Reconnecting Rotterdam Port

How public transport can enhance the competitive position of the Port of Rotterdam

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Index

1. Introduction: state of the art of the port industry
2. Problem: Disconnected port
3. Aim and general methodology
4. Analysis on what areas should be connected
5. Synthesis of public transport network alternatives
6. Simulation and evaluation
7. Transit oriented development and local transportation in different scenarios
8. Final network proposal
9. Conclusions
Introduction: State of the art of the port industry

The port of Rotterdam:

- Located in the province of South Holland
- The biggest port in Europe
- Provides 7% of the national income
- Accounts for 5.4% of the national employment
Introduction: State of the art of the port industry
Action should be taken

Threat: Competition between seaports
Action: Proposal to enhance the competitiveness

Factors important for port related companies:
- Accessibility
- Labour force
- Innovative character
- Sustainability
- Availability of space
Problem: The port is physically and mentally detached from its surroundings.

How the port got disconnected:

1900s: Port embedded in the city.
Problem: The port is physically and mentally detached from its surroundings

How the port got disconnected

1900s: Port embedded in the city

1950s: Shipping gained a boost after second world war
Problem: The port is physically and mentally detached from its surroundings

How the port got disconnected

1900s: Port embedded in the city

1950s: Shipping gained a boost after second world war

2000s: Public rejection of the port and port automation
Problem: The port is physically and mentally detached from its surroundings

Problems caused by poor connections

Congested highways delay trucks
Problem: The port is physically and mentally detached from its surroundings

Problems caused by poor connections

Port is physically and mentally detached from its surroundings.

Congested highways delay trucks.

Port unknown as potential employer.
Problem: The port is physically and mentally detached from its surroundings.

Problems caused by poor connections:

- Congested highways delay trucks.
- Port unknown as potential employer.
- Limited spillover of innovations.
Problem: The port is physically and mentally detached from its surroundings

Problems caused by poor connections

Port

- Congested highways delay trucks
- Port unknown as potential employer
- Limited spillover of innovations
- Limited sustainable and space efficiency innovations
Problem: The port is physically and mentally detached from its surroundings.

Existing plans

In Port Vision 2020: Focus on accessibility, sustainability and space.
Problem: The port is physically and mentally detached from its surroundings

Existing plans
Limited relation between accessibility, space and infrastructure.

Infrastructure interventions are all car oriented. 75% of traffic on the A15 are passenger cars.
Approach: Public transport as integral solution

Why is the design of public transport relevant in the port area?

- Potential to combine accessibility, sustainability and space.
- Potential to solve the many problems
- No public transport interventions are proposed in the area.
Approach: Public transport as integral solution

Problems with cost-effective public transport

Unbalanced flows

Morning peak

Evening peak
Approach: Public transport as integral solution
Possibilities for cost-effective public transport

Unbalanced flows, can be solved by:
- Combining port flows and external flows
Approach: Public transport as integral solution

Problems with cost-effective public transport

Low employee density in the port area
Approach: Public transport as integral solution
Possibilities for cost-effective public transport

Low employee density in the port area, solved by:
- Transfers from regional station to work location
Approach: Public transport as integral solution
Possibilities for cost-effective public transport

Low employee density in the port area, solved by:
- Transfers from regional station to work location
- Redistribution of port activity
Approach: Public transport as integral solution
Possibilities for cost-effective public transport

Low employee density in the port area, solved by:
- Transfers from regional station to work location
- Redistribution of port activity
Approach: Public transport as integral solution

Hypothesis

*Cost-effective public transport can be created that restores connections between the port and its surroundings, thereby enhancing the competitive position of the Port of Rotterdam.*

Tested with different network alternatives
Methodology: General approach

Adaptation of the general network design approach

General approach: only simulated on travel behavior
Methodology: General approach

Adaptation of the general network design approach

General approach: only simulated on travel behavior

Socioeconomic relevance and transit oriented development opportunities are added
Methodology: General approach

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Adaptation of the general network design approach

General approach: only simulated on travel behavior

Socioeconomic relevance and transit oriented development opportunities are added

General design cycle: From analysis to an approved design
Analysis: Design criteria

Travel behavior and cost efficiency

Investment costs
Return on investments
Yearly $CO_2$ reduction
Car usage reduction

Socioeconomic relations
Analysis: Design criteria
Travel behavior and cost efficiency

Investment costs
Return on investments
Yearly CO₂ reduction
Car usage reduction

Socioeconomic relations
Port employees - port area
Potential new port employees - port area
Youngsters - knowledge institutes
Leader firms - knowledge institutes
..within 60 minute public transport travel time

Car usage reduction
Investment costs
Yearly CO₂ reduction
Analysis: Design criteria
Travel behavior and cost efficiency

Socioeconomic relations
- Port employees - port area
- Potential new port employees - port area
- Youngsters - knowledge institutes
- Leader firms - knowledge institutes
- Within 60 minute public transport travel time

Transit oriented development opportunities
- Transit oriented development potential

Investment costs
Return on investments
Yearly CO₂ reduction
Car usage reduction
Analysis: Areas to connect

Port employees

Port employees/km² in 2025

- 0 - 25
- 25 - 50
- 50 - 100
- 100 - 150
- 150 - 200
- 200 - 300
Analysis: Areas to connect
Port employees

Port employees/km² in 2025

- 0 - 25
- 25 - 50
- 50 - 100
- 100 - 150
- 150 - 200
- 200 - 300
Analysis: Areas to connect

Ageing

Shortage in 2025:
Maasvlakte: 5000 employees
Botlek: 1000 employees

Decrease in working population between 2009-2025

-10,0
-10,0 - -2,5
-2,5 - 2,5
2,5 - 10
>10
Analysis: Areas to connect
Potential new port employees

Potential port employees/km in 2025

- 0 - 50
- 50 - 150
- 150 - 300
- 300 - 450
- 450 - 600
- 600 - 750
Analysis: Areas to connect
Potential new port employees
Analysis: Areas to connect
Youngsters

15 - 25 year olds/km² in 2025

- 0 - 50
- 50 - 200
- 200 - 350
- 350 - 500
- 500 - 650
- 650 - 800
Analysis: Areas to connect
Youngsters
Analysis: Areas to connect

Leader firms

leader firms/km²

0 - 0,01
0,01 - 0,1
0,1 - 0,2
0,2 - 0,3
0,3 - 0,4
0,4 - 0,5
Analysis: Areas to connect
Leader firms

leader firms/km²

- 0 - 0,01
- 0,01 - 0,1
- 0,1 - 0,2
- 0,2 - 0,3
- 0,3 - 0,4
- 0,4 - 0,5
Analysis: Areas to connect
A15 car drivers

Daily A15 car drivers/km²
Analysis: Areas to connect

A15 car drivers

Daily A15 car drivers/km²

- 0 - 50
- 50 - 100
- 100 - 200
- 200 - 300
- 300 - 400
- 400 - 505
Analysis: Areas to connect

Ideal network
Analysis: Areas to connect
Existing network

- Existing network
- Existing with speed>60km/h
- Existing with speed>40km/h
- Proposed public transport
Analysis: Areas to connect
Proposed new connections

Connection 1: Rotterdam-Botlek-Hellevoetlsuis
Connection 2: The Hague-Port area
Connection 3: Spijkenisse-Maasvlakte
Connection 4: Schiedam-Rotterdam-Drechtsteden
Possible expansion
Synthesis: Network alternatives

Three principles for network design

1. Port railway
2. River crossing
3. Waterbound

Three principles for network design:

Port railway
River crossing
Waterbound

1. Port railway
2. River crossing
3. Waterbound
Synthesis: Network alternatives

Legend

- Connection 1: Rotterdam-Hellevoetsluis
- Connection 2: The Hague-Port area
- Connection 3: Spijkenisse-Maasvlakte
- Connection 4: Schiedam-Drechtsteden

Existing infrastructure

New infrastructure

- Existing stop
- New stop

1. Port railway alternative
Synthesis: Network alternatives

Legend

- Link 1: Rotterdam-Hellevoetsluis
- Link 2: The Hague-Port area
- Link 3: Spijkenisse-Maasvlakte
- Link 4: Schiedam-Drechtsteden

- New infrastructure
- Existing infrastructure
- Existing stop
- New stop

2. River crossing alternative
Synthesis: Network alternatives

Legend

- Link 1: Rotterdam-Hellevoetsluis
- Link 2: The Hague-Port area
- Link 3: Spijkenisse-Maasvlakte
- Link 4: Schiedam-Drechtsteden

Legend:
- New infrastructure
- Existing infrastructure
- Existing stop
- New stop

3. Waterbound system
Simulation: Travel behavior

Estimating mode choice with a logit model

Mode choice (car, public transport and bike) estimated with a logit model.

For 5100 zones in the RVMK model

\[
P_i = \frac{\exp(V_i)}{\sum_{n} \exp(V_i)}
\]

with:

\[
V(i) = \sum_k B_{ki} x_{ki}
\]

- \(P(i)\) = probability alternative \(i\)
- \(V(i)\) = utility for mode \(i\)
- \(B_{ki}\) = weight for explanatory variable \(k\) for mode \(i\)
- \(x_{ki}\) = explanatory variable \(k\) for mode \(i\)
- \(n\) = number of alternatives

Simulation: Travel behavior

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- \(B_{ki}\) = weight for explanatory variable \(k\) for mode \(i\)
- \(x_{ki}\) = explanatory variable \(k\) for mode \(i\)
- \(n\) = number of alternatives

\[
\exp(V)_{\text{car}} = 0.7 \quad P_{\text{car}} = 70\%
\]
\[
\exp(V)_{\text{PT}} = 0.2 \quad P_{\text{PT}} = 20\%
\]
\[
\exp(V)_{\text{bike}} = 0.1 \quad P_{\text{bike}} = 10\%
\]
Simulation: Travel behavior

Estimating mode choice with a logit model

Mode choice (car, public transport and bike) estimated with a logit model.

For 5100 zones in the RVMK model

\[ P_i = \frac{\exp(V_i)}{\sum_{i} \exp(V_i)} \]

with:

- \( V(i) = \sum B_{ki} x_{ki} \)
- \( P(i) = \) probability alternative i
- \( V(i) = \) utility for mode i
- \( B_{ki} = \) weight for explanatory variable k for mode i
- \( x_{ki} = \) explanatory variable k for mode i
- \( n = \) number of alternatives

\[
\begin{align*}
\exp(V)_{\text{car}} &= 0.7 & P_{\text{car}} &= 70\% \ 50\%
\exp(V)_{\text{PT}} &= 0.2 \ 0.6 & P_{\text{PT}} &= 20\% \ 43\%
\exp(V)_{\text{bike}} &= 0.1 & P_{\text{bike}} &= 10\% \ 7\%
\end{align*}
\]
Simulation: Travel behavior

Utility factors in the scope area:

Utility factors are unknown

Derived by iteration of the RVMK data

\[ V_{\text{car}} = 1,00 - 0,08 \times T_{\text{travel car}} \]
\[ V_{\text{PT}} = 0,30 - 0,02 \times T_{\text{travel PT}} - 0,08 \times T_{\text{wait PT}} \]
\[ V_{\text{bike}} = 1,00 - 0,07 \times T_{\text{travel bike}} \]
Simulation: Travel behaviour and cost efficiency

Loads on the different network alternatives

Legend
- 10,000 travelers
- 20,000 travelers
- < 25% capacity used
- > 50% capacity used
- between 25 and 50% capacity used
## Simulation: Travel behaviour and cost efficiency

<table>
<thead>
<tr>
<th></th>
<th>Investment costs</th>
<th>Return on investment</th>
<th>Car usage reduction</th>
<th>CO(_2) emission reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Port railway</td>
<td>€</td>
<td>€</td>
<td>🚗</td>
<td>🦅</td>
</tr>
<tr>
<td>River crossing</td>
<td>€</td>
<td>€</td>
<td>🚗</td>
<td>🦅</td>
</tr>
<tr>
<td>Water bound</td>
<td>€</td>
<td>€</td>
<td>🚗</td>
<td>🦅</td>
</tr>
</tbody>
</table>
Simulation: Socioeconomic relevance and TOD

Transit reach
Simulation: Socioeconomic relevance and TOD

Transit reach

Legend
- < 15 minutes
- 15 - 30 minutes
- 30 - 45 minutes
- 45 - 60 minutes
- Destination
## Simulation: Socioeconomic relevance and TOD

<table>
<thead>
<tr>
<th></th>
<th>Port employees</th>
<th>Potential new port employees</th>
<th>Youngsters-Knowledge institutes</th>
<th>Innovative companies-Knowledge</th>
<th>development potential inside port</th>
</tr>
</thead>
<tbody>
<tr>
<td>Port railway</td>
<td><img src="image1" alt="Icon" /></td>
<td><img src="image2" alt="Icon" /></td>
<td><img src="image3" alt="Icon" /></td>
<td><img src="image4" alt="Icon" /></td>
<td><img src="image5" alt="Icon" /></td>
</tr>
<tr>
<td>River crossing</td>
<td><img src="image6" alt="Icon" /></td>
<td><img src="image7" alt="Icon" /></td>
<td><img src="image8" alt="Icon" /></td>
<td><img src="image9" alt="Icon" /></td>
<td><img src="image10" alt="Icon" /></td>
</tr>
<tr>
<td>Water bound</td>
<td><img src="image11" alt="Icon" /></td>
<td><img src="image12" alt="Icon" /></td>
<td><img src="image13" alt="Icon" /></td>
<td><img src="image14" alt="Icon" /></td>
<td><img src="image15" alt="Icon" /></td>
</tr>
</tbody>
</table>
Evaluation: Network preference

River crossing alternative

Legend

Link 1: Rotterdam-Hellevoetsluis
Link 2: The Hague-Port area
Link 3: Spijkenisse-Maasvlakte
Link 4: Schiedam-Drechtsteden

New infrastructure
Existing infrastructure
Existing stop
New stop

River crossing alternative
Transit Oriented Development and local transport

Legend:
- Link 1: Rotterdam-Hellevoetsluis
- Link 2: The Hague-Port area
- Link 3: Spijkenisse-Maasvlakte
- Link 4: Schiedam-Drechtsteden
- New infrastructure
- Existing infrastructure
- Existing stop
- New stop

River crossing alternative

Maasvlakte
Botlek
Cityports
## Transit Oriented Development and local transport

### Development principles for different scenarios

<table>
<thead>
<tr>
<th>Steady Growth scenario 2035</th>
<th>Prosperous Port scenario 2035</th>
</tr>
</thead>
<tbody>
<tr>
<td>Space innovations not important</td>
<td>Space innovations very important</td>
</tr>
<tr>
<td>No redistribution of port activity</td>
<td>Redistribution of port activity</td>
</tr>
<tr>
<td>Cityports taken over by urban development</td>
<td>Symbiosis between city and port in Cityports</td>
</tr>
</tbody>
</table>
Transit Oriented Development and local transport

Development principles for different scenarios

Steady growth

Prosperous Port
Transit Oriented Development and local transport

Maasvlakte

Steady growth

Prosperous Port
Transit Oriented Development and local transport

Maasvlakte

Steady growth  Prosperous Port

Steady growth  Prosperous Port
Transit Oriented Development and local transport

Cityports

Steady growth

Prosperous Port
Transit Oriented Development and local transport

Cityports

Steady growth

Prosperous Port
Transit Oriented Development and local transport

Cityports

Prosperous Port

P&R
Transit Oriented Development and local transport
Botlek

Steady growth

Prosperous Port
Transit Oriented Development and local transport

Botlek

Steady growth

Prosperous Port
Transit Oriented Development and local transport
Transit Oriented Development and local transport
Transit Oriented Development and local transport
Provide amenities for truckdrivers and port employees

Provide guarded parking spaces for truck drivers

Improve the image of the port by opening up the area for visitors

Create new dwelling programs to accommodate port employees

Attract small and medium sized companies to stimulate innovation

Transit Oriented Development and local transport
Transit Oriented Development and local transport
Transit Oriented Development and local transport
Transit Oriented Development and local transport
Final network proposal

Legend

- Link 1: Rotterdam-Hellevoetsluis
- Link 2: The Hague-Port area
- Link 3: Spijkenisse-Maasvlakte
- Link 4: Schiedam-Drechtsteden

New infrastructure
Existing infrastructure

- Existing stop
- New stop

River crossing alternative
Final network proposal

Legend

- Link 1: Rotterdam-Hellevoetsluis
- Link 2: The Hague-Port area
- Link 3: Spijkenisse-Maasvlakte
- Spatial development potential
- New infrastructure
- Existing infrastructure
- Existing stop
- New stop
Final network proposal

Legend

- Link 1: Rotterdam-Hellevoetsluis
- Link 2: The Hague-Port area
- Link 3: Spijkenisse-Maasvlakte
- Spatial development potential
- New infrastructure
- Existing infrastructure
- Existing stop
- New stop

1.7 billion euro

77%
Final network proposal

Legend
- Link 1: Rotterdam-Hellevoetsluis
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- Link 3: Spijkenisse-Maasvlakte
- Spatial development potential
- New infrastructure
- Existing infrastructure
- Existing stop
- New stop

1.7 billion euro

77%

+0

+16
Final network proposal

Legend

- Link 1: Rotterdam-Hellevoetsluis
- Link 2: The Hague-Port area
- Link 3: Spijkenisse-Maasvlakte
- Spatial development potential
- New infrastructure
- Existing infrastructure
- Existing stop
- New stop

1.7 billion euro

<table>
<thead>
<tr>
<th></th>
<th>+0</th>
<th>-0.2</th>
</tr>
</thead>
<tbody>
<tr>
<td>77%</td>
<td>+16</td>
<td>-15</td>
</tr>
</tbody>
</table>
Conclusions

Testing the hypothesis

Cost-effective public transport can be created that restores connections between the port and its surroundings, thereby enhancing the competitive position of the Port of Rotterdam.
Conclusions

Testing the hypothesis

Cost-effective public transport can be created that restores connections between the port and its surroundings, thereby enhancing the competitive position of the Port of Rotterdam.

The designed network:

- Reduces car traffic on the highways with 5%
- Additional 4,500 port employees connected
- Additional 170,000 potential new employees are connected. 4% is needed until 2025
- Connections between Leader firms and Knowledge institutes improve
- CO₂ emission reduction by 17,000 tonnes/year
- Development opportunities in the port are enhanced
- Has a benefit-cost ratio of 62% - 93%
Conclusions
Implications for the Port of Rotterdam

The port of Rotterdam can take position in the regional transit discussion.

Investment costs of 1.7 billion euros, therefore:
- Partner up to make the investments

Ageing will become a big problem in the area, therefore:
- Connect to The Hague for labour

Long lasting contracts and safety contours:
- Plan far ahead
Conclusions
Implications for regional network design

Public transport in the port area was considered unfeasible, therefore:
- Context study, external flows

Not only travel behavior and costs are important, therefore:
- Socioeconomic relevance should and can be included

Transit oriented development can enhance the feasibility, therefore:
- Transit oriented development potential should be taken into account
Port of Rotterdam Reconnected