# Increasing customer value and decreasing distribution costs with merge-in-transit

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**Keywords** *Logistics, Supply-chain management, Customers, Value, Distribution, Strategy*

**Abstract** *A broad product assortment is usually valued highly by customers. However, holding a great number of product variants in inventory increases the costs of a supplier. It is possible to reduce need for warehousing with direct deliveries from manufacturing units, but customer value is reduced when orders are received on several shipments. Merge-in-transit is a distribution method in which goods shipped from several supply locations are consolidated into one final customer delivery while they are in transit. This article examines the effects of merge-in-transit distribution on delivery costs. The analysis is performed with a maintenance, repair, and operations products distributor as the case company. The evidence in this article supports the claim of merge-in-transit being a cost efficient distribution alternative in business networks. Based on the results advocates that companies in multi-company networks should study the possibility of using the merge-in-transit delivery model.*

## Introduction

Presenting more valuable solutions to customers while decreasing the associated costs is the biggest challenge and main goal in supply chain management (Hoover *et al.*, 2001, p. 7). The traditional way to create customer value is to offer a broad assortment of products at as low a price as possible (Bowersox *et al.*, 2000). However, broadening the product assortment also increases the costs of the supplier (Putsis and Bayus, 2001; Boatwright and Nunes, 2001). Successful companies create customer value in such a way that an optimal cost/benefit trade-off is reached and the profit contribution for the company is maximised (Christopher, 1992, pp. 24-52). Nevertheless, the most valuable solutions are those that increase customer value while simultaneously reducing costs.

Providing all the products that the customer needs, and delivering them in one drop-off is a valuable service for the customer (Bowersox *et al.*, 2000). A wide product offering is important as customers can then use fewer suppliers, reducing their co-ordination and transaction costs (Daniels and Klimis, 1999). Getting everything delivered in one lot is important for the customer, because

The authors would like to acknowledge Hannu Heikkonen from Kauppatalo Hansel Oy for his co-operation, and his fruitful ideas during the case study. The authors are also indebted to TEKES, Tekniikan edistämissäätiö and Kuorma-autoliikenteen Volvo-säätiö for the funding of this research.

International Journal of Physical Distribution & Logistics Management
Vol. 33 No. 2, 2003
pp. 132-148

0960-0035
DOI 10.1108/09600030310469144

receiving several shipments incurs notable costs to the customer (Manunen, 2000). How then can the supplier provide this service to the customer?

For suppliers, the conventional way of widening their product offering has been increasing the number of stock-keeping units (SKUs), i.e. the supplier keeps an inventory of all the products it offers to its customers. However, this is an expensive practice for the supplier, because inventory carrying and warehousing costs are increased. If the number of SKUs becomes considerably large, e.g. one-stop shopping is enabled for very different types of customers, the inventory-related costs of the supplier will also become unreasonably high (Putsis and Bayus, 2001). This is because each SKU necessitates certain inventory management activities (Bowersox and Closs, 1996, pp. 281-306).

Thus, even if a broad assortment of products would be advisable from a marketing point of view, it may prove infeasible due to inventory related costs. As the number of product variants grows, the marginal increase in customer value by adding SKUs becomes too expensive in an inventory based service model. Direct deliveries from manufacturing units to the customer decrease the need for central warehousing, but result in multiple deliveries to the customer, thus reducing customer value. Merge-in-transit distribution is a new option for delivering customer orders.

Merge-in-transit distribution enables suppliers to offer a large variety of products and deliver them to the customer with one drop-off, without the need for centrally storing the products. Merge-in-transit distribution refers to a process of consolidating goods from several locations into one final customer delivery while they are in transit (Bradley *et al.*, 1998; McLeod, 1999; Dawe, 1997).

There are some practitioner-oriented articles covering the issue of merge-in-transit (see, e.g. Bradley *et al.*, 1998; McLeod, 1999; Richardson, 1994; Dawe, 1997). However, there is little academic research on the subject, and a lack of results on the economical impact of merge-in-transit distribution. One unpublished academic study has been prepared by Kopczak and Fransoo (2000). The study presents the areas, from which economic benefits can be expected (Bradley *et al.*, 1998; Geologistics, 2002). The main benefits of merge-in-transit were seen to be derived from the added value to the customer, reduced process costs due to lower total inventory levels and reduced transportation costs. Hau Lee also singles merge-in-transit out as one of the four key logistics enablers of successful e-commerce (Lee and Whang, 2001). However, no quantitative results of the cost effects of merge-in-transit distribution have been presented. Further information on the cost effects of merge-in-transit would increase the attractiveness of this distribution model and contribute to the development of new logistics services.

The aim of this article is to examine the effects of merge-in-transit on distribution costs. The quantitative analysis is performed with data from a distributor in the field of business-to-business e-commerce of maintenance, repair, and operations (MRO) products. The first section of this article discusses different possibilities of delivering goods to the customer. The second part presents the setting of the case used in our study. The results of our case are reported in the third section. These results are analysed in the fourth part of the article, and in the final section we make concluding remarks of this analysis and present areas in need of further research.

## Distribution alternatives

This section examines the basic options of organising customer deliveries. As discussed above, holding the whole product assortment in supplier's inventory is the traditional way of organising distribution. But since it is an expensive way of operating, if not totally infeasible if the product assortment including variations is vast, we will focus on other distribution models.

To decrease inventory-related costs, many companies have begun to use direct deliveries, i.e. their suppliers deliver the ordered goods directly to the customer. This enables offering a broad product assortment without holding all product variants in inventory. However, the value for the customer is lower when operating with direct deliveries, because of the costs associated with receiving several shipments. Furthermore, direct deliveries often result in several invoices (one from each supplier), the processing of which also causes significant costs to the customers (Kestilä, 2001; Wallström, 2001). Thus, although direct distribution can reduce costs incurred by the supplier, customer value is decreased.

It is possible, however, to build innovative distribution solutions that increase customer value while simultaneously lowering costs (Kärkkäinen and Holmström, 2002; Hoover *et al.*, 2001, pp. 37-68). A good example of an innovative distribution solution simultaneously increasing customer value and decreasing process costs is cross-docking, made famous by Wal-Mart. In cross-docking the customers (individual stores in the case of Wal-Mart) can receive loads containing an optimal mix and amount of products daily, while the batches arriving at the distribution centres are optimised to minimise product and process cost. (Stalk *et al.*, 1992). The value for the store is increased, as it gets all the needed goods in one delivery, and the quantity of incoming shipments is well adjusted to the shelf replenishment system. Also, the costs of the operations are decreased due to increased efficiency achieved by consolidating the flows of goods in distribution centres.

Due to its characteristics, cross-docking is most appropriate for perishable products and fast-moving products with a predictable, high demand (Aichlmayr, 2001). In distribution networks with a higher number of customers and lower ordering frequencies, the material flows to each customer are too thin to justify static cross-docking arrangements. Such a situation is common for industrial distributors and wholesalers, for example in the trade of maintenance, repair, and operation (MRO) goods.

Another way of simultaneously increasing customer value and lowering costs is merge-in-transit distribution. Merge-in-transit is closely related to cross-docking, but it is more flexible in the customer-end of the process. It refers to a process of uniting multiple component-shipments from several suppliers into one final customer delivery to fulfil one customer order (Bradley *et al.*, 1998; McLeod, 1999; Dawe, 1997). Besides customer order volumes, the difference between merge-in-transit and cross-docking is in the way orders are fulfilled. With merge-in-transit it is essential to identify all the component-shipments of a single order in the merging terminal and to ensure that all the components are delivered at once, delaying the earliest shipments if necessary. In a cross-docking situation the emphasis is more on process efficiency, as the shipments incoming to a terminal are forwarded with the next delivery to the customer, often regardless of the order they belong to. The operational efficiency achievable with merge-in-transit is not as high as with cross-docking, but it can be economically performed with a wide product offering and a large customer-base (Richardson, 1994; Dawe, 1997).

The most significant obstacle that has prevented cross-docking and merge-in-transit from becoming a common practice is the difficulty of managing it. This is because managing either operations model demands vast amounts of up-to-date information (Stalk *et al.*, 1992; Dawe, 1997; Schaffer, 1997; McLeod, 1999).

High-tech industries are considered to be prime candidates for merge-in-transit operations. Inventory carrying costs are high, products are often customised and there are numerous product variants (Bradley *et al.*, 1998; Dawe, 1997). With merge-in-transit distribution, high-tech components or products originating from different facilities can be consolidated into one final delivery without unnecessary inventories. This enables postponed assembly of customer-specific variants and reduces the need to store multiple configurations in several warehouses. Merge-in-transit is also considered to be a good operational model for distributors that offer products originating from more than one source (Dawe, 1997). The case study presented in this article is from a company operating as a distributor of MRO products.

## Case description

The focus of this article is on evaluating the effects of merge-in-transit on distribution costs. The distribution costs of merge-in-transit and direct delivery models are compared using data from a distributor of MRO products. The case company started to offer the merge-in-transit distribution as an alternative delivery model to its clientele in May 2002 (Heikkonen, 2002).

The case company in this paper is a Finnish MRO distributor, Kauppatalo Hansel Oy. Hansel is located in Helsinki, the capital of Finland. Hansel offers 2.5 million product variants to its customers, 6,000 of which it stores in its own warehouse in Helsinki. The rest of the products are stored by 500 suppliers included in Hansel's supplier network (Hansel, 2001). Hansel has about 6,000 electronically ordering organisational customers (Kossila, 2001).

Due to the extensive amount of product variants, Hansel has organised the distribution of the majority of products with direct deliveries from the suppliers, and holds only a small subset of its product offering in its own inventory. During the last years, Hansel has been developing a merge-in-transit distribution process with its transportation service provider with the aim of increasing customer value. The ability of delivering goods in one customer drop-off was perceived to be important especially as more and more customers turned to the electronic sales channel. The goal of the development project is to always fulfil one order in one delivery.

The merge-in-transit model has been developed in co-operation with the transportation service provider. Shipments belonging to a multi-supplier order are specifically marked as merge-in-transit consignments. The information regarding these shipments is delivered to the transportation service provider in advance either via an EDIFACT connection or through a web application, in which the needed information is entered manually.

In the beginning of merge-in-transit operations, all shipments are consolidated in one specific distribution centre (DC). Later the consolidation process will be expanded to distribution centres spanning the whole country. A majority of the suppliers included in the merge-in-transit process are in the vicinity of the DC where the operations start. This is because economic activities in Finland are concentrated in the southern regions of the country.

The goal of the merge-in-transit distribution model was to increase the customer's added value, and thus gain competitive advantage. However, the cost effects of the merge-in-transit distribution model were not clear to the case company even while it was planning implementation. Together with experts from the distributor, our research team engaged in a study to discover the effects of merge-in-transit on distribution costs.

To support the study, a simulation model for assessing distribution costs of different kinds of deliveries was constructed. The model calculates the delivery chain costs in both the direct delivery and merge-in-transit operations models. The costing model is based on the current transportation service contract between Hansel and the transportation service provider. The costs reflect the actual prices that the transportation service provider currently charges from Hansel. The suppliers' outbound warehousing costs as well as the costs of the customer's receiving activities, were calculated by using an activity based costing model developed at The Technical Research Centre of Finland (VTT) (Aminoff *et al.*, 2000; Manunen, 2000). In the construction of the VTT model, cost information from 45 Finnish warehouses was used.

The tool needs the following attributes to calculate the distribution costs of a delivery:

- location of all the suppliers that participate in delivering an order;
- number of order lines per supplier;
- weight of each supplier's shipment; and
- location of the customer.

Using this information, the model calculates costs of different delivery chain phases.

Outbound warehousing costs of the supplier are based on average costs in Finnish warehouses (Aminoff *et al.*, 2000). The outbound warehousing cost of a delivery is estimated to be €9.6 + €3 times the order lines in the delivery.

The pick-up surcharge is derived from the pricing tables of the logistics service provider. It is applied if a supplier is not located in the vicinity of any of the service provider's distribution centres. The drop-off surcharge is similarly dependant on the customer's location.

Transportation and merging costs are derived from the pricing tables of the logistics service provider and dependant on the number and weight of consignments.

Customer receiving costs are based on average costs in Finnish warehouses (Manunen, 2000). The receiving cost of a delivery is estimated to be €14 + €4.5 times the order lines in the delivery.

The costs of direct delivery distribution and merge-in-transit distribution were compared using case deliveries. Case deliveries were selected to represent the whole spectrum of the deliveries, and to bring out the behaviour of total delivery chain costs in the two operational models.

## The effect of merge-in-transit on distribution costs

The two service models compared are:

(1) direct delivery from the suppliers to the final customer; and

(2) merge-in-transit in the delivery chain before delivery to the final customer.

Consolidating the deliveries near the source of supply reduces the number of shipments to be handled later in the delivery chain, which reduces the distribution costs. In theory, merge-in-transit is cost efficient in situations where processing deliveries is expensive compared to the cost of consolidation.

An average MRO order and three examples with more extreme attributes are used to illustrate the difference between the service models in the Hansel case. The case deliveries correspond to four situations in which a customer at different distances from the consolidation point orders products from either three or six different suppliers:

(1) In the first case – an average MRO order – the consolidation point is close to the customer and the suppliers. The size of the order is close to the median size of an order for the MRO distributor. The order contains 15 order lines from three suppliers.

(2) In the second case delivery the three suppliers are still close to the consolidation point, but the end customer is located farther away. The size of the order is also larger – it is in the top quartile. The order contains 41 order lines from three suppliers.

(3) In the third delivery the suppliers are located at a distance from the consolidation point, but very close to the end customer. The size of the order is close to the median size of an order for the MRO distributor. The order contains 16 order lines from three suppliers.
(4) In the last example the situation is the same as in the first example, except that the number of suppliers on the order is increased from three to six, i.e. the 15 order lines come from six different suppliers. The total size of the order remains the same, close to the median.

The results of the four different case deliveries are reported one by one in the following sections.

The costs represent the total delivery chain cost, which is important to keep in mind. Changing the service model also changes the division of costs between the companies in the delivery chain. However, in this study we mostly have a supply-chain-management viewpoint (Christopher, 1992, p. 13), and look at the delivery chain as a single entity without discussing the sharing of cost and benefits between individual companies.

*An average MRO order*

Our example of an ordinary MRO order contains 15 order lines that are shipped from three suppliers to a customer, all in the Helsinki capital area. The consolidation point is also located in the capital area, which makes all the transportation distances relatively short.

In the merge-in-transit model the shipments are first transported to the consolidation point. The consolidation point is the freight terminal of a third party logistics service provider. There the consolidation (merging) of the three supplier consignments takes place, and the merged consignment is then shipped to the customer as a single delivery. In the direct delivery model each supplier delivers directly to the end customer. The delivery costs are calculated with the same freight rates in the both distribution models.

From the customer perspective the difference lies in how many shipments the order is received in. With direct deliveries the order is received in three shipments, while in the merge-in-transit model the customer receives only one shipment.

The cumulative delivery chain costs of a typical MRO order are illustrated in Figure 1. The cost elements considered in the comparison between merge-in-transit and direct delivery are the following:

- The outbound warehousing operation of the suppliers. The operations consist of picking and preparing the ordered goods for shipment at the three different suppliers.
- The pick-up surcharge of the ordered items from the suppliers. The logistics service provider adds an additional pick-up charge to a

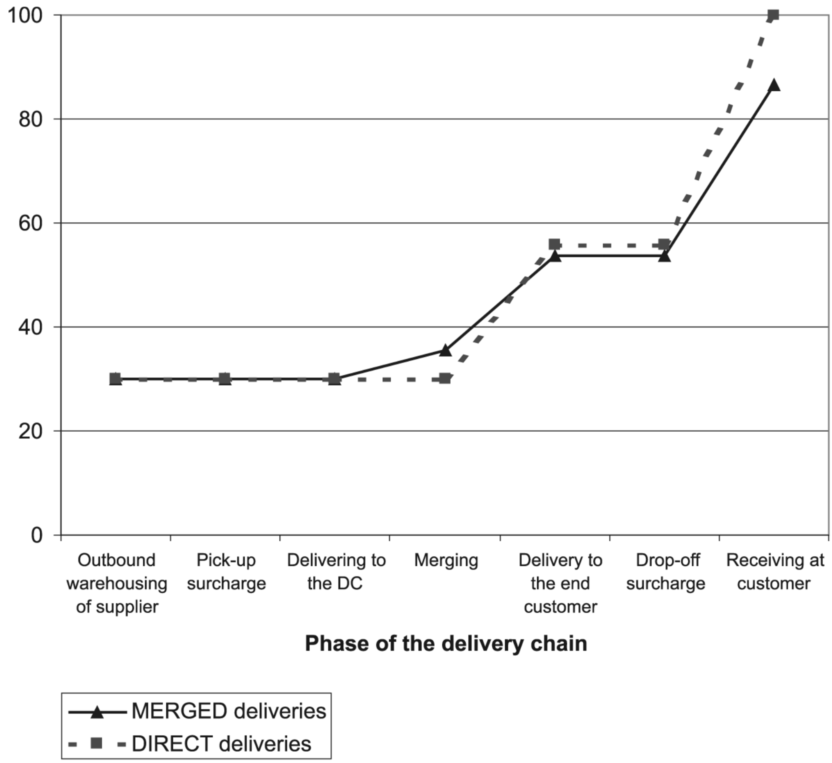


**Figure 1.** Cumulative delivery chain costs of an ordinary MRO order

consignment if the supplier is not located nearby one of the logistics company's distribution centres.

- The transportation cost of the delivery from the supplier to the consolidating distribution centre. No fee is charged in this case as the suppliers are located in the area of the distribution centre doing the merging operations. Local area operations are included in the total transport charge.
- The cost of transportation to the end customer. The cost is derived from customer specific freight tables that are based on the weight of the freight, and transportation distance.
- The cost of drop-off at the end customer. The logistics service provider adds a drop-off surcharge to a consignment if the customer is not located nearby one of the logistics company's distribution centres.
- Receiving by the customer. The cost includes handling and administration by the customer.

In addition to the above elements there is the cost of consolidation – that is merging – in the case of merge-in-transit.

The graphs for the two operating models compare the cumulative costs. The costs are indexed so that 100 represents the total delivery chain costs with direct deliveries. (The same indexing is used also in Figures 2-4.) In the case of a typical MRO order the cost of merging the order lines is lower than the extra cost of receiving separate shipments at the customer end. From a total supply chain perspective the difference in total costs is approximately 13 per cent.

*A best-case for merge-in-transit*

In the first delivery example the order was selected to represent a typical order for the MRO distributor. The second example is a best case from the point of view of merge-in-transit. The suppliers remain the same, but the size of the order is larger, there are now 41 lines in the order. Also, the customer is now located far away from the consolidation point. In this situation consolidation directly improves the cost efficiency of transportation.

The cumulative distribution costs of the example order are illustrated in Figure 2. The indexing principle is the same as in Figure 1. The index 100 represents the total delivery chain costs with direct deliveries for the example order.

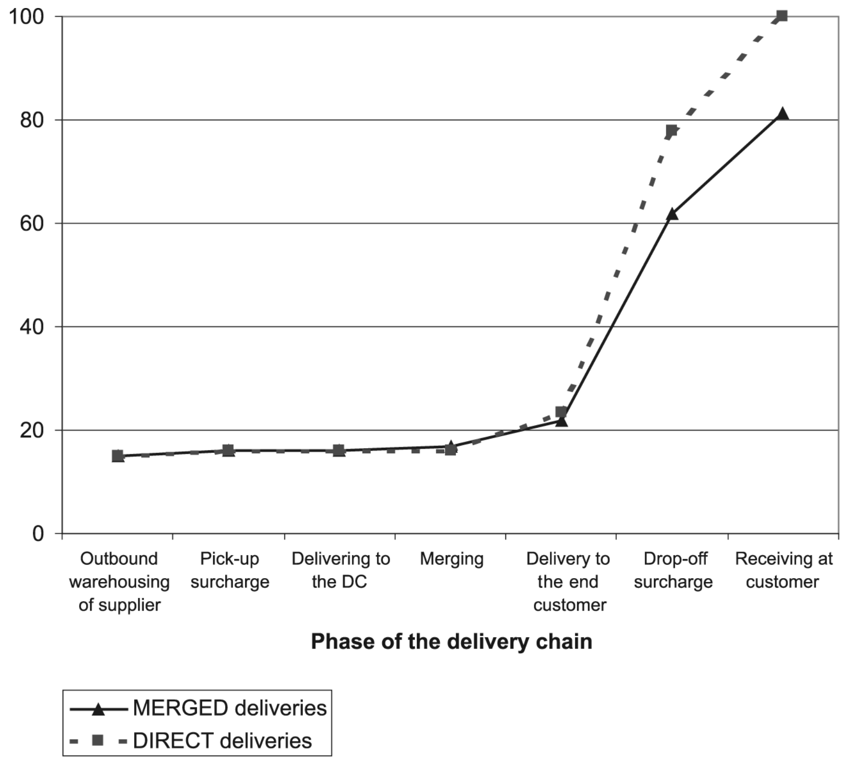


**Figure 2.**
Cumulative delivery chain costs of a best-case order for merge-in-transit

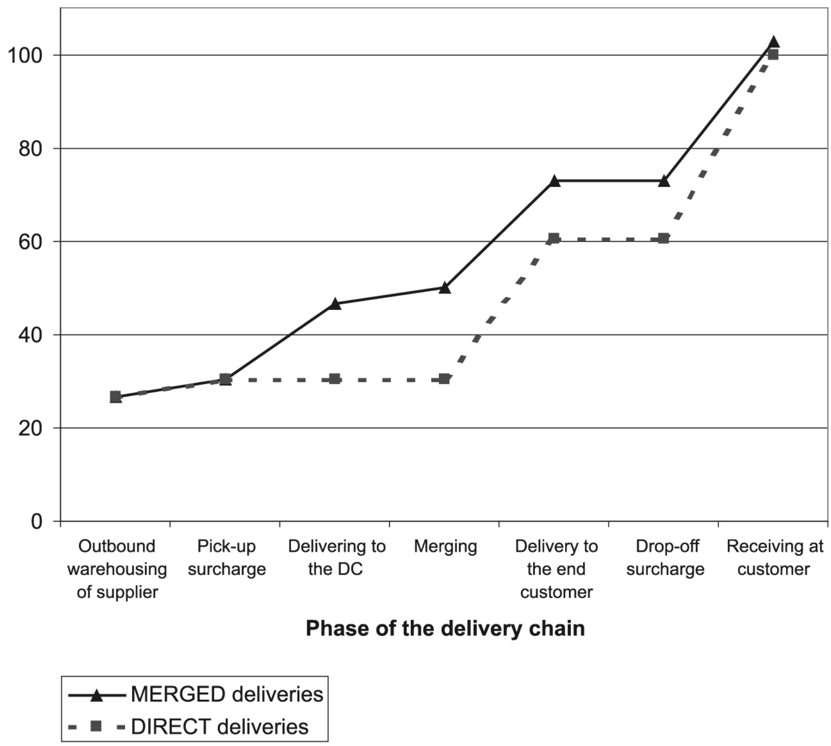


**Figure 3.**
Cumulative delivery chain costs of the worst-case order for the merge-in-transit operations model

The total cost savings with the merge-in-transit model are as much as 19 percent. The cost of consolidation is in this case very small in relation to the cost of transportation to the end customer. More significant, however, is that consolidation considerably reduces the drop-off charges incurred because of the location of the end customer. A drop-off charge is incurred because the customer is located far away from a distribution centre of the logistics company.

This example illustrates a large order delivered to the northern part of Finland. Orders to Northern Finland tend to be larger than average, as the delivery fees charged by the distributor are higher. A smaller order would enlarge the relative differences between the two operating models (the difference can be over 50 per cent) while the absolute cost differences are greater for larger orders.

*A worst-case order for merge-in-transit*

In the worst-case order for the merge-in-transit, suppliers are located far away from the consolidation centre, but close to the end customer. Here, it should be

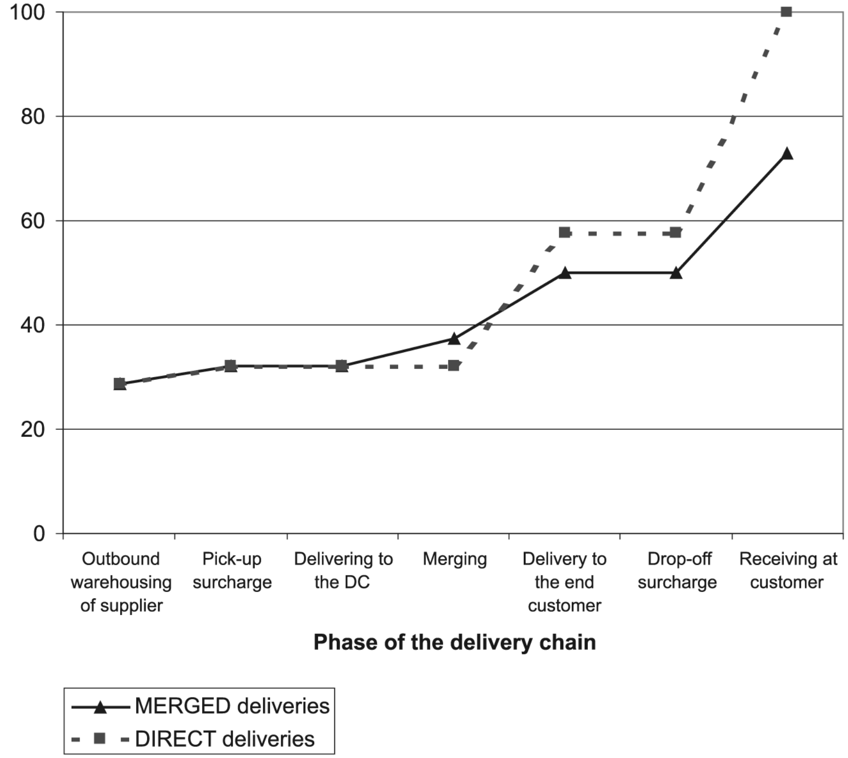


**Figure 4.**
Cumulative delivery chain costs of an order with six suppliers

possible to deliver the ordered goods much more cost efficiently to the end customer directly from the suppliers than with the mere-in-transit process.

However, the cost difference for the case MRO distributor is less than could be expected. The cumulative costs in the delivery chain of such an order are illustrated in Figure 3 (index 100 represents the total cost with direct deliveries for the example order). The cost increase when moving to merge-in-transit distribution is 21 per cent, and this difference is almost offset by the higher cost to receive three separate shipments at the customer. In total, merge-in-transit operations are only 3 per cent more expensive.

*An order with a high number of suppliers*

A concern for the case distributor is that introducing merge-in-transit will reduce the value of the average supplier consignment, as the receiving costs of the customer are not dependent on the amount of suppliers included in the order. To test the impact of decreased order line value the last case delivery increases the number of suppliers from three to six, while keeping the total value of the order constant. This case delivery is equivalent to the example of an ordinary MRO order but the number of suppliers is increased from three to six. The goods ordered are evenly spread between the suppliers.

In Figure 4, the cumulative delivery chain costs of such an order are illustrated (100 equals total delivery chain costs with direct deliveries). The total delivery costs are now 27 per cent lower with merge-in-transit. However, a change that is not visible in Figure 4 is the change in absolute costs. For example the total outbound costs of picking and preparing for shipment at the suppliers have increased by 45 per cent compared to a the situation when the order is delivered from three suppliers instead of six.

## Merge-in-transit – business implications

In the previous section, the costs of the whole delivery chain were presented. The motivation of each member of the supply chain to participate in merge-in-transit operations is addressed in this section. The end customer's, distributor's, transportation service provider's, and suppliers' points of view are taken into account.

### *The customer's viewpoint on merge-in-transit*

Using the services of distributors and wholesalers the customers have access to a variety of products from a large selection of suppliers. This one-stop shopping makes procurement easier as it is not necessary to contact every supplier separately. Merge-in-transit deliveries further simplify the procurement process for the customers. By receiving only one delivery for each order placed, the customer can control the fulfilment of the order with much less effort than when receiving partial deliveries directly from individual suppliers.

Reduction in the number of shipments to the customer also means reduction in the receiving costs of the customer. Manunen (2000) suggests that the inbound logistics costs in a warehouse can be estimated with two cost components: a base cost for each delivery and a cost for each order line in the delivery. For Finnish wholesalers and manufacturers the handling costs have average figures of €15 per delivery and €5 per order line. Due to the high delivery-specific costs, it is evident that delivering the same amount of order lines as one shipment instead of several can notably reduce the receiving costs.

However, the customers may not perceive the real value of these benefits, as the costs associated with the administration and the physical handling of an order are seldom clearly visible in any accounting system. Thus it can be hard to get customers to pay for the consolidated delivery service provided by merge-in-transit operations. This is a very typical issue with value added logistics services (Lambert and Burduroglu, 2000). Especially in the case of MRO products, where the purchase price is most often the main decision criteria in sourcing, it is essential for the distributor to have a cost efficient merge-in-transit process.

*The distributor's viewpoint on merge-in-transit*

Implementing a merge-in-transit process affects the distribution costs of the goods offered by the distributor. The needed consolidation activities add new costs to the deliveries, but the increase may be offset by the savings obtained with easier handling and transportation discounts later in the delivery chain. Based on the results presented earlier, it seems that the total distribution costs can be decreased with the merge-in-transit operations.

A very essential benefit for the distributor resulting from the merge-in-transit model is the ability to offer better service to the customers. The distributor can extend the concept of one-stop shopping to the physical delivery of the goods with one drop-off, without storing all the products itself. This is a valuable service, as the customers often not only expect but require the deliveries for their orders to be complete (Geologistics, 2002). Furthermore, the distributor can move products currently shipped from its own warehouse to the merge-in-transit process with no effect on the customer service level. Reducing the inventories decreases the costs of the distributor and enhances flexibility of the entire supply chain.

The distributor can also provide better customer service by broadening its product assortment. By adding suppliers to the merge-in-transit process the distributor can do this without increasing the number of stock-keeping units in its warehouse and without increasing the receiving costs of its customers. Both these customer service improvements provide competitive advantage and can increase the profits of the distributor.

As the demand aggregator the distributor is in the position to initiate the merge-in-transit implementation project. There are several requirements for a successful merge-in-transit process: Technical requirements in terms of information technology, careful implementation project execution, and managing business relations (Geologistics, 2002; Schaffer, 1997). The business relations also include the decisions concerning cost allocation among the distribution chain partners. As the distribution structure changes, the distributor may have to pay all the transportation costs from the merging onwards, as it also takes the overall responsibility for the customer delivery. Covering these expenses with higher customer prices is not always easy, as customers are not always willing to pay for top class logistics services (Lambert and Burduroglu, 2000).

*The transportation service provider's viewpoint on merge-in-transit*

For a transportation service provider, the ability to provide merge-in-transit services in its distribution centres is a valuable asset. The service provider can offer the consolidation services developed with one customer to a range of other customers, thus gaining competitive advantage in the highly competitive transportation market.

Despite the decrease in the total number of shipments when moving from direct deliveries to merge-in-transit, the transportation service provider can benefit from better capacity utilisation due to increased co-ordination of deliveries. Furthermore, in the direct delivery model the suppliers could freely choose their service provider, whereas in the centrally managed merge-in-transit process a single transportation service provider takes care of all the deliveries. Thus, there is potential for a significant increase in transportation volumes for the merge-in-transit service provider.

Being among the first companies to develop merge-in-transit services in its operating area, a transportation service provider can also benefit from the first-mover advantage in two forms: There is more time to develop cost efficient operations and an early installed base of distributors relying on the service is valuable should competition get more fierce in the merge-in-transit area.

An important issue for the transportation service provider is the risk associated with getting enough volume for the merge-in-transit operations to justify the fixed costs of the process. The merging operations require floor space in the distribution centre and there are investments needed in the information systems for managing the individual customer orders.

*The supplier's viewpoint on merge-in-transit*

The operational benefits from merge-in-transit attainable for the suppliers result from the reduction in the number of delivery addresses, as each supplier can ship the consignments to the (nearest) distribution centre performing merging operations for the distributor. This means that the supplier can rationalise its shipping activities for the items sold through the merge-in-transit channel, and possibly benefit from consolidated deliveries to the distribution centre in form of less tasks in shipping and reduced transportation costs.

The suppliers can also gain a moderate competitive advantage from being included in the merge-in-transit process. Should the customers of the merge-in-transit distribution truly appreciate the one-drop logistical service, the sales volumes for the suppliers included can be expected to increase.

The most notable risk for the suppliers is that the average order sizes from the end customers may decrease, as cost efficient merge-in-transit deliveries may lessen the need for large order batches to bring down the transportation costs per unit. This again leads to more frequent orders and thus increased outbound logistics costs (Manunen, 2000).

## General applicability of the results

Our study indicates that merge-in-transit can be a cost efficient delivery model in MRO distribution. The delivery chain reviewed in the study has some characteristics that have to be taken into account when considering the generalisability of the results. First, a major part of the suppliers of the distributors supply network are located in a geographically limited area (namely the Helsinki region in Finland). Therefore, it is possible to successfully start the merge-in-transit process with only one distribution centre doing the consolidation. This enables economies of scale to be attained faster, and implementation is simpler due to the gradual ramp-up of the process. Second, the case distributor is a large customer of the transportation service provider. Therefore the distributor has influence to guide the development efforts of the transportation service provider. We believe, however, that the majority of merge-in-transit operations of other logistics service providers will also be developed with large clients. Third, the costs discussed in this paper represent costs of the particular logistics service provider. The costs charged by other service providers from merging operations may differ due to, for example, differences in labour costs.

Due to case characteristics, it can not be stated that merge-in-transit is the most efficient delivery method in other cases. However, we feel safe to claim that merge-in-transit is a distribution option worth studying. We believe that in many cases it will help reducing operational costs while simultaneously enabling offering better customer value.

## Further research

Merge-in-transit is a distribution strategy that can provide customer value and cost savings in situations where a large portfolio of products is offered to the customers. However, merge-in-transit is a distribution model that is difficult to master, because of a steep increase in information management needs. The case distributor, Hansel, has therefore started the process with a limited selection of suppliers, and is gradually enlarging the product offering attainable via the merge-in-transit service. Still, the development of information sharing practices with the suppliers and the logistics service providers has proved to be cumbersome. The development of suitable EDIFACT messages actually postponed the start of the operations. Besides the heavy implementation effort needed, message based information sharing methods also run the risk of losing the synchronicity of the information and material flows (Johnston and Yap, 1998).

An important question in the need of further study is, thus: How can the flows be managed, if the merge-in-transit operations are carried out in a high number of distribution centres and with a large supplier network?

We are currently building a potential solution by transferring the information transmitting responsibility to the consignments themselves. In such a operations mode, the shipments themselves provide the handling and merging instructions to the systems in the distribution centre (*Frontline Solutions*, 2000). To build such a system we are applying the concepts of intelligent products (Kärkkäinen *et al.*, 2002b) and distributed information management (Främling and Holmström, 2000). There is a multi-agent information system called Dialog, which is able to store and transmit the information needed, and is quick to install to the nodes of the transportation network (Kärkkäinen *et al.*, 2002a).

An initial test with the system has been performed with the case distributor and logistics service provider. It took only seven minutes to install the system at the logistics service provider. The system promises benefits by removing EDI transaction costs, by facilitating electronic communication with low installation overhead, and by ensuring the availability of up-to-date information in the delivery chain.

Further study is needed also to find out, when to apply merge-in-transit. This paper suggests that in operating models where a large number of product variants is offered to the customers, merge-in-transit can be a beneficial distribution strategy. However, how can one know, what products should be included in the merge-in-transit model, and which should be excluded? Thus, questions needing further study are: What characteristic of products, suppliers and the logistics environments contribute to the attractiveness of merge-in-transit? And, what general rules can be formulated for decision making on distribution models?

Currently our research team is developing an evaluation model, which can help managers decide which distribution strategies to choose. The tool is based on the cost calculation model presented in this paper, but is developed further. The model is, for example, capable of also comparing centralised warehousing to direct delivery and merge-in-transit distribution.

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