Dock Assignment and Truck Scheduling in Crossdocks : New formulation and solution approach

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1 Introduction

We study a dock assignment and truck scheduling problem arising within crossdocks. In the literature, variants of this problem are often modeled as big-M-like mixed integer programming formulations, which are known for their computational difficulties and often poor bound quality restricting their practical use. In this work, we propose a new integer programming (IP) formulation with $\mathcal{O}(n^4)$ variables. We then propose a Dantzig-Wolfe reformulation and an efficient branch-and-price for solving real-life size instances of this model. Our extensive computational experiments confirms the efficiency of our exact method.

This work has been motivated by a consultancy project we are carrying in a regional multimodal logistic platform. The pallets unloaded from a truck (or to be loaded to another truck) do not have to be transferred immediately and can remain in the buffer zone for a few hours during a day, making it unnecessary to plan for a direct transfer and simultaneous presence of unloading and loading trucks at the corresponding gates. Moreover, given the type of product and the use of standard pallets, every truck is served by a fixed number of lift-trucks and therefore, in this scenario we are not planning for resource allocation.

The truck dock assignment problem, as many other optimization problems arising in cross dock management, has been receiving an increasing attention during the last decade. This is evidenced by several recent surveys ([4], [1], [5]) devoted to operations management and to scheduling in cross docks.

Our previous contributions on similar topics include [2] for analyzing different mathematical model and investigating their properties as well as a polyhedral and branch-and-cut approach in [3].

2 Problem Description

A set of trucks and a set of bi-function docks of a cross-dock are given. Every truck has an arrival time, a strict latest departure time, a docking time, which is the time spent for aligning the dock in front of a gate and the setups required by both truck and the dock to start the loading/unloading and a processing time which is required to load/unload the truck are given. In its general form, every truck belongs to different client and carries different cargo with different level of sensitivity translated to penalty cost, for every unit of waiting time before admission

for service. A penalty cost is charged when a truck is not served at all. We would like to minimize the waiting cost of every single truck such that it can leave soonest possible and also to minimize the penalty weighted cost of missed trucks in the crossdocks day planning.

3 Our contribution

We propose a new compact mixed integer programming formulation for this problem. This formulation is particulary tailored for a Dantzig-Wolf reformulation and a branch-and-price.

Our computational experiments show that we push the limit of computational efficiency in the literature.

4 Computational Experiments

TAB. 1: Computational experiments instances of realistic size using branch-and-price.

Instance	Obj. Val.	#Nodes	Status	CPUTime (sec.)	#nCols	#PrIter	Served/Total
tf-16-d-58-tr-174	4036.00	1	Optimal	11.57	2	2	97.13
tf-16-d-58-tr-179	168.00	1	Optimal	9.61	2	2	100.00
tf-16-d-58-tr-184	3164.00	1	Optimal	145.84	19	2	97.83
tf-16-d-58-tr-189	5142.00	1	Optimal	232.53	12	3	96.30
tf-16-d-58-tr-194	4725.00	1	Optimal	2897.87	16	3	96.91
tf-16-d-58-tr-199	7515.00	1	AbortUser (461.79)	10858.78	59	2	94.97
tf-16-d-60-tr-180	4088.00	1	Optimal	12.28	5	2	96.67
tf-16-d-60-tr-185	4171.00	1	Optimal	8.81	2	2	96.76
tf-16-d-60-tr-190	2025.00	1	Optimal	19.71	7	3	98.95
tf-16-d-60-tr-195	3738.00	1	Optimal	9.69	2	2	97.44

5 Conclusions and Perspectives

Further research directions include integration of further features of the real practice, polyhedral analysis of the pricing problems (including identifying some classes of face-defining tightening valid inequalities) and some clever (combinatorial) solution algorithms for the pricing problem to improve the efficiency of solution proces.

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