1   System description

In this chapter the assigned physical system, under study and the typical operational task is carried out in the transport process is described. Analyzing the system component and its interactions within the network and its potential intelligence provide a foundation to build the systems objectives and its state-space model.

1.1. Physical system

The assigned physical system under study is the Cargo Train, which operates within a complex intermodal transport network that connects the sea port railway terminal and the hinterland railway terminal, shown in Figure 1.2. Although the system enables cargo movement in both directions, the physical system in this section is described from the sea port's perspective, transferring cargo from the seaport to the hinterland.

Cargo train connections with sea port rail terminal
At the **sea port rail terminal**, the cargo arrives from the **deep sea terminal** by **truck or terminal truck**, where it is stored in a **storage yard** or directly transferred to the **railway tracks**. The cargo is then loaded onto the trains using a **reach stacker** or a **portal crane**, depending on the type of cargo. A **portal crane** is more suitable for high-volume cargo, while a **reach stacker** is more mobile and flexible, suitable for smaller volumes of cargo. The cargo that has been stored in the **storage yard** is only loaded onto the cargo train by a **reach stacker**. Once all the cargo is loaded onto the train, the train leaves the terminal via the **railway tracks**, which will transfer the cargo to the **rail terminal** or directly to the **consignee/shipper**.

Cargo train connection with hinterland rail terminal
When the train arrives at the **hinterland rail terminal**, the cargo is unloaded using a **reach stacker** and placed in the **storage yard**. After the designated storage period, the cargo is once again handled by a **reach stacker** and loaded onto a truck for **road transport**.

Alternatively, if storage is not required, the cargo is immediately unloaded from the train using either a **reach stacker** or a **portal crane** and transferred directly onto a truck for transport. From the hinterland rail terminal, the cargo continues its journey by truck or may be integrated into an **intermodal transport system**, combining road, rail, and barge transport for further distribution. With this last mode of transport, the cargo can be shipped to the **consignee/ shipper**.
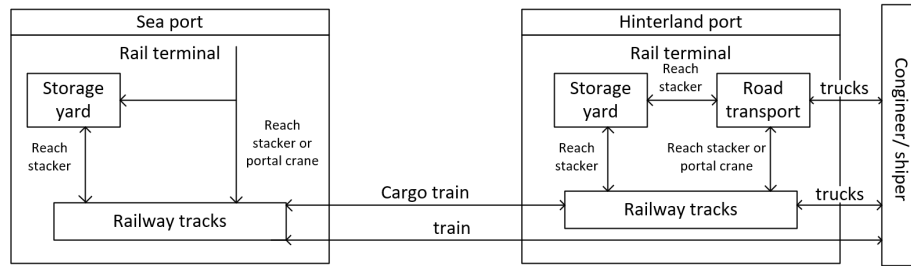

Figure 1.1: Cargo$_T rain$[1]

Figure 1.2: Overview physical system [2]

1.2. Potential Intelligence

- **Improved freight train schedule planning**: Efficient scheduling allows for better use of time slots and maximizes rail network capacity.

- **Real-time tracking of cargo and trains**: Accurate tracking enhances the loading and unloading process by minimizing dwell time and enabling smoother operations.

- **Smarter stacking strategies for space and efficiency**: Organizing cargo in a way that allows for easy wagon separation at split points helps avoid unnecessary restacking of containers.