of the shipment, as identified above. Other factors include roadway regulations (e.g. vehicle weight restrictions), availability of the vehicles, availability of the drivers, and cost.

Scheduling of vehicles that are not shipping consolidated loads depends on driver availability, road network characteristics such as travel time and congestion, pick up and delivery time windows associated with the shipment,

loading and unloading times, and the other stops or shipments that must be made by that vehicle. **Route choice** also depends on road network characteristics such as truck route restrictions and tolls. The next step is vehicle **loading;** which directly affects vehicle scheduling. Loading and unloading decisions may be made by the vehicle operator or the receiver. **Physical movement** proceeds once the vehicle is loaded. In this step, the vehicle operator may dynamically adjust the route in response to unanticipated traffic congestion.

Unloading of the shipment occurs at the receiver's location. This step also can affect the vehicle schedule, since unloading can be time consuming and unpredictable.

Consolidation shipments, either intermodal or truck only, require additional **scheduling and coordination** upfront before the shipment is made. This additional scheduling and coordination is required because intermediate storage, loading, unloading, shipment handling, are involved. Consolidated shipments involve many of the same steps as are involved in the non-consolidation branch of the activity diagram, however, these steps are repeated more than once, for the pick-up leg, the line-haul leg(s), and the delivery leg of the journey. Two differences are notable from the non-consolidation branch. First, the shipment may require **storage** at the either the distribution centre where the load is consolidated, or at the distribution centre where the load is de-consolidated. Second, at either the pickup or delivery end, the shipment is more likely to be

coordinated as part of a tour, therefore, **tour-formation** is shown in Figure 3 to be a part of the route choice decision.

CONCLUSIONS AND FUTURE WORK

This paper has explored the various actors involved in the freight transportation component of the supply chain and the complex decisions and relationships among these actors. A variety of actors are involved at various stages of both strategic logistics planning, and tactical goods movement decisions. However, a trend towards long-term contracts and alliances, for example between shippers and carriers, shows that decision making is increasingly being delegated as part of the strategic planning of shipping firms. The delegation of decision making to logistics firms, carriers, or other types of firms, has implications for the outcomes of those decisions because different actors have differential access to resources, information, expertise and economies of scale. Therefore, it is important that delegated decision making be represented in conceptual and operational models of freight transportation. The "decision-oriented" approach provided in this paper includes such a representation.

The conceptual model can be considered a starting point towards the development of an "agent-based" model that attempts to capture the variety of actors, relationships, decision making responsibilities, and goods movement outcomes described in this paper. Development of a comprehensive model will be difficult because of a well-documented lack of quantitative data for model estimation

(MTO, 2004; Region of Peel, 2004; Transport Canada, 2004a, b). The conceptual framework presented in this paper, therefore, can be used as a guide for data collection to support quantitative analysis of behaviour at each identified stage of decision making.

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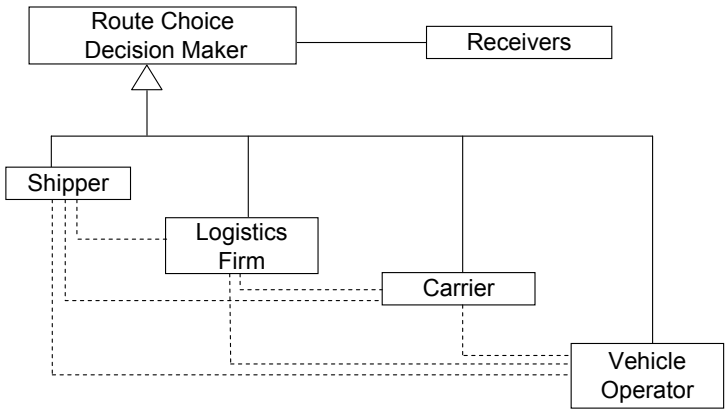

Figure 1: Class Diagram

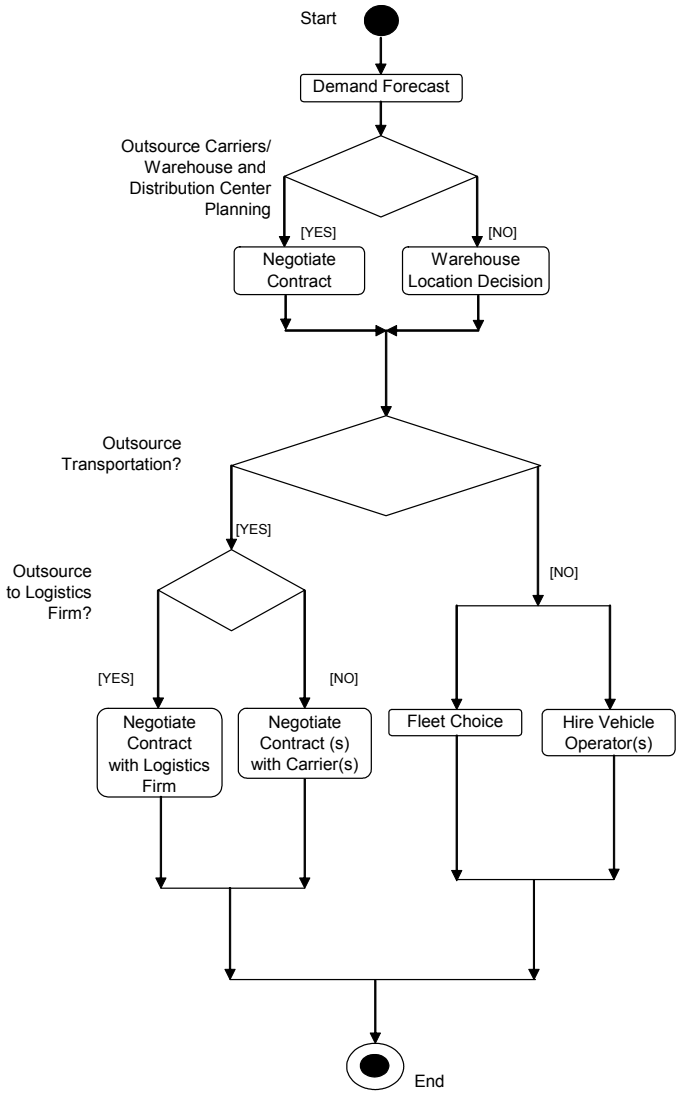

Figure 2: Shipping Firm's Strategic Logistics Planning

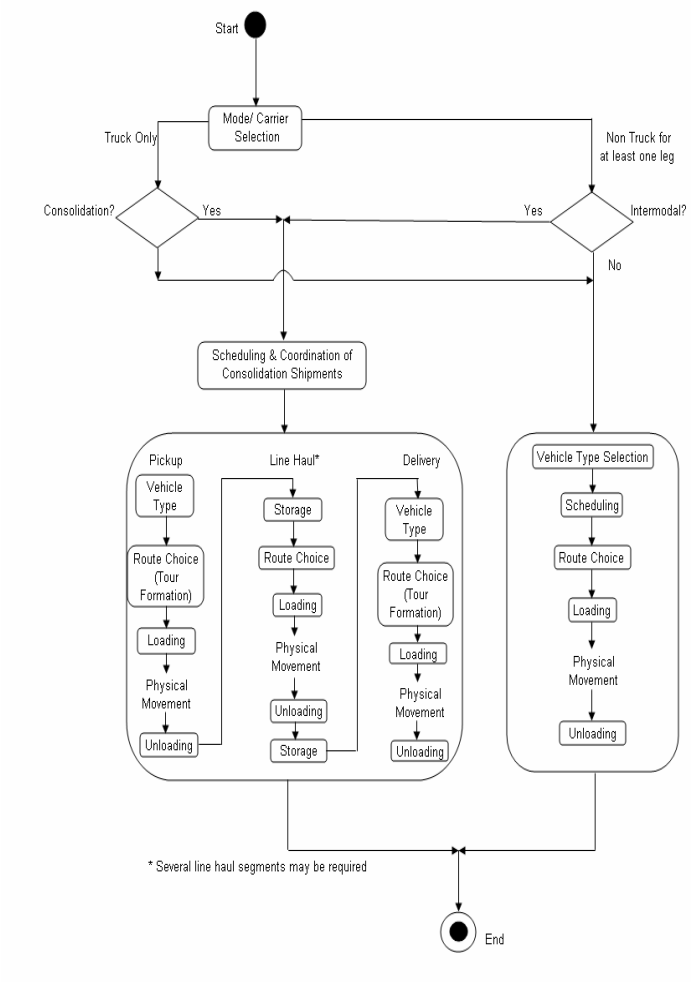

Figure 3: Goods Movement Decisions