Summary

Introduction

Due to mismatches in time and place, temporary storage of empty marine containers is inevitable. Imbalances and fluctuations in trade cause an accumulation of empty containers at (amongst others) port areas. The inequity in cargo flows has great impact on the Port of Rotterdam (PoR), as major European port. The flow of empty containers to and from the PoR will increase, supported by the development of Maasvlakte 2 (MV2), a 1000 ha port expansion to be built in the North Sea starting in 2008.

The aim of this research is to give insight in the effects of port planning strategies of the Rotterdam Port Authority (RPA), regarding storage facilities for empty containers (empty depots) at the Port of Rotterdam (PoR).

In formulating the port planning strategy towards the spatial planning of empty depots, four points of interests can be distinguished:

- Conflicting interests between RPA and shipping lines as container owners;
- Efficiency of empty container logistics;
- Environmental constraints
- Accessibility of the PoR;

Conflicting interests

The RPA prefers to use the available space in the port for commercial activities other than storing empty containers, because this is more lucrative. Nevertheless, many empty containers are stored in empty depots located at the PoR. Shipping companies as container owners prefer to have available empty containers in a buffer in port depots in order to supply these when required to exporting companies.

Efficiency of empty container logistics

Economic savings can be reached with efficient empty container logistics. There seems to be an inefficiency regarding the movements of empty containers. In case an inland depot is used for the storage of empty containers near the market of receivers/shippers in the hinterland (see figure S.1, situation B), the travelling distance can be reduced.

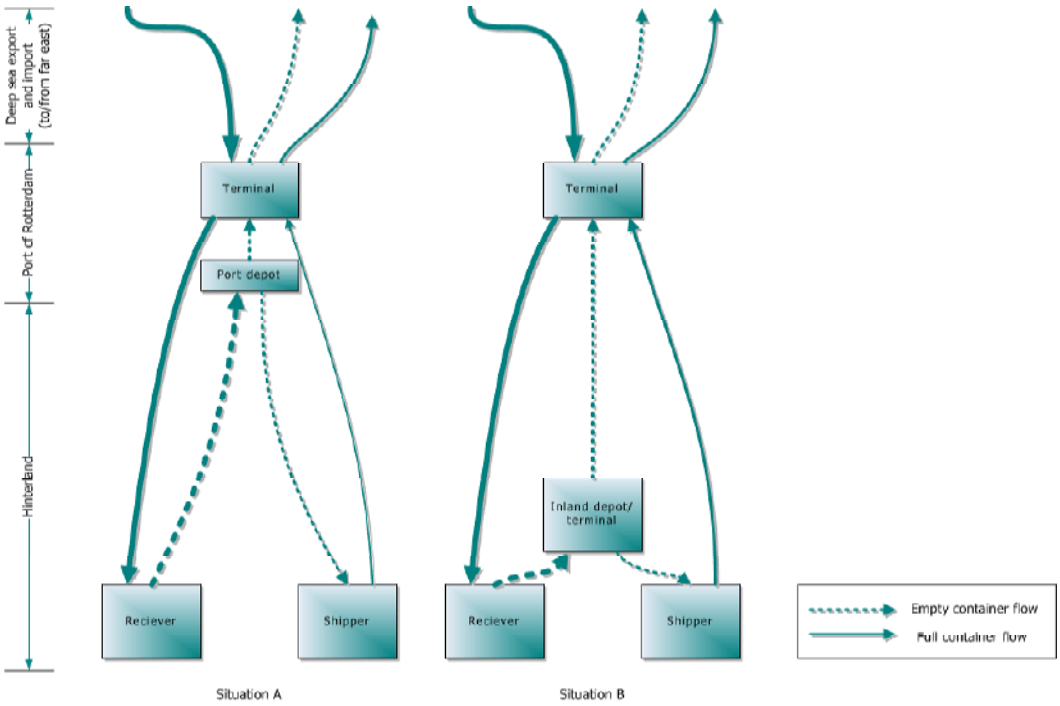

Figure S.1: Container movements

Environmental constraints

The movements related to the empty container logistics have an impact on the environment. The RPA is constrained in her plans by environmental regulations.

Accessibility of the PoR

The movements related to the empty container logistics have an impact on the capacity of the hinterland network and the accessibility of the PoR.

For the RPA it is imperative to anticipate on the growing presence of empty containers by facilitating storage for empty containers. In the allocation of storage areas for empty containers the following aspects are important for RPA:

- location
- dimensions of the required area;
- environment;
- accessibility;
- market.

These aspects are taken into account by using a multi-actor approach and a multi-criteria analysis.

Supply of empty depots

The flow of full and empty containers to and from the PoR will increase, certainly with the development of MV2. Due to imbalances, fluctuations and mismatches in time and place, temporary storage of empty marine containers in port areas is inevitable.

Apart from public objectives, the RPA has a commercial role. In this latter role the RPA develops, allocates and leases port areas to port related companies for various port activities as terminal operations, industry, distribution, empty containers storage (empty depots). Empty depots appear to be not very profitable for the RPA.

The PoR needs to have good hinterland access, while traffic (and related pollution) generated by the port activities needs to remain within environmental constraints. It is in the interest of the RPA to limit hinterland transport by road traffic and to stimulate a modal shift to inland waterway and rail traffic.

The current policy of RPA towards the allocation of empty depots is aimed at passively diminishing depot area in the Waal-/Eemhaven area. This is accomplished by rejecting new requests and by no longer extending existing contracts for that area. For reasons of modal split, the contracts for depots with a water connection are extended.
Since (empty) container flows are increasing, the RPA has to search alternatives for new incoming requests for depot area (terrain). Decisions need to be made on the location, the quantity, the dimensions, the related infrastructure and the lease price of empty depot terrain.

Empty containers in the supply chain and the relation to depot surface

The supply of empty depots should be balanced with the demand. Both the RPA and the users of depots have their interests and requirements towards empty depots. The users of empty depots are the shipping companies and the transport operators, who both aim at efficient use of their resources (container and vehicle fleet). This generates certain requirements towards the location and number of empty depot terrain. The multi actor aspect of the problem will be discussed. However, before the reasons for storage at empty depots will be clarified, insight in function of an empty depot within the supply chain of empty containers is needed first.

Similarly to a supply chain of goods, there are storage points (buffers or depots) in the supply chain of empty containers. These depots can be offered at various locations; a port depot, an inland terminal or inland depot and a port terminal. A port terminal in general offers only a limited capacity for empty containers, which results in relative high cost. Port and inland terminals offer less services regarding maintenance and repairs than specific empty port and inland depots.

Almost every empty container pays a visit to an empty depot on their trip from consignee (importer) to consigner (exporter). A significant part (estimates vary from 30 to 56%) of empty containers (960,000 to 1,792,000 TEU in 2002) handled at empty depots is not directly related to deep-sea transport (see figure S.1).
The direct routing of empty containers between importer and exporter is limited (only a reported 2 to 5%), since containers may need inspection for damage and cleaning before their next trip and information on the next trip is often lacking between parties.

Carrier haulage is characterised by an exchange between inland repositioning providers and ocean carriers and by less inefficient movements between inland terminal and the port. Shipping companies have a better insight in origin and destination of the containers. Shipping companies, using merchant haulage, prefer to have the containers returned to the port for financial and organisational reasons.

Although storage is the prime function of an empty depot, other services (such as inspection, cleaning and repair) to empty containers can be offered.

Importance of empty port depots for users

The possibilities for reduction of storage and in particular movements to and from the depots are explored by analysing the logistics of empty containers. The need for storage facilities of empty containers has been analysed by literature study, interviews and application of the list extension method. The list extension method is systematic causal approach to identify most important influencing factors on, in this case, the need for empty depot terrain in the port.

Direct clients of a port depot are shipping companies and lease companies. Since a leased container is dropped off and picked up under direction of shipping companies, these are the main user of the empty depots.
Transport operators are the indirect users of empty depots. The location and infrastructural connection of empty depots affect the routing and fleet management.

The management of empty containers requires major organisational effort, in order to direct the empty container flows efficiently and to position the right type of container, with the right condition, at the right place when needed. For shipping companies, it is interesting to keep the centre stock that is located closely to points of exit. In that sense, the port is an ideal location, since it has good connections with the hinterland and overseas destinations.

The imbalance in world trade causes a surplus of container in North West Europe. It is not financially efficient to store a surplus of empty containers to deficit region overseas, e.g. the Far East. The *storage costs* in the Far East are significantly higher than in Europe for reasons of tight capacity. It is preferable to position empty containers, in shipping terms "match back" containers, at a port in North West Europe, and only to reposition the containers to the Far East when needed.
Storage at an inland terminal extends the transit time of a trip to the Far East and is therefore less attractive.
Another reason for storage in Europe is the *secondary container market.* In Europe the demand for used containers is higher than in Asia.
Shipping companies aim at minimizing the transportation costs, by reducing the transport of empty containers and by mode choice. Efficiency of hinterland transportation is also important for transport operators, who try to maximize the occupation rate of their vehicle fleet. An optimal container route does not imply an optimal vehicle route. Empty depots near ports enable more *possibilities to combine trips*.

Throughput as basis for the demand for depot terrain in the future

Empty containers are becoming noteworthy. Different former researches estimated the demand for depot terrain at Maasvlakte 2 at23 to 34 ha in 2020, 15 to 95 ha in 2035 and 81 to 136 ha in 2040. These estimates are based on an extrapolation of the present relation on port and empty depot throughput or space.
In this research, the future trends of the determinants of depot utilisation are taken into account. The key determinants are ICT developments, type of haulage, empty deep-sea transhipment and scale enlargements.
It is reasonable to expect an increase in *ICT applications*, which may decrease the need (volume and time) for storage of empties.
The organisational structure is characterised by merchant and carrier *haulage*. The share between these two types is known to fluctuate, but short-term trends are disputable. A shift towards merchant haulage increases the need for storage in the port area.
The *empty deep-sea throughput* has a linear relation with the full deep-sea container throughput ánd the imbalance, between import and export deep-sea container throughput. By means of regression analysis, the relation between the future numbers of empty deep-sea throughput is identified. This results in the following forecasts:
In 2020 the deep-sea throughput will be on average (in neutral scenario) 11 million TEU, of which 2 million TEU empty and in 2040 27 million TEU, of which 5 million empty. The empty throughput in the PoR is growing slower than the throughput in full containers.
The relation between empty container throughput at the port terminal and port depots is not linear. The depot arrivals increase less than port throughput.
Economies of scale positively influence the chance of matching a container with cargo. The trend of the relation between the empty depot arrivals and the empty container throughput in the port is identified and extrapolated to the future.
The future number of depot arrivals are estimated on 2.1 to 2.4 million TEU in 2020 and on 2.7 to 3.2 million TEU in 2040.

Strategies for allocation of depot terrain

The possibilities for distributing the storage areas of empty containers over the port area and the effects of allocation are approached by scenario's, within the boundaries of the decision-making ability of the RPA. Several design concepts have been constructed based on a morphological method. A morphological analysis is a developing technique for exploring all possible solutions to a multi-dimensional non-quantified problem context. The analysis reduces the number of possible solutions through elimination of illogical solution combinations in a grid box.
Each design variable has two to three levels. A variation in levels results in three design concepts and one reference design. The reference design is based on the scenario, in which current policy will continue and autonomous developments are taken into account (i.e. zero-alternative).
The depots are distributed over the port in three main areas: behind the Maasvlakte terminals, elsewhere at the Maasvlakte and at the Waal-/Eemhaven area. It is assumed that an inland depot provides the remaining capacity for the storage of empties.

The concepts are assessed on their performance in 2020 and 2040 regarding the criteria of the main parties involved, by means of a multi criteria analysis. In first instance, the four concepts are assessed by the values of the RPA. Next, the concepts are assessed to the criteria of the shipping companies.
The current policy can be corrected in order to create a better balance between supply and demand. Although it seems advantageous to eliminate empty depots from the Waal-/Eemhaven area, it may have a negative effect on the trip combinations. A depot behind the terminal is valuable, but can be kept minimal. Furthermore, there is a need for a certain amount of depot terrain in the remaining part of the port, which is also in the interest of the RPA to supply.
It is feasible to allocate a substantial amount of empty depots behind the terminal and to offer storage at the Waal-/Eemhaven. A limited part of the storage can be crowded out to inland terminals.

Conclusions

The research results in the recommendation to facilitate empty depots with a barge connection in the Waal-/Eemhaven area, to plan depot terrain ahead and to increase lease prices for depot areas. There is opportunity for improvement of empty logistics, which allows the dimensions of depots in the port area to be less than the demand resulting from an extrapolation of the present situation.

A modal shift in empty container transport can be achieved by locating empty depots behind terminals or by assigning depots to land with a water connection. A connection of a depot with the terminal is logistically efficient. Nevertheless, it is not lucrative for the RPA to locate all empty depots behind the terminals at MV2.

The analysis of the different allocations of depot terrains, confirmed that it is advantageous to allocate terrain in a masterplan in order to prevent planning difficulties in later stages. This strategy results in lots, that are suitable for empty container storage, due to their accessibility by different modalities and to logistical efficient location. Until the empty depot volumes reach the maximal level of occupancy, there will be terrain that the RPA cannot lease to depot operators yet, because the market for depot operators is insufficient at that moment. Therefore, it is lucrative and recommendable for the RPA to find temporary destinations for terrain that will be used for empty depot in a later stage.
It is advantageous to increase the depot prices, since this will stimulate the crowding out effect. Regarding the prices of competing ports there is enough room for price increase.

Under conditions that the current average dwell time and the terrain productivity remain unchanged in the future, the required space for empty depots varies from 100 to 113 ha in 2020 and 127 to 149 ha in 2040, for the entire PoR. Currently there are 85 ha of depot terrain. If it is assumed that the current area remains available, the demand is for an additional 15 to 28 ha empty depot terrain in 2020 and 42 to 64 ha for 2040 for the PoR.

The gradual growth of the future container flow, complicate the planning task of the RPA. Empty containers are in the starting phase of a new terminal stored at the terminal. This retreats the moment at which a critical mass is reached for depots behind future container terminals. Depot operators need a certain amount of depot arrivals to profitable exploit a depot in highly competitive environment. Therefore, leasing terrain behind a new terminal to depot operators in the starting phase is not achievable.
The RPA should use an adaptive, flexible policy to adjust the supply of depot terrain, as it complies with the need.
By restricting the duration of lease contracts with depot operators (about five years) flexibility will be achieved.

An interesting issue in this research is the identification of possibilities to relatively decrease the area for empty depots at the PoR. It is likely that the storage of empty containers shifts towards inland depots. The tight supply of terrain however may result in the following effects.
A reduction in supply may lead to less service to port users. The throughput of the port will decrease, as shipping companies take refuge in other ports for their storage of empty containers.
Tight supply might be an incentive to further increase matchability, to a shift from merchant towards carrier haulage, or to less dwell time by avoiding maintenance and repair in the port depots. Due to the complicated logistic market, it is difficult to predict the future developments.

To protect the competitive strength of the port, in case of tight supply, mitigating measures are needed to keep the same level of service to the clients. Potential mitigating measures can compensate for the decrease in supply of depot terrain. This new approach requires a commercially innovative attitude of the PoR towards empty container services. The possibilities for mitigating measures were investigated, but both the RPA and the shipping companies are of the opinion that those extra container services should originate independently as result of market dynamics.

Discussion

The demand and supply of empty depots should be balanced in the future. Because of the dynamic environment, monitoring is important.

Developments around the mega depot Maersk is planning to create should be followed. Maersk creates large transhipment volumes in the PoR and is consequently responsible for a large part of the need for empty container storage. When Maersk (in stead of depot operators) takes care of depot services at its terminal, there is less need for depots elsewhere in the PoR.

The following aspects of the depot moves are of importance to refine the estimates of the future demand:

- Type of container (distinction in reefer or standard and TEU or FEU)
- Type of modality
- Direction (towards MV or hinterland)
- Dwell time
- Price level of depot services

It is recommended that the RPA monitors the above-mentioned aspects, since an objective and multimodal approach is required.