Capacity for Rail

Rail-Road, Rail-Sea, Marshalling Yards: Enhancement of Interfaces
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WP2.3 Leader
Team

C4R Capacity for Rail

DB BAHN
IK INSTYTUT KOLEJNICTW
KTH VETENSKAP
New OPERA
Network Rail
Newcastle University
TRAIFIKVERKET
UIC
FUNDAÇÃO
Valenciaport
Contributions of terminals to future rail freight systems 2030 and 2050

1. Features and role of typical terminals and yards = **What the terminals should do**
2. Key Performance Indicators (KPI) = **How the terminals performances can be measured**
3. Case studies = **How the terminals are working today**
4. Innovations = **What the terminals can take onboard and integrate**
5. Effects of innovations = **How the terminals could work**
6. Economical and financial feasibility = **To what extent the terminals will be economically and financially sustainable**
## Features and role: standards

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Common standard 2010</th>
<th>Incremental change 2030 *</th>
<th>System change 2050 *</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Infrastructure</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rail Freight Corridors</td>
<td>18.000km</td>
<td>25.000km</td>
<td>50.000km</td>
</tr>
<tr>
<td>Signalling systems</td>
<td>Different</td>
<td>ERTMS L2 in RFC</td>
<td>ERTMS L3 in RFC</td>
</tr>
<tr>
<td>Standard rail weight</td>
<td>UIC 60 kg/m</td>
<td>70 kg/m</td>
<td>70 kg/m</td>
</tr>
<tr>
<td>Speed ordinary freight</td>
<td>100 km/h</td>
<td>100 - 120 km/h</td>
<td>120 km/h</td>
</tr>
<tr>
<td>Speed fast freight</td>
<td>100 km/h</td>
<td>120 - 160 km/h</td>
<td>120 - 160 km/h</td>
</tr>
<tr>
<td><strong>Traffic system</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SWL</td>
<td>Marshalling - feeder</td>
<td>Automatic marshalling</td>
<td></td>
</tr>
<tr>
<td>Train load</td>
<td>Remote controlled</td>
<td>Liner trains - duo-loco</td>
<td></td>
</tr>
<tr>
<td>Inter Modal</td>
<td>Endpoint - trains</td>
<td>Liner trains with stops at siding</td>
<td>Endpoint - trains Liner trains - fully automated loading</td>
</tr>
<tr>
<td>High Speed Freight</td>
<td>National post trains</td>
<td>International post and parcel - trains</td>
<td>International post and parcel - train network</td>
</tr>
<tr>
<td><strong>IT /monitoring systems</strong></td>
<td>Some different</td>
<td>Standardized control system</td>
<td>Full control of all trains and consignments</td>
</tr>
<tr>
<td><strong>Wagons</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Running gears</td>
<td>Different</td>
<td>50% Track-friendly</td>
<td>All track friendly</td>
</tr>
<tr>
<td>Brakes</td>
<td>Casted-brakes</td>
<td>LL-brakes</td>
<td>Disc-brakes</td>
</tr>
<tr>
<td>Brake control</td>
<td>Pneumatic</td>
<td>Radio controlled EOT</td>
<td>Fully Electronic</td>
</tr>
<tr>
<td>Couples</td>
<td>Screw couples</td>
<td>Automatic couplers on some trains</td>
<td>Automatic couples on all trains</td>
</tr>
<tr>
<td>Max Speed</td>
<td>100 km/h</td>
<td>120 km/h</td>
<td>120-160 km/h</td>
</tr>
<tr>
<td>Max Axle load</td>
<td>22,5 tonnes</td>
<td>22,5 - 25 tonnes</td>
<td>22,5 - 30 tonnes</td>
</tr>
<tr>
<td>Floor height lowest</td>
<td>1100 mm</td>
<td>1000 mm</td>
<td>800 mm</td>
</tr>
<tr>
<td>IT-system</td>
<td>Way-side</td>
<td>Some in wagons</td>
<td>All radio controlled</td>
</tr>
<tr>
<td><strong>Locomotives</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Traction effort kN</td>
<td>300</td>
<td>350</td>
<td>400</td>
</tr>
<tr>
<td>Axle load</td>
<td>20 tonne</td>
<td>22,5 tonne</td>
<td>25 tonne</td>
</tr>
<tr>
<td>Propulsion</td>
<td>Electric</td>
<td>Some duo-locos</td>
<td>Most duo-locos</td>
</tr>
<tr>
<td>Fuel</td>
<td>Diesel</td>
<td>LNG/Diesel</td>
<td>LNG/electric</td>
</tr>
<tr>
<td>Engineers</td>
<td>Always drivers</td>
<td>Some driverless</td>
<td>All driverless</td>
</tr>
<tr>
<td><strong>Trains</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Train lengths in RFC</td>
<td>550-850 m</td>
<td>750-1000 m</td>
<td>1000-2000 m</td>
</tr>
<tr>
<td>Train weight</td>
<td>2 200 tonnes</td>
<td>4 400 tonnes</td>
<td>10 000 tonnes</td>
</tr>
</tbody>
</table>
Features and role: typical terminals

**Rail-Road: interchange interchange**
DB DUSS Riem – Munich (Germany)
IFB Zomerweg – Antwerpen (Belgium)
NV Combinant – Antwerpen (Belgium)
HUPAC HTA – Antwerpen (Belgium)
Typical small scale automatic linear terminal
DB DUSS Duisburg (Germany)

**Rail-Rail: marshalling yard**
Hallsberg (Sweden)

**Rail-Sea: port rail terminal**
Valencia Principe Felipe (Spain)
KPI: selection criteria

**Capability to display the present performances**
- Meeting requests of operators
- Effectiveness to describe terminal operation performances

**Sensibility to potential changes introduced by innovations**
- Capability to assess effects of new technologies
- Capability to assess effects of innovative operational measures
- Homogenization with forecasting methods and models

**Large scale identification**
- Rail-Road: 13; Rail-Rail: 15; Rail-Sea: 14

**Fine tuning**
- Most effective from operation performances viewpoint
- Most reliable method (algorithms and/or simulation) for KPI calculation
- Rail-Road: 4/13; Rail-Rail: 4/15; Rail-Sea: 4/14
Case studies: Riem today

**DB DUSS Riem Terminal – Munich (Germany)**

- 5 arrivals tracks in the holding area
- 3 operative modules
- 14 loading/unloading tracks
- 6 trucks lanes
- 8 storage lanes
- 6 RMG cranes

**24 trains/day**
Mean number of containers: 65 (10.36 m per ITU)
Long Train: 670 m
H24 working time
Direct access of train in operative area
Automatic coupling/uncoupling loco
Multi lift spreader handling
ITU and vehicles automatic control and data exchange
Case studies: Hallsberg today

Hallsberg marshalling yard (Sweden)

Arrival sidings: 8 tracks (590÷690 m)
Double Hump
Direction sidings: 32 tracks (374÷760 m)
Departure sidings: 12 tracks (562÷886 m)
Capacity: 1370 wagons/day

836 wagons/day
Tracks operative length till 1500 m
MMM (Multi Modal Marshalling) Yard: classification tracks accessible not only via hump
Automatic wagon identification
Automatic coupling and uncoupling
Automatic brakes on wagons
Self-propelled wagons
Duo propulsion and driverless locomotives
Working time 24 hours
Case studies: Valencia Principe Felipe today

Valencia Principe Felipe port rail terminal (Spain)

Total area: 50,000 m²
4 loading/unloading tracks
Extra track to shunt locomotives
Electrified tracks until approaching loading/unloading area
Two road access
Two storage areas (9,000 + 20,000 m²)
Case studies: Valencia Principe Felipe tomorrow

Long Train: 850 m / 1000 m
H24 working time
Automatic coupling and uncoupling loco
Number of containers: 80/100 (10.36 m per ITU)
Multi lift spreader handling
ITU and vehicles automatic control and data exchange
Effects of innovations: evaluation

**Requirement: capability to reproduce terminals’ operation**

- **Analytical methods** based on combined algorithms (e.g. queuing theory)
- **Simulation models** based on event-based processes reproduction

**Calibration on typical terminals**

- Subset of data describing the typical operation
- Cross analysis of typical/calculated/simulated KPI

**Tests for validation on case studies**

- More extended set of data describing the present operation
- Cross analysis of real world/calculated/simulated KPI

**Extended application to selected scenarios for case studies**
Examples of calculation flows

- Activities Identification
- Waiting Phases Analysis
- Waiting Times Formalisation
- Parameters and Constraints Identification and Classification
- Times Depending Upon External Parameters
  - TE (C, O)
- Times Depending Upon Internal Parameters
  - TI (T, D, R)
- Transit Time Calculation
  - TTR = TE + TI

Examples of hierarchical layers
Effects of innovations: Riem

**ITUs total transit time**

- **Relevant reduction in truck-train direction (14% in CS)**

**Vehicles total transit time**

- **General reduction for train**

**Equipment performance**

- **Relevant increase (25% in CS)**

**Vehicles utilisation rate**

- **Important decrease in CS**
Effects of innovation: Hallsberg

**Average wagon transit time**
- Relevant reduction in CS (about 60%)

**Tracks utilization rate**
- Relevant increase (48% in CS with long trains)

**Maximum flow through the yard**
- Relevant increase (75% in CS with long trains)

**Average number of wagons in the yard**
- Relevant reduction (50% in CS)
Effects of innovation: Valencia

**ITUs total transit time**
- Significant reductions: 9% train-ship and 29% ship-train

**Vehicles total transit time**
- Relevant reductions: 34% for ships and 74% for trains

**Equipment performance**
- Huge increase: 230% for RTG crane

**Vehicles utilization rate**
- Relevant decrease for train: 51%
Feasibility: total costs %

- **Inter modal Munich**: 300,000 TEU/year
- **Inter modal Valencia**: 100,000 TEU/year
- **Inter modal Liner AMCCT**: 16,500 TEU/year
- **Marshalling yard Hallsberg**: 250,000 wagons/year
Feasibility: unit costs

Cost €/unit

- Annuity basic terminal investment
- Annuity technical equipment
- Other operating and maintenance costs
- Cost for shunting engines/marshalling

<table>
<thead>
<tr>
<th>Location</th>
<th>Capacity</th>
<th>Cost €/unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inter modal Munich</td>
<td>300,000 TEU/year</td>
<td></td>
</tr>
<tr>
<td>Inter modal Valencia</td>
<td>100,000 TEU/year</td>
<td></td>
</tr>
<tr>
<td>Inter modal Liner AMCCT</td>
<td>16,500 TEU/year</td>
<td></td>
</tr>
<tr>
<td>Marshalling yard Hallsberg</td>
<td>250,000 wagons/year</td>
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</table>
### Feasibility: Net Present Value

#### Riem

<table>
<thead>
<tr>
<th>Rate of Return</th>
<th>BAU</th>
<th>Low</th>
<th>High</th>
<th>BAU</th>
<th>Low</th>
<th>High</th>
<th>BAU</th>
<th>Low</th>
<th>High</th>
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<tbody>
<tr>
<td>2%</td>
<td>139</td>
<td>189</td>
<td>267</td>
<td>348</td>
<td>429</td>
<td>578</td>
<td>418</td>
<td>501</td>
<td>652</td>
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<tr>
<td>3%</td>
<td>117</td>
<td>158</td>
<td>222</td>
<td>288</td>
<td>354</td>
<td>475</td>
<td>354</td>
<td>422</td>
<td>545</td>
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<tr>
<td>5%</td>
<td>85</td>
<td>113</td>
<td>156</td>
<td>198</td>
<td>242</td>
<td>324</td>
<td>259</td>
<td>305</td>
<td>387</td>
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</table>

#### Hallsberg

<table>
<thead>
<tr>
<th>Rate of Return</th>
<th>BAU</th>
<th>Low</th>
<th>High</th>
<th>BAU</th>
<th>Low</th>
<th>High</th>
<th>BAU</th>
<th>Low</th>
<th>High</th>
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</thead>
<tbody>
<tr>
<td>2%</td>
<td>-133</td>
<td>-117</td>
<td>-104</td>
<td>-204</td>
<td>-203</td>
<td>-202</td>
<td>-176</td>
<td>-174</td>
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<tr>
<td>3%</td>
<td>-115</td>
<td>-102</td>
<td>-91</td>
<td>-179</td>
<td>-178</td>
<td>-177</td>
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<td>-141</td>
<td>-140</td>
<td>-140</td>
<td>-123</td>
<td>-122</td>
<td>-121</td>
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</table>

#### Valencia

<table>
<thead>
<tr>
<th>Rate of Return</th>
<th>BAU</th>
<th>Low</th>
<th>High</th>
<th>BAU</th>
<th>Low</th>
<th>High</th>
<th>BAU</th>
<th>Low</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>2%</td>
<td>360</td>
<td>410</td>
<td>501</td>
<td>464</td>
<td>527</td>
<td>642</td>
<td>467</td>
<td>529</td>
<td>644</td>
</tr>
<tr>
<td>3%</td>
<td>305</td>
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<td>445</td>
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<td>396</td>
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<tr>
<td>5%</td>
<td>224</td>
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<td>301</td>
<td>288</td>
<td>322</td>
<td>384</td>
<td>290</td>
<td>326</td>
<td>387</td>
</tr>
</tbody>
</table>
Feasibility: confirmed subjects

**Objectives**

a) Definition of terminals typologies capable to cover large majority of rail freight traffic

b) Identification of KPIs capable to represent operational modes of terminals and to be sensitive to effects of innovations

c) Focused and enlarged case studies to comply with all typologies

d) Identification of innovations suitable to be included in consolidated scenarios for each terminal typology and case study

e) Identification of innovations suitable to increase global efficiency of logistic chains

f) Assessment of future terminals including effects of innovative technologies and operational measures

g) Calculation of operational and capital costs of newly designed terminals

h) Consolidation of a suitable methodology for future traffic estimation

**Quantitative results**

1) Achievable operational standards of intermodal and wagonload terminals;

2) Financial business case of future terminals

3) Economic results from societal viewpoint useful to select future European actions in freight transport and rail systems fields
Thank you for your kind attention

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