

Strategic Planning of Hinterland Container Terminals: A Simulation Based Procedure

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Hinterland container terminals (HCTs) are important hubs in modern logistic-networks that ensure efficient and frictionless intermodal container turnover. In fact HCTs play an important role in the distribution of containerized goods into the hinterland and are therefore significant for the development of industrial regions. To meet the requirements HCTs have to be designed and coordinated carefully.

HCTs enable the transshipment of containers between different transport modes and can be characterized according to the number of the involved transport modes into bimodal and trimodal terminals. In contrast to trimodal HCTs, which combine transshipment from ship, train and truck, bimodal HCTs turnover usually takes place between train and truck.

Bimodal HCTs are commonly divided into three functional areas: truck gates, train interchange and yard. The first two areas represent external interfaces of the terminal and are used for the processing of incoming and outgoing trucks and trains. The yard of a HCT is the storage area which is used to bridge the time gap between container import and export; and consists of at least one block. Usually a part of the yard is dedicated to empty containers, which are characterized by a longer storage time and additional services provided like cleaning and repairing.

Truck gate, train interchange and yard are connected by the handling equipment, which transports, lifts and stacks the containers. In HCTs mainly two types of equipments can be found: gantry cranes and reach stackers. Gantry cranes can be rail mounted (RMGC) or rubber tyred (RMGC) and have a spanning capacity of an entire block. While gantry cranes can reach any container within the block, reach stacker can be limited in their access, depending on the depth and height of the block. In fact reach stackers can only lift containers up to the fifth tier and into the second or third row.

In accordance to the terminal structure and operations described above the main goals of a HCT are:

- To allocate terminal resources as handling equipment, gates, trucks and storage space efficiently,
- to reduce waiting times and total time for trains and trucks in the terminal and

- to maximize the overall throughput of the terminal defined by the total number of handled containers.

To achieve these goals, the planning of new HCTs as well as the extension of existing ones, has to be done carefully and must take into account capacity and infrastructure requirements.

A major part of the literature, written on container terminal operation and management, focus on optimization methods for individual sections or subareas of maritime container terminals. The main covered areas are dispatching and scheduling of handling equipment (see [KP04], [Ng05], [CLL02], [DEO02]), berth allocation (see [Im07]), storage space allocation (see [PKR00], [KPR00], [KP03]) and sequencing the loading and unloading of ships (see [Av98], [Im06]).

Although some of this work can be used to deduce strategic decisions for the future operation of HCTs, most of the optimization methods remain primary suited for tactical and operational issues. Yet for the strategic planning of HCT Infrastructure, an integrated view of the terminal as a whole is needed. Especially the correlation between equipment scheduling, storage allocation and load sequencing has to be considered while analysing possible configuration of a terminal.

However there is some research dedicated to the overall definition of container terminal operations and strategies, which is mostly based on the simulation as an evaluation method. Simulation studies for container terminals can be grouped into two categories. The first category concentrates on a certain subarea (see [LA07], [LM01]), while the second category models the whole container terminal (see [BBR06], [DO00], [TH00], [Ya05]). This last category is rather comparable with our work. But due to the fact that nearly most relevant work is devoted to maritime terminals, activities around ships play a predominant which is less suitable for our purpose. In fact, in HCTs activities and goals are rather centered on container shipment by railway.

Our purpose was therefore to implement a simulation based methodology, which can be used while designing new HCTs or extending existing ones and which enables the comparison of different material handling technologies, shift patterns, resource scheduling and infrastructure capacities. To do so, we had to consider the specific nature of HCT strategic needs:

- The operation of a HCT differs from the operation of a maritime container terminal. This is due to its dimension, throughput, automation degree, container properties and involved transport modes. Process modelling has therefore to be tailored to HCT operations.
- The model underlying the simulation has to integrate all HCT operations in order to provide valuable support to HCT-Managers.
- The simulation has to be based on an open configuration which means that any user-defined terminal configuration can be analysed. This is particularly of interest when analysing different scenarios of HCT configuration.

- Due to the lack of detailed information about the import and export flows, the simulation has to include a data generation methodology which supplies it with adequate data.

Figure 1 shows the implemented modules. The configurator is the interface used to define the Terminal to analyse and hence is used to determine all relevant parameters (see [GPB07]). These can be separated into two groups. The first set of parameters defines the layout and the infrastructure of the terminal and contains for instance information about the handling equipment, the yard blocks or the train interchange. In the second set parameters describing the terminal operation (arrival rate for containers, transshipment, distribution of container attributes, etc.) are defined.

The Terminal data is then passed automatically to the simulation which generates based on a few user-defined parameters detailed lists of incoming and outgoing transport modes and containers. Further the simulation evaluates the performance of the terminal by simulating terminal operations given a period and configuration. Finally the results of the simulation are passed to the report generator where they are aggregated in a clear and comprehensive overview.

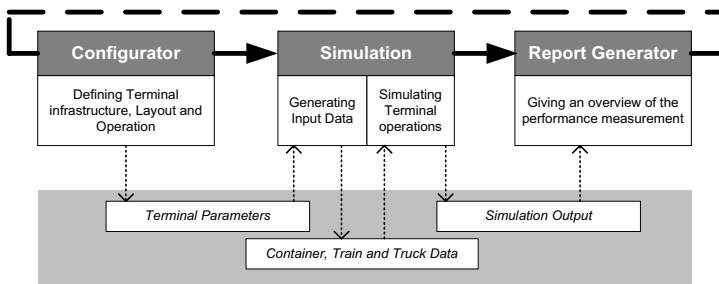


Figure 1: SimConT modules

With this procedure we managed to develop a framework suited to the needs of HCTs and flexible and quick enough to be applied while planning or analysing HCTs.

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