HORIZONTAL COOPERATION BETWEEN CO-LOCATED NON-STOCK HOLDING TRADE FIRMS TO MINIMIZE THE SUM OF INBOUND LOGISTICS COSTS AND MATERIALS AVAILABILITY RELATED PRODUCTION COSTS.

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Introduction

This report describes an approach to take advantage of co-location for trade firms that serve different markets but that share suppliers by 1) using the combined volume of supply to decrease logistics costs, and 2) using the detailed control over supply to reduce the capacity needed for the internal materials handling processes. The approach is based on a solution that has been developed for IPCW, a cooperation of plant trade firms settled in the Westland, The Netherlands.

Scope

The approach can be used to evaluate the possible benefits for non-stock holding firms that serve different markets and that share suppliers, from co-locating their production sites and using their combined volume to decrease both external and internal costs. External cost can be decreased by optimizing the transportation of goods to their co-located production sites. Internal costs can be decreased by controlling the arrival times of incoming goods so as to minimize the materials handling capacity needed to produce the customers orders.

The trade firms receive customer orders on a daily basis, each customer order to be delivered within a certain number of days. One day is needed for shipping the orders to the customers, and one day is needed for producing the customer orders out of the materials. The customer lead time is therefore two days or more. The process of shipping customer orders to the customers is out of scope of this design.

Each customer order requires a combination of different materials, to be delivered to the trade firms by different suppliers. Each supplier is specialized in producing a distinct range of materials. The production process of the suppliers is out of scope of this design. The design assumes that items ordered at the suppliers can be made available at the suppliers site within a specific number of hours. Immediately after a customer order is received. each trade firm places material orders for the amount of the materials needed, with a earliest pick-up time at the supplier equal to 4 hours before the start of the day of production of that customer order. The materials ordering process and the delivery preparation process at the suppliers are out of scope of this design. The inbound transportation process is in scope of this design.

For producing the customer orders out of the supplied materials, the trade firms can daily hire personal with a zero lead time. Working hours for hired personal consists of an uninterrupted period of 8 hours, and must be specified in advance as from 6.00 hours AM to 14.00 hours PM, from 8.00 hours AM to 16.00 hours PM, or from 10.00 hours AM to 18.00 hours PM. Cost of personal depends on working hours specified. The terms of hiring personal are out of scope for this design. The actual hiring decisions and the production processes on the shop floor are in scope of this design.

Description of approach

The approach starts with the trade firms jointly establishing the working day from 6.00 hours AM to !8.00 hours PM, and the overlapping time slots of 8 working hours per working day, for which one day in advance personal can be hired. For each trade firm, each time slot is an element of a N dimensional vector, N being the number of different hiring time slots (3 in this case) whose elements represent the number of persons hired for working in that time slot on that day.

Next, each day, for each trade firm, the customer orders that must be delivered the next day are grouped according to the clock hours at with they must be ready for shipment. Input to this process is the shipment plan agreed upon with the LSP's who take care of transportation of customer orders to the customers. This shipment plan has been established at the end of the day before the production day.
Based on an estimate of the number of minutes to produce the order and on these ready-for-shipment times, for each customer order a latest production hour, which is the hour in which production still can be done without missing the ready for shipment time, is determined. For each customer order, the earliest production hour is the first hour of the working day at which it must be shipped.

Now, each trade firm selects a personal hiring vector that minimizes the total hiring costs under the constraint that production of each customer order takes place in an hour between the first working hour of that day and the latest allowed working hour. This problem can be formulated as a mixed integer optimization problem, where production orders are allocated to hours in such a way that total capacity needed per hour is equal to or smaller than the available capacity given the personal hiring vector. The model and its solution are presented in section X. The solution gives a daily production schedule per trade firm.

From these daily production schedules, each trade firm derives the latest time at which the materials for each production order need to be available at the joint unloading station. Note that the orders for these materials have already been placed at the suppliers, immediately after the customer order was received. It is assumed that unloading of materials and their transportation to the production shops takes a fixed amount of time. This unloading and transportation proces is out of scope in this design.

Next, these time phased material needs are combined for all trade firms and grouped per supplier. The grouped supply orders are given a latest time of delivery to the unloading dock, that equal to the earliest latest availability time at the unloading dock of any of the material orders in the group
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This results in a volume of materials per supplier on a day, to be delivered before a specific time at that day. Remember that the material orders that need to be transported have already been placed at the suppliers, with a ready-for-pick-up time equal to 4 hours before the start of the working day of the trade firms. This leaves at least 4 hour for picking up and delivering to the co-located production site. This design assumes that the trade firms can hire manned trucks and can plan the transportation; we therefore continue with the optimization of transportation.

The transportation problem faced by the trade firms is a capacitated pick-up and delivery problem with delivery due dates. This is standard problem in OR literature, for which many commercial software packages provide good solutions. However, we can take advantage of certain properties of the specific case situation to derive a quite simple effective solution.

The first property relates to the time available for the transportation. In this design, the suppliers have at least 11 hours to make the ordered materials available for picking-up. We assume that this is sufficient to to achieve a very reliable performance. Thus we can assume that materials are available when a truck arrives for picking up.

Note that the orders for these materials have been received by the suppliers at 15.00 PM on the day before, at latest. Thus, at least 11 hours are available for making the material orders available for pick up. So the total supply lead time of 15 hours between 15.00 PM the day before and 6.00 AM, is split up in 11 hours for the supplier and 4 hours for transportation. Whether 4 hours is sufficient for transportation of course depends on distances to suppliers. In the case, average distance to a supplier is 20 minutes by truck, and average daily supply is 1/9 full truck load, and suppliers are located close to each other, so 320 minutes seems to be sufficient time for any pick-up and delivery in this case.

The second property relates to the earliness costs. Since there is sufficient space and capacity at the unloading dock, there is no penalty on early deliveries. Nor do the transportation costs depend on the time of transportation. This means that the problem can be solved by first neglecting the time constraints and minimize the number of pick-up rounds, thereby minimizing the number of trucks needed, to get all materials delivered, and then position each pick-up round in time such that all materials it contains are delivered before their due dates.

For solving this transportation problem, a variant of the Saving Algorithm (Clark and White, 1964) can be used.