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Karlsruher Institut für Technologie

CAMMP

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OPTIMAL LOADING STRATEGIES

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Brief Description:
It's not just us who like to buy on the Internet. Companies involved in wholesale heating and plumbing for construction sites also order their goods from an (online) product catalogue. For carriers who then deliver the ordered goods to customers, it is of great interest to plan this delivery as efficiently as possible.

(Quellen: links: https://de.clipartlogo.com/istock/logistics-warehouse-with-loading-truck-1512153.html, rechts: https://www.juschkat.com/)

Left: Tractor with Steering system. Right: Surface with grooves.

Background:
Customers order from the product list and create an order. The products to be delivered are defined by weight, volume as well as the required pallets and can be assigned to different product classes (tubes, baskets and pallets; see supplement). The products are assembled and delivered to the customers by truck in routes. So far, however, there is no strategy for optimally distributing the orders among the fleet of trucks and loading the trucks. The capacity of the trucks consists of maximum permissible weight and volume, as well as two loading levels with a certain number of places for pallets. The products occupy different amounts of space. In addition, there are restrictions due to the stacking capacity of the product classes (cf. supplement).

In addition, there is another problem. Once the truck is loaded, some products cannot be moved freely because other products block them. One exception is baskets, which can always be unloaded because they have side openings. Empty baskets remain on the truck after they have been completely emptied. Trucks are to be loaded so that only the current customer order must be unloaded without moving others. The sequence in which the customers are, must be considered.

Finally, there may be orders where material has to be collected from the customer, so-called collection requests. Here, too, subsequent customers must not be customers must not be unloaded and reloaded, as this costs time and therefore money.

Problem: The forwarder is now looking for a quick way to answer the following four questions:
1. is a given route without considering the sequence even permissible?
2. can the return orders be fulfilled?
3. can the order sequence be maintained during the delivery?
4. can the loading capacity of the trucks still be optimized?

Find a way to load the lowest number of Trucks as possible. Splitting an order for one customer to several trucks is not allowed.

Truck features:
Truck capacity consists of maximum permissible weight (23500 kg) and volume (12700 l) and two loading levels. The two loading levels describe the height of the trucks with two pallets. Each loading level of the trucks is two pallet spaces wide, and its length is six pallet spaces (see Fig. 1).

Product Classes:
- tubes (engl. pipes) - P,
- -baskets for small non-palletized products - B,
- -pallets
    - - light - L,
    - - medium - M,
    - - heavy and non-stackable - H,
    - - heavy and stackable - S.

Characteristics of the product classes:

Tubes are transported in special frames that always occupy six pallet spaces in a row (see Fig. 2). In addition, there are restrictions due to the The stackability of the product classes also imposes restrictions.
• Röhren (P), leichte und mittelschwere Paletten (L, M) sind auf Paletten M, H und S stapelbar,
• Paletten S sind auf Paletten S stapelbar,
• Körbe (B) sind nicht stapelbar, sowie
• Röhren (P) sind sowohl auf Röhren (P) als auch auf Körben (B) stapelbar.

Orders do not necessarily consist of whole pallets, but usually of partial pallets, which are counted proportionally on the capacity of the trucks. Baskets and tubular scaffolds, however, always occupy whole pallet spaces regardless of their proportion, i.e. two orders with 0.3 baskets each require a whole pallet space on a truck for one basket. The situation is similar with tube stands, where, for example, three orders with 0.6, 0.2 and 0.4 tubes require two ear stands, each of which then takes up six pallets.
which then occupy six pallet positions in a row, i.e. a total of twelve. The remaining product classes can be added up proportionally so that, for example, 0.8 pallets M and 1.2 pallets L can be stacked above or next to each other (see Fig. 2).

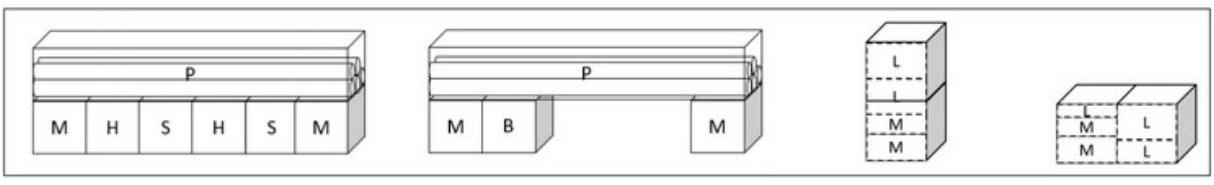

Abbildung 2: *Ladebeispiele* (Quelle: Inform GmbH)