

Coordinated inventory replenishment and outsourced transportation operations



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ABSTRACT

We consider a one-warehouse N retailers supply chain with stochastic demand. Inventory is managed in-house whereas transportation is outsourced to a 3PL provider. We develop analytical expressions for the operating characteristics under both periodic and continuous joint replenishment policies. We identify the settings where a periodic review policy is comparable to a continuous review one. In our numerical test-bed, the periodic policy performed best in larger supply chains operating with larger trucks. We also observed that if the excess utilization charge is less than 25%, outsourcing becomes beneficial even if outsourcing cost is 25% more than the in-house fleet costs.

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1. Introduction

Inventory management and transportation are among the major operations of supply chains. In practice, these operations are generally managed in a decoupled fashion. Approximately 1.2 trillion USD or about 8.5% of the US GDP is attributed to the total logistics activities in USA in 2011 (Burnson, 2012). Of these logistics costs, transportation (largely trucking costs) accounted for 63% while inventory carrying costs accounted for 33% in the US economy in 2002 (FHWA, 2005). A recent study by Büyükkaramikli et al. (2014) reveals the value of coordinating these two logistics operations in a particular setting in which retail orders are centrally shipped by an in-house fleet of vehicles from a warehouse or a distributor to multiple retailers. We extend this model to consider the case where the transportation operations are outsourced to a third party logistics (3PL) provider through a transportation contract. In particular, we consider a one-warehouse- N -retailer supply chain where inventory replenishment decisions at the retailers are made in a coordinated fashion and the retail orders are shipped by a third party carrier with their own fleet of vehicles according to the terms of a contract. Firms started to use outsourcing as a strategic management tool since 1990s and have been outsourcing some of their key business operations including logistics since then (Craumer, 2002). As mentioned by Lieb and Bentz (2005), outsourcing logistics functions has been favorable among large US manufacturers not just to control costs but also as a means of differentiation in domestic and international markets.

3PL companies provide a broad collection of logistics activities including freight forwarding, consolidation centers, direct transportation service, inventory management/replenishment, warehouse management, in-store logistics, delivery services, and reverse logistics (see Ton and Wheelwright, 2005, for a full list). The market for 3PL providers increases gradually in

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years; the gross revenue of the global market was 391 Billion USD in 2007 (Lin and Yen, 2008) whereas this figure jumped to 616.1 Billion USD in 2011 (Langley and Capgemini, 2013). The results of the annual 2013 3PL survey show the size and the benefits of outsourcing logistics, based on more than 2000 companies captured worldwide by the survey: (i) firms that use 3PL providers spend about 12% of their revenues to logistics costs whereas 39% of this cost is spent for outsourced logistics activities, and (ii) outsourcing accounted for a 15% cost reduction in logistics operations on the average for all companies worldwide. Even though 3PL providers offer a wide range of logistics activities to their customers, the “transactional, operational, and repetitive” activities, such as transportation, are the ones that are outsourced the most; whereas “more strategic, customer facing and IT-intensive” activities, such as inventory management, order management and fulfillment are less frequently outsourced (Langley and Capgemini, 2013). Fig. 1 compares the worldwide percentages of logistics activities outsourced and percentages of 3PL companies that provide such services.

In this study, we consider a firm which prefers to outsource only the transportation operation and runs the inventory management in-house. Economies of scale, savings in capital investments, and reduction in financial risks are among the advantages of using 3PL providers for transportation (Vasiliauskas and Jakubauskas, 2007). Other advantages are increasing efficiency, controlling costs, and reliability and speed (Ton and Wheelwright, 2005). The continuous growth in the 3PL market lead to consolidation in 3PL industry, and large 3PL companies have emerged consequently (Selviaridis and Spring, 2007). For example, Giraud Logistics acquired four transportation operators from Belgium, France, Spain and Italy between the years 1999 and 2001 (Carbone and Stone, 2005), which further was acquired by Geodis Logistics in the year 2010 (EUbusiness, 2010). Such giant logistics companies serve to a wide collection of customers including shippers, receivers, and carriers. These are either “asset-based” or “non-asset-based” companies depending on whether they own their fleet or not. Non-asset-based companies find transportation capacity from the market whenever necessary. Asset-based 3PL companies also can find additional transportation capacity easily from the market whenever necessary (Applegate, 2002). Therefore, one can safely assume that 3PL providers do not experience any constraint on the number of trucks that they can provide to their customers, in general.

There are substantial number of papers in literature that deal with different aspects of 3PL transportation. For example, Alp et al. (2003) deal with an inventory control problem under deterministic demand and stochastic lead time where transportation is conducted by a 3PL provider. Cai et al. (2013) consider the pricing decision of a 3PL provider and its impact on the performance of a supply chain where a producer ships fresh products to a downstream distributor which resells the product to end customers. Li et al. (2008) deal with the problem of coordinating 3PL transportation with manufacturing scheduling in a make-to-order consumer electronics supply chain. Ulku and Bookbinder (2012) deal with the price and delivery time quotation decisions of a 3PL provider in a price and time sensitive logistics market for a long range haul between an origin and destination.

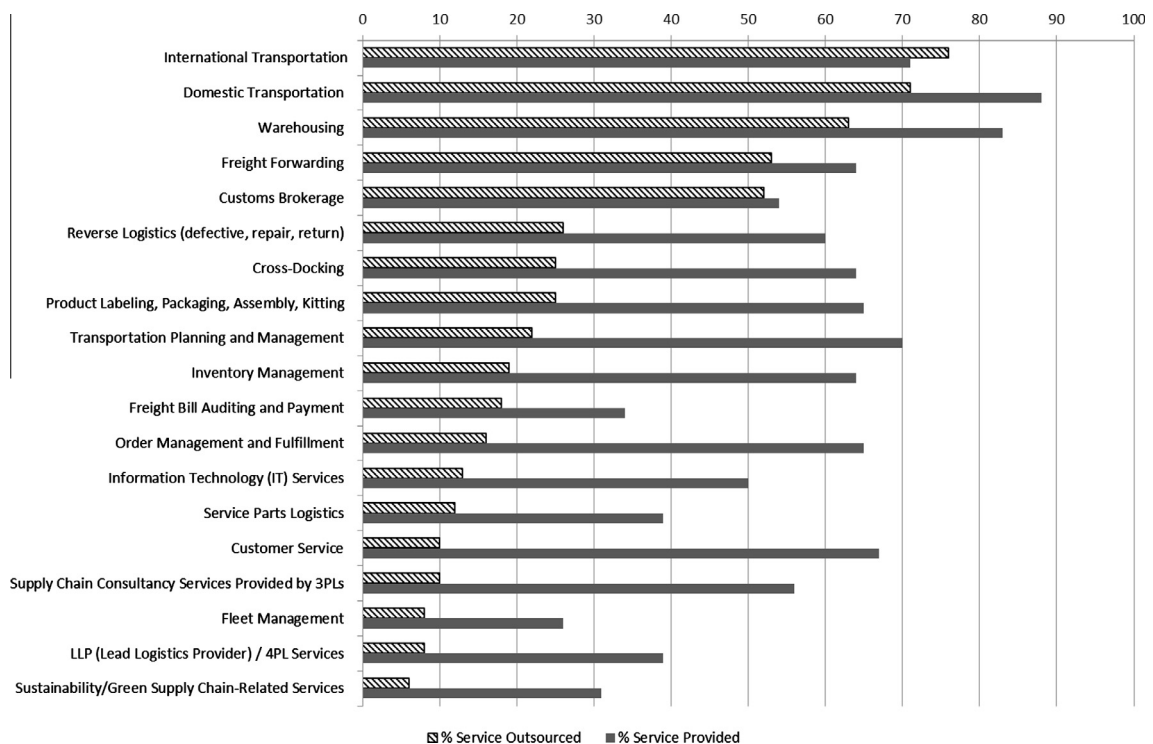


Fig. 1. Percentage of logistics activities outsourced vs provided by 3PL companies (source: Langley and Capgemini, 2013).

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