C4R

Capacity for Rail

SP2 New Concepts for Efficient Freight systems

WP2.3 Co-modal Transhipment and Interchange Logistics

Dissemination Workshop #2 – 3rd NOVEMBER 2016

SAPIENZA UNIVERSITÀ DI ROMA

SEVENTH FRAMEWORK PROGRAMME

Team

Scopes

Capacity for Rail

Contributions of terminals to rail freight systems 2030 and 2050

- Expected performances and requisites = What the terminals should do
- Key Performance Indicators (KPI) = How to measure terminal performances
- Integration of innovations = What the terminals can take onboard
- Future scenarios = How the terminals could work
- Methods and models to assess scenarios = How to assess scenarios
- Assessment of scenarios = How much expected performances are performed

Typology of terminals (case studies)

- Rail-Road – inland freight interchanges
  - Munich Riem (DE)
  - Antwerp Combinant (BE)
  - Antwerp Hupac (BE)
  - Antwerp Zomerweg (BE)
  - Typical small scale automatic linear terminal
- Rail-Rail - marshalling yards
  - Hallsberg (SE)
- Rail-Sea – containers port terminals
  - Valencia Principe Felipe (ES)

"a modern, automated, intelligent and fully-integrated system for efficient, reliable freight Operations"

Key Performance Indicators

Selection criteria

- Sensibility to potential changes introduced by innovations: operational measures and technologies
- Meeting requests of operators
- Identified KPIs by terminal typology: 13 (Rail-Road), 15 (Rail-Rail), 14 (Rail-Sea)
- Examples:

Key Performance Indicator for rail – sea intermodal terminal

Definition		Description	Depend of
Total Transit Time (ITU) Total Transit Time (vehicle)	$TTR = \sum_{i=1}^{n} TWi + \sum_{i=i}^{n} TOi$	Time period from the arrival of the freight unit (or vehicle) to the terminal gate from railway network (an external transport infrastructure) to the exit of the unit (or vehicle) from the terminal towards the railway network or sea. • TTR = total transit time; • TW = waiting time; • TO = operational time.	• external infrastructures and transport services; • technologies; • operational rules; • terminal dimensions.
Utilization Rate of Handling Equipment	$Er = \left(\frac{nETr}{nE}\right)_{Th}$	Is the average number of handling equipment, engaged on a train during the handling time (Equipment rate utilization in handling area). • Er = utilization Rate of Handling Equipment; • nETr = number of handling equipment employed per train; • nE = total number of handling equipment available in handling area; • Th = handling (loading/unloading) time.	• handling technologies; • operational rules; • terminal dimensions.
Utilization of ITU Storage Space	$s_{ITUi} = \left(\frac{(n\,ITU_{in} + nITU_{s(i-1)} - nITU_{out})}{Cs_{max}}\right)_{Ti}$	It is the influence of the number intermodal units which transit within terminal, on the storage area capacity. • S ITU, i = utilization rate of ITU storage area; • n ITU_in = number of incoming ITUs in terminal; • n ITU_s (i-1) = number of stored ITUs; • n ITU_out = number of departing ITUs; • Cs_max = maximum storage capacity; • T = time gap (day, week, month or year); • i = i –th. time gap.	• external infrastructures and transport services; • technologies; • operational rules; • flow of ITUs handled in the terminal.
Energy Consumption rate	$Ec(ITU) = \frac{Ec(v)}{n\,ITU(v)}$	It is the energy consumption of handling equipment per ITU. • Ec (v) = energy consumption of handling equipment per vehicle; • n ITU (v) = number of intermodal transport units per vehicle.	• flow of Intermodal Terminal Units (ITUs); • technologies; • number handling equipment; • operational rules (e.g. terminal time operative).
	$Ec(ta) = \frac{C}{S}$	It is the energy consumption of Terminal area compared to its surface: e.g., terminal lighting, office consumption. • C = energy consumption of terminal; • S = terminal area.	

Innovations to be integrated

Compatibility check

INNOVATIVE OPERATIONAL MEASURES/INNOVATIVE TECHNOLOGIES		INNOVATIVE OPERATIONAL MEASURES							INNOVATIVE TECHNOLOGIES				
		Horizontal and parallel handling	Faster and fully direct handling	Handling with moving train	Automatic ITU/V. control and data exchange	No locomotive change	Long train	working hour (all 24h)	Automatic systems for horizontal parallel handling	Automated fast transtainer	intermodal complex spreader	Duo loco	Automated gate
INNOVATIVE OPERATIONAL MEASURES	Horizontal and parallel handling												
	Faster and fully direct handling												
	Handling with moving train												
	Automatic ITU/V. control and data exchange												
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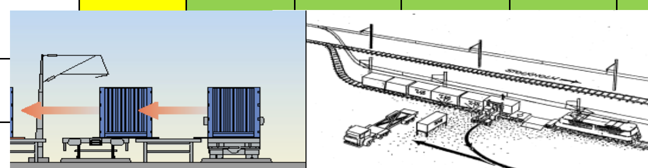
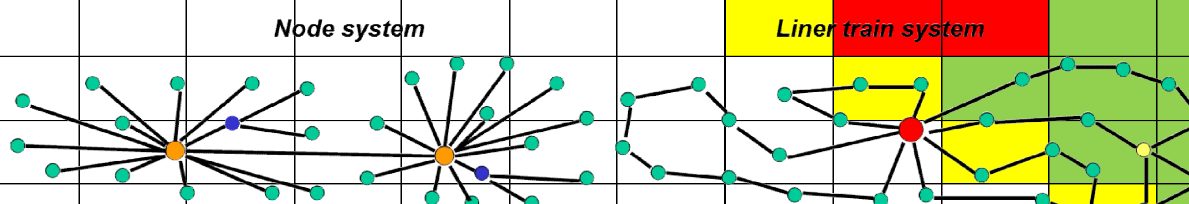




Suggestions taken into account

From dissemination meeting in September 2015

- Self-propelled wagons to be included in all scenarios for marshalling yards
- Duo-locomotive are already reality
- Business cases should take into account the added value of logistic services
- Increase of traffic from/to ports as key scope of future scenarios
- Future terminals to focus on effective traffic of parcels/carriers services
- Smaller shunting stations should be proposed and simulated
- Digitalization of information to be included in all scenarios
- Transparency in information exchanges between stakeholders
- Best practices in info-management applied in ports/airports communities
- Vision papers on future logistics by various stakeholders to be considered

Scenarios building

- Scenario 1 (2030): incremental change
- Scenario 2 (2050): system change
- Consolidated Scenario: integrated by operators' feedback and local constraints
- Example:

Rail - Road terminal Munich Riem					
Scenario 1		Scenario 2		Consolidated Scenario	
Innovative operational measures	*Innovative technologies*	*Innovative operational measures*	*Innovative technologies*	*Innovative operational measures*	*Innovative technologies*
Faster and fully direct handling Automatic ITU and vehicles control and data exchange No locomotive change Long train (1500 m) H24 working time	Automated fast transtainer Intermodal complex spreader Duo loco Fast automated gate	Horizontal and parallel handling Faster and fully direct handling Automatic ITU and vehicles control and data exchange No locomotive change Long train (1500 m) H24 working time	Automatic systems for horizontal parallel handling Duo loco Fast automated gate	Automatic ITU and vehicles control and data exchange Partial and fast locomotive change Long train (670m) H24 working time	Fast transtainer (+30-40% RMG performances) Fast Automated gate Automatic coupling loco

Assessment of scenarios

Requirements

- ❑ Capability to reproduce terminals' operation
- ❑ Sensibility to innovations: operational measures and technologies

Analytical methods

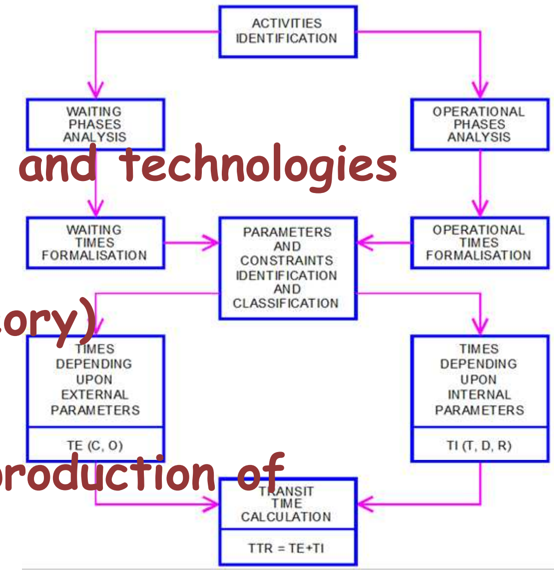
- ❑ Based on combined algorithms (e.g. queuing theory)

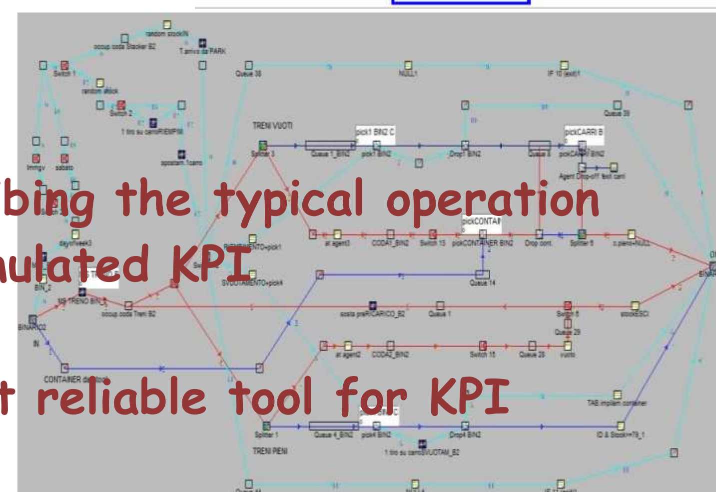
Simulation models

- ❑ Synchronous and asynchronous event-based reproduction of operational processes

Methodological process

- ❑ Calibration on typical terminals
- ❑ Identification of subsets of data describing the typical operation
- ❑ Cross analysis of typical/calculated /simulated KPI
- ❑ Tests for validation on case studies
- ❑ Identification of application fields: most reliable tool for KPI calculation
- ❑ Extended application to selected scenarios





Rail-Road: Inland freight interchange

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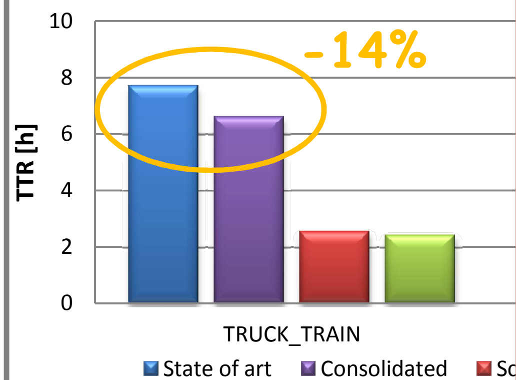
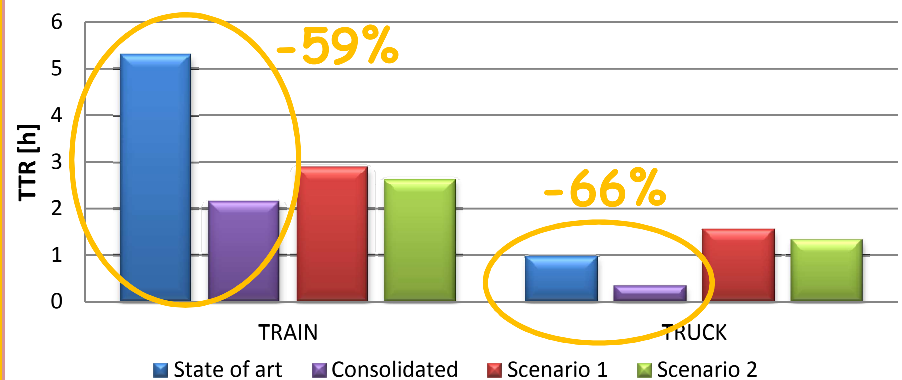
Consolidated Scenario	
Automatic ITU and vehicles control and data exchange	Fast transtainer (+30-40% RMG performances)
Partial and fast locomotive change	Fast Automated gate
Long train (670m)	Automatic coupling loco
H24 working time	

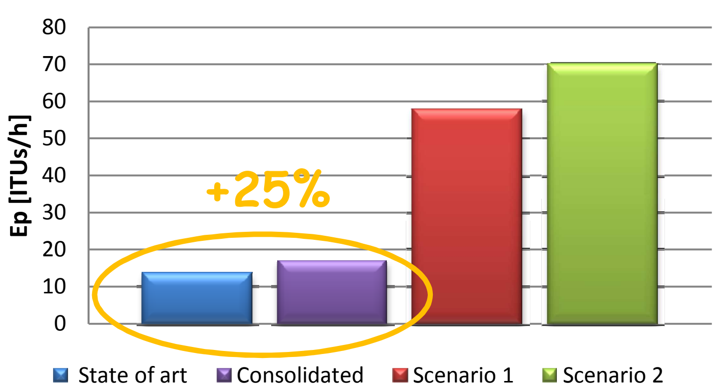
ITUs total transit ti
(by analytical metho



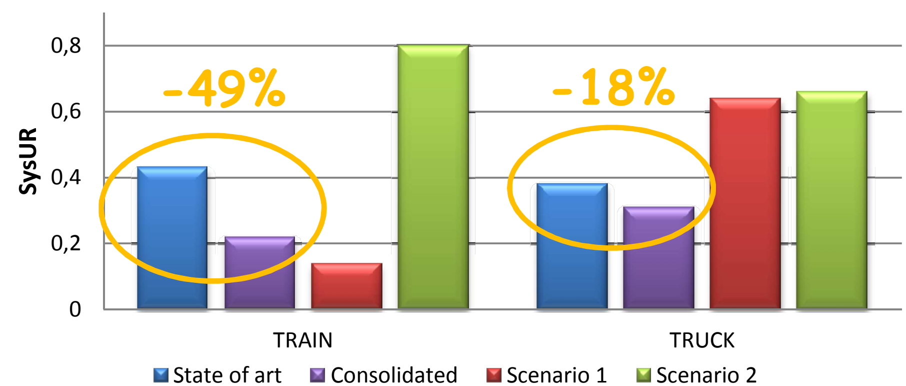
Vehicles total transit time
(by analytical method)



Equipment performa
(by simulation model)



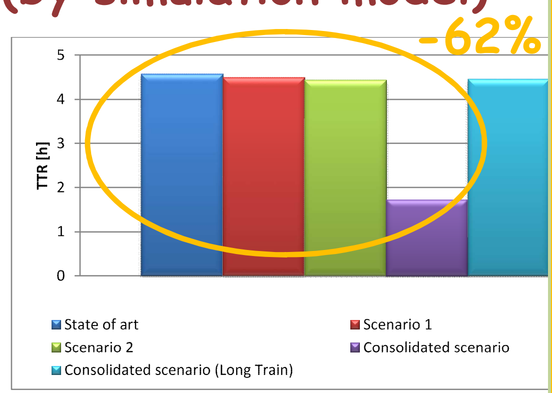
Vehicles utilisation rate
(by simulation model)



Rail-Rail: Marshalling yard

Capacity for Rail

Average wagon transit t
(by simulation model)



Consolidated Scenario

Tracks operative length till 1500 m

Multi Modal Marshalling (MMM): classification tracks accessible not only via hump

Automatic wagon identification

Automatic coupling and uncoupling

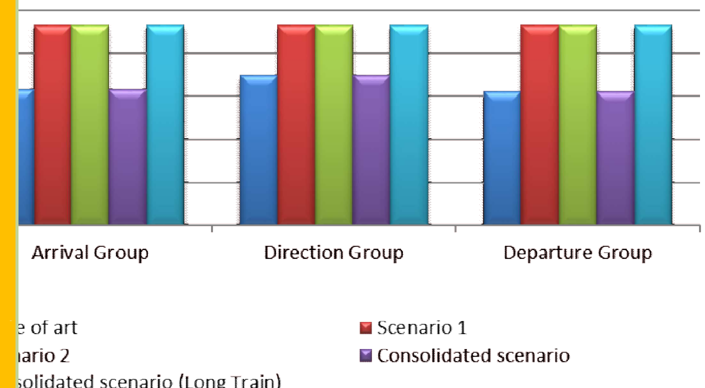
Automatic brakes on wagons

Self-propelled wagons

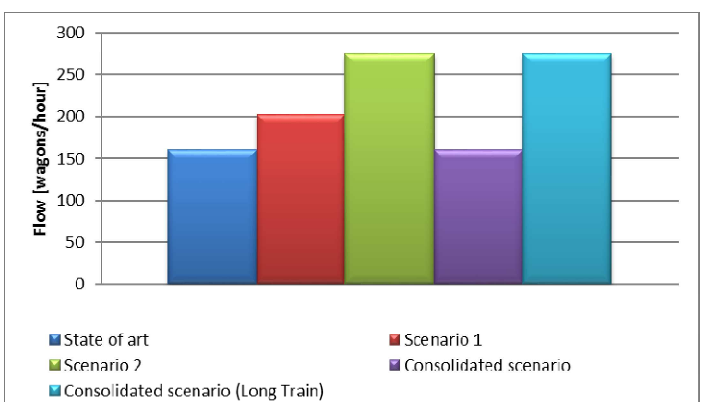
Duo propulsion and driverless loco

H24 working time

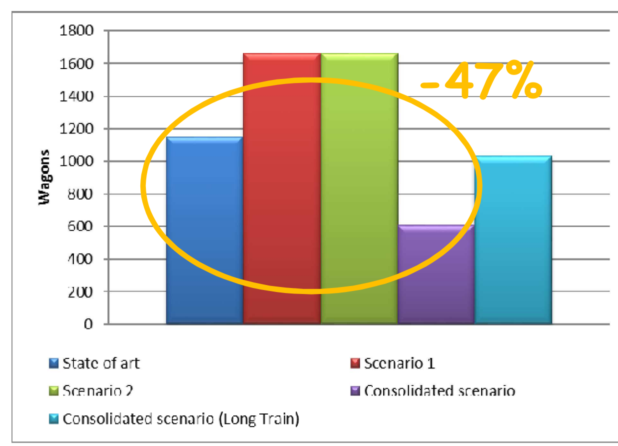
Tracks utilization rate
(by simulation model)



Maximum flow through
(by analytical method)



Average number of wagons in
(by simulation model)



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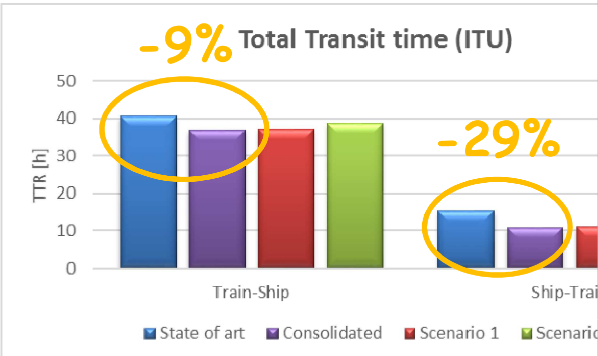
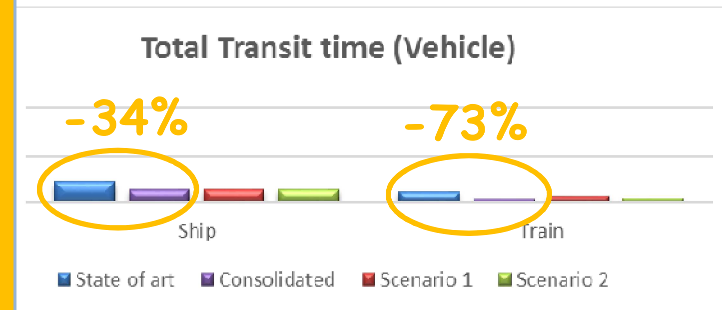
Rail-Sea: Containers port terminal

ITUs total transit time
(by analytical method)

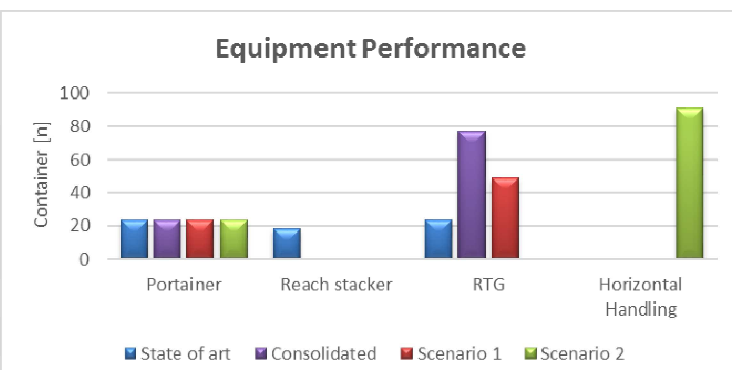


Consolidated Scenario	
Automatic ITU and vehicles control and data exchange Long train (850-1000 m) H24 working time	Multi lift spreader handling Fast Automated gate Automatic coupling loco

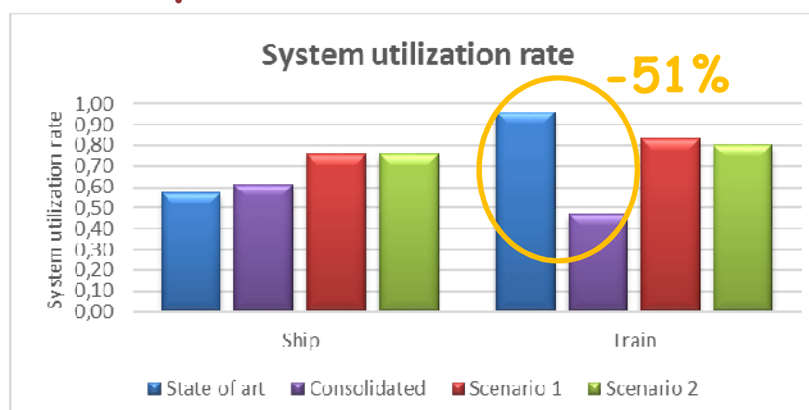
Vehicles total transit time
(by analytical method)



Equipment performance
(by simulation model)



Vehicles utilisation rate
(by simulation model)



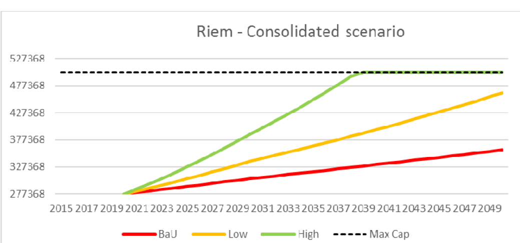
Traffic forecast

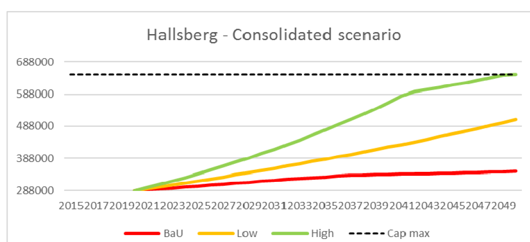
C4R Capacity for Rail

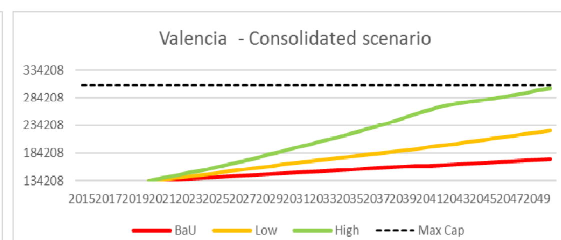
Expected increase

- ❑ Main Source: EU White Paper

	Increase factor			Increase % per year		
	2015-2030	2030-2050	*2015-2050*	2015-2030	2030-2050	*2015-2050*
Business as Usual	1.16	1.17	***1.37***	1.0%	0.8%	***0.95***
Modal shift Low scenario	1.34	1.38	***1.87***	2.0%	1.6%	***1.8%***
Modal shift High scenario	1.65	1.84	***3.06***	3.4%	3.1%	***3.2%***







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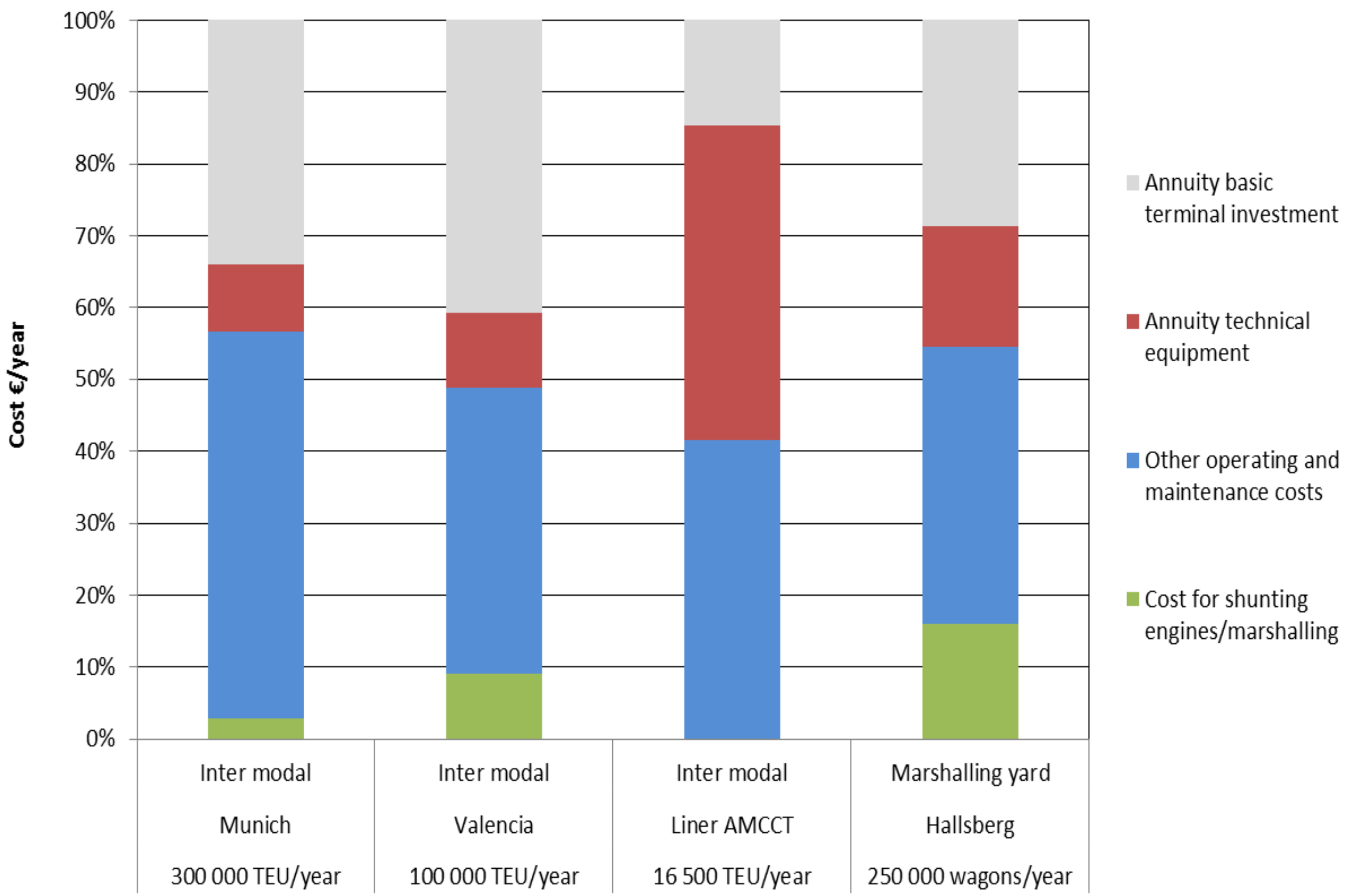
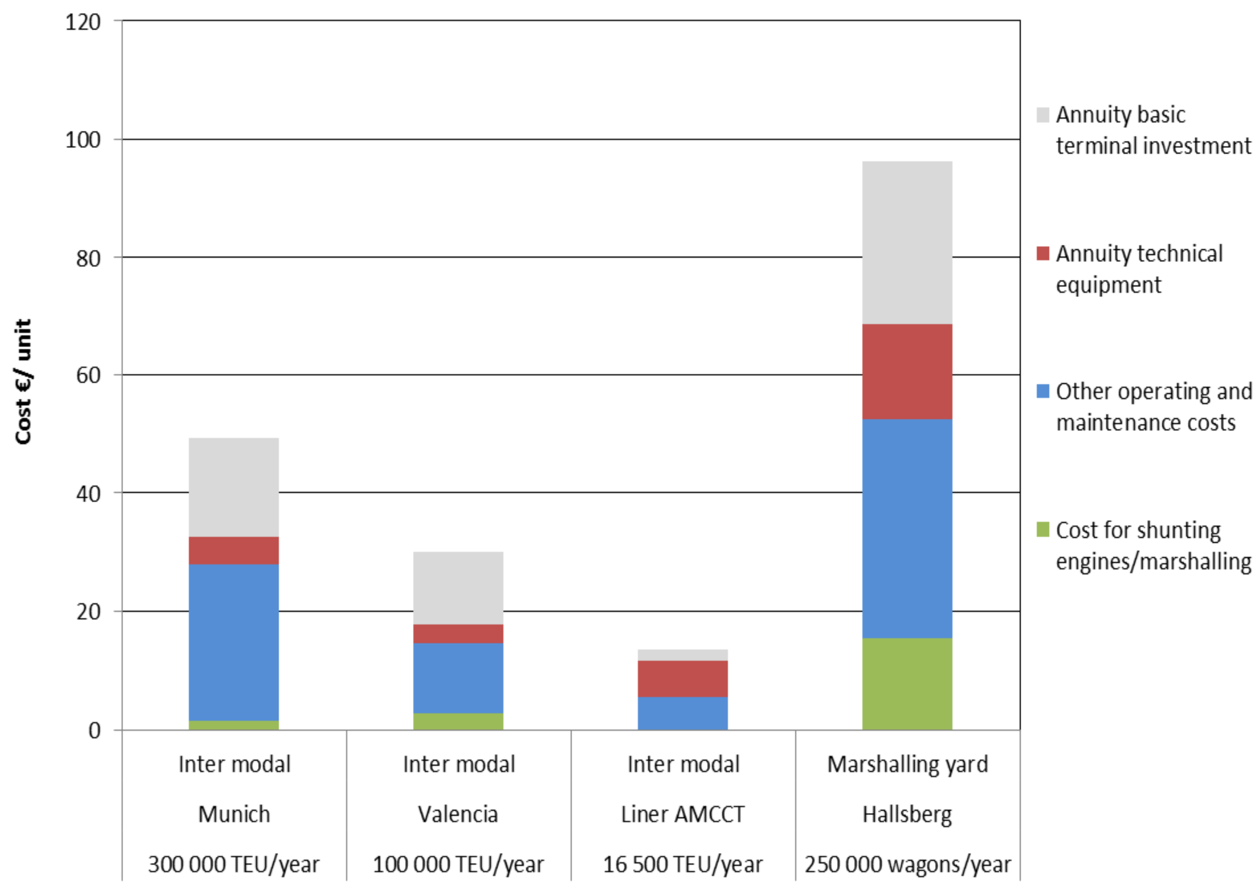
Total costs analysis

% Costs distribution by category



Unit costs analysis

Costs / handled UTI distributed by category



Results of economic analysis

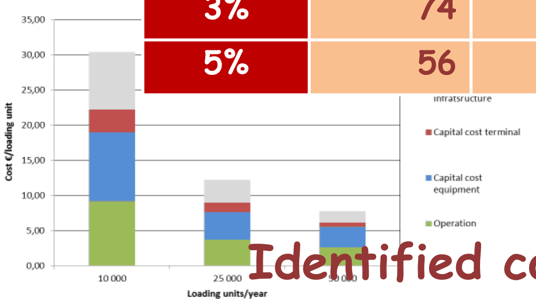
Net Present Value by Rates of Return

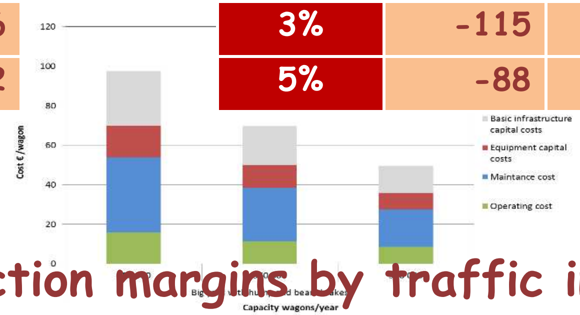
	Rail-Road (Munich Riem) [Billion €]		
Rate of Return	BAU	Low	High
2%	139	189	267
3%	117	158	222
5%	85	113	156

	Rail-Sea (Valencia) [Billion €]		
Rate of Return	BAU	Low	High
2%	360	410	501
3%	305	346	420
5%	224	251	301

	Rail-Road (I.L.AMCCT) [Billion €]		
Rate of Return	BAU	Low	High
2%	86	93	102
3%	74	80	86
5%	56	59	62

	Rail-Rail (Hallsberg) [Billion €]		
Rate of Return	BAU	Low	High
2%	-133	-117	-104
3%	-115	-102	-91
5%	-88	-79	-71





Identified costs reduction margins by traffic increase

Summary of results

Achieved milestones

a) Definition of terminals typologies capable to cover large majority of rail freight traffic
b) Identification of set of KPI by terminal typology capable to represent operational modes and to be sensitive to effects of innovations
c) Focused and enlarged case studies
d) Identification of innovations suitable to be included in consolidated scenario for each terminal typology and case study
e) Identification of innovations suitable to increase global efficiency of logistic chains
f) Assessment of future terminal performances including effects of innovative technologies and operational measures
g) Calculation of operational and investment costs of newly designed terminals business case and cost-benefit analyses
h) Consolidation of methodology for future traffic estimation, financial and cost-benefit analysis

Follow-ups

Capacity for Rail

Generally valid feedback

1) Achievable operational standards of intermodal and wagonload terminals
2) Financial results concerning the business case of terminals
3) Economic results from the societal viewpoint useful to select future European actions in freight transport and rail systems fields

Towards C4R next steps

- WP2.4, preparing catalogue of specifications for future rail freight terminals
- SP3, developing operation strategies increasingly using automation to optimised performance and enhance capacity at network level
- SP5, cross cutting technical work streams of various SP to ensure whole-system approach to draw common vision of future affordable, adaptable, automated, resilient and high-capacity railway system

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Thank You!

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and the whole WP2.3 team