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Terminal operations management in vehicle transshipment

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Abstract

This paper reports on the development of an automated planning and scheduling system supporting terminal operations of the vehicle transshipment hub in Bremerhaven. We describe terminal operations and derive an integral decision model for manpower planning and inventory control. Thereby we propose a hierarchical separation of the integral model into sub-models and develop heuristics to solve the arising sub-problems.

Keywords: Vehicle logistics; Transshipment; Manpower scheduling; Inventory control; Heuristics

1. Introduction

The logistics of finished vehicles has grown impressively during the last decade, leading to the emergence of a world-wide hub and spoke network (Drewry, 1999). Despite high growth rates, the oligopolistic structure of the market has led to a dramatic increase in competition between ports (MarketLine, 1998). Nowadays, ports must face up to market demands and deliver quality service and improved efficiency (Cullen, 1998). To this end the authors have set out to develop a decision planning and scheduling system intended to support terminal operations at the vehicle transshipment hub in Bremerhaven.

Decision-making related to vehicle hub operations can draw on methodological support offered by standard approaches to hub location (Domschke and Krispin, 1997; Racunica and Wynter, 2000), ship routing and scheduling (Ronen, 1993; Fagerholt and Christiansen, 1999; Bendall and Stent, 2001), the design of storage areas (Iranpour and Tung, 1989; Cassady and Kobza, 1998)

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and, finally, loading issues (Agbegha et al., 1998; Nishimura et al., 2001). As yet, there has been no methodological support available for vehicle terminal operations of the type already developed for container transshipment (Steenken et al., 1993; Chen, 1999; Böse et al., 2000; Shabayek and Yeung, 2002).

Terminal operations in vehicle transshipment differ significantly from container transshipment, that is typically supported by rule-based control systems. First, container flows are strongly fragmented, whereas vehicle flows have much in common with bulk cargos. Second, containers may be relocated several times during their stay in a hub. Due to the danger of damage resulting to vehicles, the practice of relocation is avoided at vehicle hubs. Third, containers can be stacked upon one another, increasing storage space, whereas vehicles cannot.

In vehicle transshipment, the notion of bulk grouping allows the definition of reasonably sized entities for planning. Since the relocation of vehicles should be kept to a minimum, their assignment to appropriate locations is a matter of importance. Finally, the area taken up by vehicle stocks is enormous, so that the distances to be covered become an important component in the planning process. These findings have motivated the design of a planning and scheduling system, rather than a rule-based control system.

In Section 2 we introduce terminal operations and discuss the planning and scheduling problem as it generally occurs in vehicle transshipment. In Section 3 we present an integral optimization model for manpower planning and inventory control. In Section 4 we consider the hierarchical problem separation and the heuristic solution procedures for the separated sub-problems. Finally we discuss the impact on the system's efficiency in Section 5, before we conclude in Section 6.

2. Management of the Bremerhaven hub

Bremerhaven is one of the largest vehicle ports in Europe (Herfort, 2002). Its operator, Bremer Lagerhaus Gesellschaft (BLG), handles in excess of 1 million vehicles per year. Balanced ingoing and outgoing traffic produces a high frequency of carrier callings, because vessels regularly discharge and load vehicles in almost equal quantities. Bremerhaven is visited by 1350 deep sea carriers and feeders annually (Kuhr, 2000). Nearly 90,000 vehicles can be stored on 1.6 million square meters, about 500,000 square meters are under cover. For a bird's-eye view of the terminal see Fig. 1.

Vehicles for export arrive from inland via rail or truck and remain in the terminal only a few days before they are shipped in the majority of cases to the US. Import partly deals with main haul runs, for which the modal shift merely entails a certain slack in the logistic chain. These volumes leave Bremerhaven quickly, either by feeder ship or rail. Another large portion of import vehicles is subject to complex transshipment arrangements. In particular, Far Eastern manufacturers use the terminal as a "buffer stock", because they have to supply from stock in order to compete with vehicles produced in the EU, which are increasingly "made to order".

Due to high volume and complexity, operations of the vehicle terminal have thus far been characterized by short-term reaction, rather than planning. As often observed, manual planning tends to result in the inefficient and unreliable implementation of work processes. In order to improve the efficiency and reliability of work processes, a planning and scheduling system has been developed. This system integrates mid-term capacity planning and short-term scheduling.