Chapter 26
Order Picking Performance in Warehouses With Multi-Item Orders

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ABSTRACT

Internet sales have increased exponentially in the last decade. Much of the internet sales are of physical products in urban areas that require product delivery transportation with a tight delivery lead time. With this challenge, a new type of transportation services has been developed aiming to cope with a strict control of transportation lead time. In this chapter, an internet product delivery service with customer orders that are multi-item as well as single item is simulated. The authors address specifically the mismatch between supply and demand when retailers for any reason are unable to estimate the configuration of multi-item orders. Three scenarios of demand patterns are simulated (demand as forecasted, lower than forecasted, and higher than forecasted) using discrete-event simulation to look at the effect on transportation lead time. Results show the positive effect on the mismatch between demand and resource capacity which is expressed in higher number delayed delivery orders. The excess of capacity in the product delivery supply chain has not had a positive impact on delivery time of orders.

INTRODUCTION

Transportation services in urban areas have changed in the last years in terms of collaboration, configuration, operational practices and performance expectations. These challenges come from several factors that have changed the rules for providing competitive transportation services. Changes in product transportation management can be attributed to three main driving forces: Customers are raising their service expectations including the delivery of perishable products (Choi 2016). Customer demands for quick response and customized products are propagating along supply networks (Kibert 2016). Changes in life style of people require manufacturers and service providers to adjust to the new circumstances (Boyer and Frohlich 2015). Information technologies are providing more timely and detailed supply chain

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data that improves the performance of the transportation services (Waller and Fawcett 2013). Advances
in information technologies in both connectivity and reach increase the potential for information shar-
ing and enable tighter integration among supply chain partners (Zhang et al. 2011). Partnerships with
transportation service providers allow manufacturers to focus on their core competences while taking
advantage of the distribution efficiency and expertise of dedicated distributors (Yinan 2016). In turn,
distributors are offering their services beyond the traditional warehousing and transportation functions
to include value-added activities e.g., repackaging, labeling, light assembly, and non-inventory distribution
services of which cross-docking and merge-in-transit distribution are examples.

Merge-in-transit distribution (MiT) is a logistics process introduced to cope with consolidation of
orders in the same shipment (O’Leary 2000). Merge-in-transit is a distribution process that brings together
at a consolidation center multi-product order components, coming from different origins, consolidates
them into a single order, and then ships it for final delivery to the end customers. Some of the advantages
obtained with MiT are: higher customer satisfaction is obtained by delivering multi-product orders in
one event instead of making more than one delivery, one for each component or partial group of them.
Savings are achieved by not keeping inventories in the distribution process, since merge-in-transit centers
just hold order components for a short time (usually less than 24 hours) so the order is all the way in
transit to its final delivery point. Holding costs associated with warehousing operations are avoided or
at least minimized. Third, savings also arise by avoiding the risk of keeping obsolete inventories. MiT is
normally applied to distribute orders where sometimes one component has been made-to-order. Those
tailored components have been made for a specific need and are never kept in stock so there is no risk
of keeping obsolete components (Ala-Risku et al. 2013).

Product consolidation in the context of internet retailing has been researched with the name of
Merge-in-Transit (Kopczak 1995), looking at logistics partnership and supply chain restructuring. Cole
and Parthasarathy (1998) develop a linear programming model to design optimal MiT distribution net-
works and a decision support system for the same purpose. Croxton et al. (2003) developed an integer
programming formulations and solution methods for addressing operational issues in MiT distribution.
Cannella et al. (2016) have also studied the lead time performance of supply chains in the context of
reverse logistics. The models account for various complex problem features, including the integration
of inventory and transportation decisions, the dynamic and multimodal component of MiT distribution
and the specific structure of particular cost functions that arise in MiT. Ala-Risku et al. (2003) devel-
oped a guideline for logistics managers on how to evaluate the applicability of MiT operations for their
particular business situation. Karkkainen et al. (2003) presented a description of differences between
MiT and crossdocking from the point of view of how operations are carried out in merging points and
cross docks respectively, customer service implications and suitability for different business sectors. It
can be seen after the literature review that MiT has not yet been researched concerning the stochastic
behavior of the system. Monsreal and Cruz-Mejia (2014) have also integrated the solution of production
and distribution systems in supply chains for improving operational performance in reverse logistics. MiT
has implicit transportation operations, order assembly operations, inventory carrying and corresponding
inventory management decisions, demand fluctuation estimation and demand pattern estimation. None
of the research works in MiT has addressed all these sources of uncertainty in the operation of MiT.
This work aims to fill the gap on studying stochasticity in MiT product delivery supply chains. In the
next section we develop a prototypical scenario.