Yard Optimization at Sea Container Terminals

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Introduction

- Growth of container sea-freight transportation.

- Competition among terminals in terms of:
  - Service (ship’s turnaround time);
  - Productivity (TEUs per year).

- Issues: traffic, congestion and capacity limits.

- OR techniques can improve the efficiency of terminal operations.
Terminal Overview
Terminal Operations

- Ship-to-Shore
  Berth Allocation; Quay Cranes Scheduling; Ship Loading Plan.
- Transfer
  Quay-Yard; Yard-Yard; Yard-Gate.
- Storage
  Yard Management (Block and Bay Allocation); Yard Crane Deployment
- Delivery and Receipt
  Gate management; Interface with trains and trucks.

In addition to the traditional flow: transshipment containers.

*Vis and de Koster (2003); Steenken et al. (2004); Henesey (2006)*
Issues in Yard Management

• The yard serves as a buffer for loading, unloading and transshipping containers.

• The yard is usually the bottleneck of the terminal: traffic, congestion and capacity issues originate from here.

• Crucial issue: the “schedule” of the outgoing flow is unknown to the terminal.
  - Import/export terminals: yard management is strictly connected to gate operations (trucks).
  - Transshipment terminals: yard management is strictly connected to mother vessels and feeders.
Transshipment: An Overview

- Containers are exchanged between mother vessels and feeders.
- Market players: the terminal interacts with big shipping companies and feeders.
- Peculiarities of the transshipment flow:
  - Arrival and departure positions and times can be known in advance;
  - Concurrency of loading and unloading operations.
- Definition of new transshipment-related problems:
  - Service Allocation Problem (*Cordeau et al., 2007*);
  - Group Allocation Problem (*Moccia and Astorino, 2007*).
  - Short Sea Shipping: Barge Rotation Planning (*Douma et al., 2007*).
Transshipment: A New Approach

- Interactions of the terminal with the other market players:
  - Negotiation between terminal and feeders on the arrival time.

- Global optimization vs hierarchical optimization:
  - Simultaneous assignment of berths and blocks in the yard to the feeders.

- Control on crucial issues and objectives:
  - Minimize the total distance quay-yard;
  - Minimize congestion in yard blocks;
  - Balance workload among yard blocks.
Transshipment: A New Approach

Research plan on 2 levels:

- **Optimization framework:**
  1. Berth & Block Allocation Problem (BBAP);
  2. Scheduling of feeders.
     - we assume that the terminal can decide the schedule of feeders;
     - iterative procedure to find a feasible scheduling.

- **Negotiation framework:**
  - Game theory;
  - Pricing policies and strategies.
    - we aim to support the terminal in its negotiation with feeders.
Berth & Block Allocation Problem (BBAP)

- We consider the flow of containers from one mother vessel to several feeders;
- We associate a container group to each feeder;
- Each container group must transit by a yard block and a berth;
- Capacity limits on space (blocks) and time (berths).

- We can associate a network to the problem.
We can find the optimal berth-block assignment by solving a multicommodity flow problem on the transshipment network.
Conclusions

- Focus on yard management and its interactions with:
  - gate operations;
  - transshipment flow.

- A new approach in the optimization of transshipment operations:
  - combined assignment of berths and blocks to feeders (BBAP);
  - scheduling of feeders.

- Pricing policies to support the terminal in the negotiation with feeders.
References


