Collaborative Intermodal Operations at a Container Terminal

A drayage company transports containers between a terminal and customers’ places by trucks. A container terminal temporarily stores containers to connect transportation between drayage trucks and container ships. However, constant growth in the volume of containers has strained the capacity of intermodal operations through a container terminal. The limited resources at a terminal causes significant delays of drayage trucks waiting at a container terminal. To alleviate the burden of intermodal transportation, the important thing is how to handle transfer activities between a drayage company and a container terminal, which is shown in Figure 1. These transfer activities cannot be improved by itself, thus it is not avoidable to synchronize drayage operations and terminal operations. Therefore, this research proposes a collaborative transfer operational methodology where a drayage company and a terminal are able to influence each other by joining decision-making processes.

Motivation

It is essential to identify what causes truck congestion and inefficient terminal operations. Figure 2 illustrates how long trucks stay at a terminal, including waiting at a gate and a yard.

The truck turnaround time differs between morning and late afternoon with the peak at 6 a.m., which means that trucks do not arrive uniformly over a day period. Thus, the gate and yard have the heavy amount of works that have to be done at times of peak demand, which inevitably results in waiting of trucks.

Operations in a yard needs more time than those in a gate. This is because a yard crane spends a considerable time to pick up or release a container on a block. Additionally, a terminal operator has little knowledge of the arrival of drayage trucks to pick up or drop off specific containers before trucks arrive. According to the arrival of trucks, yard cranes could be overloaded or idle. Thus, the unbalanced workloads between blocks inevitably causes waiting of trucks. Furthermore, a yard crane is able to pick up a container at the top. It means that it needs additional activities to retrieve the container stacked under other containers in a block. Thus, the uncertain sequence of truck arrival can worsen the productivity of yard cranes as well as the truck turnaround time.

The transfer operations are joint activities between interrelated players, but drayage operations are pushing terminal operations. In other words, since drayage trucks are allowed to deliver containers at any time of terminal operating hours, a terminal operator should control terminal resources responding to unexpected arrival of trucks.

![Figure 1: A flow of transfer activities between drayage and terminal operations](image1.png)

![Figure 2: Average monthly statistics on the truck turn time at a terminal](image2.png)

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Problem Definition and Solution Approach

A truck dispatcher and a terminal operator are the decision makers of a drayage company and a terminal, respectively. A truck dispatcher makes a daily truck schedule with the minimum costs or travel time to complete the set of transportation orders. A terminal operator controls yard cranes on blocks for pick-up or drop-off transactions with drayage trucks. This work collaborates these two decision making problems. Therefore, it determines which truck delivers which container considering the situation of the terminal, as well as how to efficiently control the terminal resources. In addition, this problem should satisfy the objectives for each company as below:

- To minimize the truck turnaround time at a terminal and total operation time of trucks.
- To balance supply capacities of resources at a terminal and minimize the rehandling movements of cranes.

This research proposes ‘categorized transportation’ where a truck is able to deliver any containers with the same category. In other words, a truck dispatcher postpones the decision on which truck delivers which container until it arrives at a terminal. Moreover, a terminal operator puts off the decision on an inbound container that a yard crane retrieves as well as a location where an outbound container is stacked until the operation. For instance, it assumes that the containers in adjacent customers’ places could be in the same category of containers as illustrated in Figure 3. The category of containers can be assigned to a truck. Then, a terminal operator retrieves any inbound containers with the same category onto the truck. Additionally, an outbound container can be stacked on any spaces with the same category at a terminal.

Thus, drayage companies and a terminal can take advantages of postponing the decision to reduce a truck turnaround time at a terminal and balance workloads of terminal resources.

Expected Benefits

For example, when a truck come into a terminal, the truck is able to select the container with the same category considering the workload of cranes. As a result, the number of trucks in queues of blocks are distributed in Figure 4. Moreover, the turnaround time of trucks would be reduced.

In the operation of a yard crane, the categorized transportation can reduce the number of rehandling movements to pick up the desired container. A yard crane can transfer a container having not only the same category, but also the minimum number of relocating activities. For instance, Figure 5 shows that the case without the categorized approach should need more relocations of containers to satisfy the sequence of trucks.

The proposed work will identify the impact of the collaborative decision making approach for the synchronized container logistics. It is expected to show the decrease of the waiting time of trucks at a container terminal. Moreover, distributed workloads and improved productivity of resources at a terminal will help ease the burden on terminal operations.

Furthermore, it is actually difficult to share and split the benefits among players in a system and to motivate them to take part in the collaboration. However, this research anticipates that the effects of the collaboration will provide incentives for both of players and encourage them to participate in the cooperation.