Deliverable 8.1
Executive Summary

The technological tools and solutions

Executive summary

WP 8 consists of three tasks and deals with impact assessment. The first task ("The technological tools and solutions"), treated in this deliverable, is about the technical tools and solutions. Co-modal solutions for realising modal shift from road to rail are in focus. The contribution for the achievement of the ambitious targets (e.g. in terms of GHG emissions) is indispensable. In task 8.2 ("The cost benefit analysis including KPI definition and measurement") parts of the selected tools and solutions are assessed in terms of costs and benefit. The third task within this work package ("The expected impacts on SPIDER PLUS 2050 mobility vision") provides a further assessment concerning the key performance indicators (KPIs), social performance indicators (SPIs) and cost-benefit analysis (CBA) results of the selected tools and solutions.

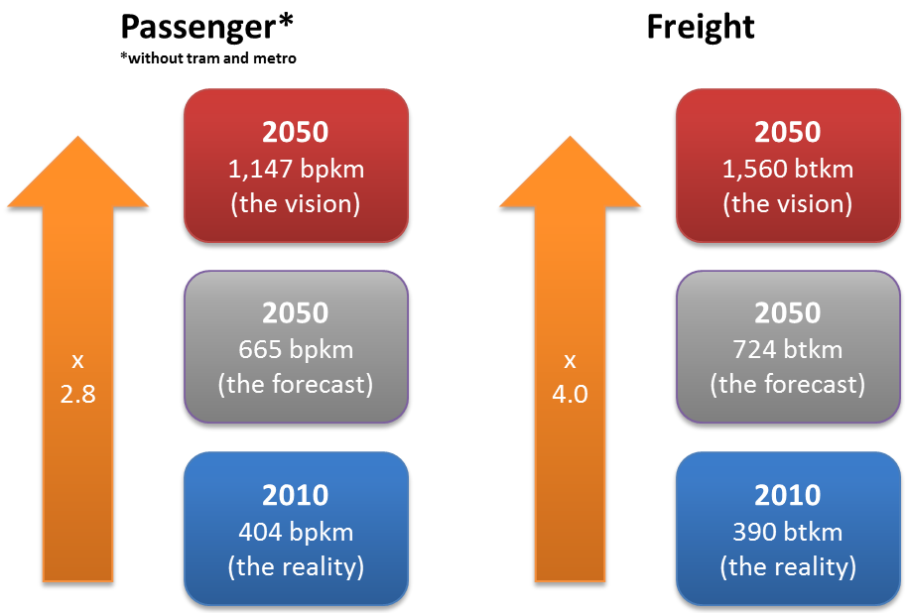
With a "European society overwhelmingly served by electrified rail" as central part of the SPIDER PLUS vision, two questions arise:

1) What does this vision imply for the quantitative development of freight and passenger services on rail?
   ➔ Quantitative dimension (quantitative challenge)

2) What can be done to achieve this vision and how has the European rail world to look like in 2050?
   ➔ Development of technology, infrastructure as well as management and operation

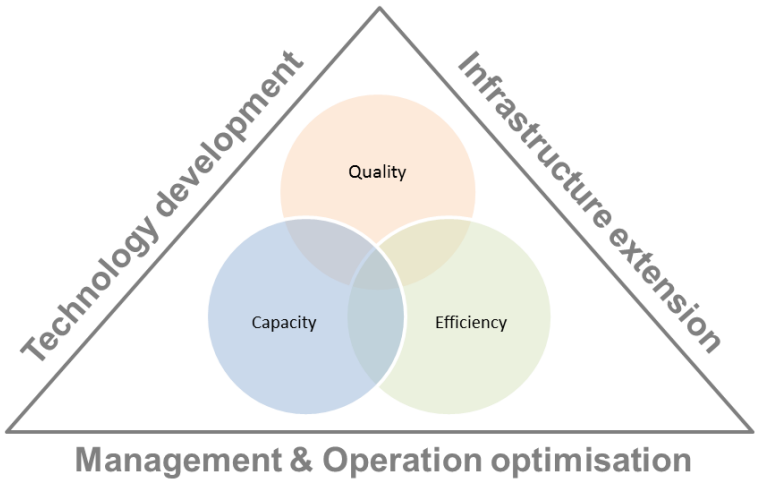
The European Commission has set the baseline for SPIDER PLUS with its ambitious vision:

"A European society overwhelmingly served by electrified rail"



Quantitative dimension – quantitative challenge

Figure 1: The Quantitative dimension – Source: HaCon (EU 27; own expert calculation based on current volumes and expected market developments due to improvements in service quality and new production concepts (mixed rail freight) and implementation of required developments in operations, infrastructure and technology the , Appendix 2)



Logical triangle as orientation for the development of the European rail world

Figure 2: Logical triangle

The first question touches the quantitative challenge. Regarding the existing forecasts and expert estimations for the mobility development and transport demands for freight and passenger services until 2050, it is to be expected, that this overwhelming transport volume of 1,147 bpkm for passenger and 1,560 btkm for freight (Figure 1) will exceed the present capacity of the European rail infra- and suprastructure by far.

For this reason, the second part deals with the development of technology, infrastructure as well as management and operation. Therefore it paints the picture of a European railway system in the year 2050 and describes measures and strategies that are needed to achieve the ambitious target.

In task 8.1 a relationship is set between the quantitative challenge, the logical triangle and the vision elements that have been elaborated in work package 7. The vision elements have been evaluated by the aspect of improving co-modal solutions and their capability to meet the quantitative challenge.

Existing facts and possible action fields (technology, infrastructure, management & operation) in the European railway world are mirrored on the vision elements in order to identify the most suitable vision elements/measures that enable the system to achieve this target. This process is directly linked to the aims quality, capacity and efficiency (see Figure 2 above).

Figure 3 shows the context of Task 8.1.The elaborated technological tools and solutions belong to the following four areas:

- **Freight production systems** (Single wagon load services (SWL), Block train services (BT) and intermodal services).
- **Passenger production systems** (High speed rail and "conventional" (inter-) regional and commuter services).
- **Infrastructure** (belonging to both parts of production systems).
- **Accompanying measures** (additional solutions and supporting strategies).

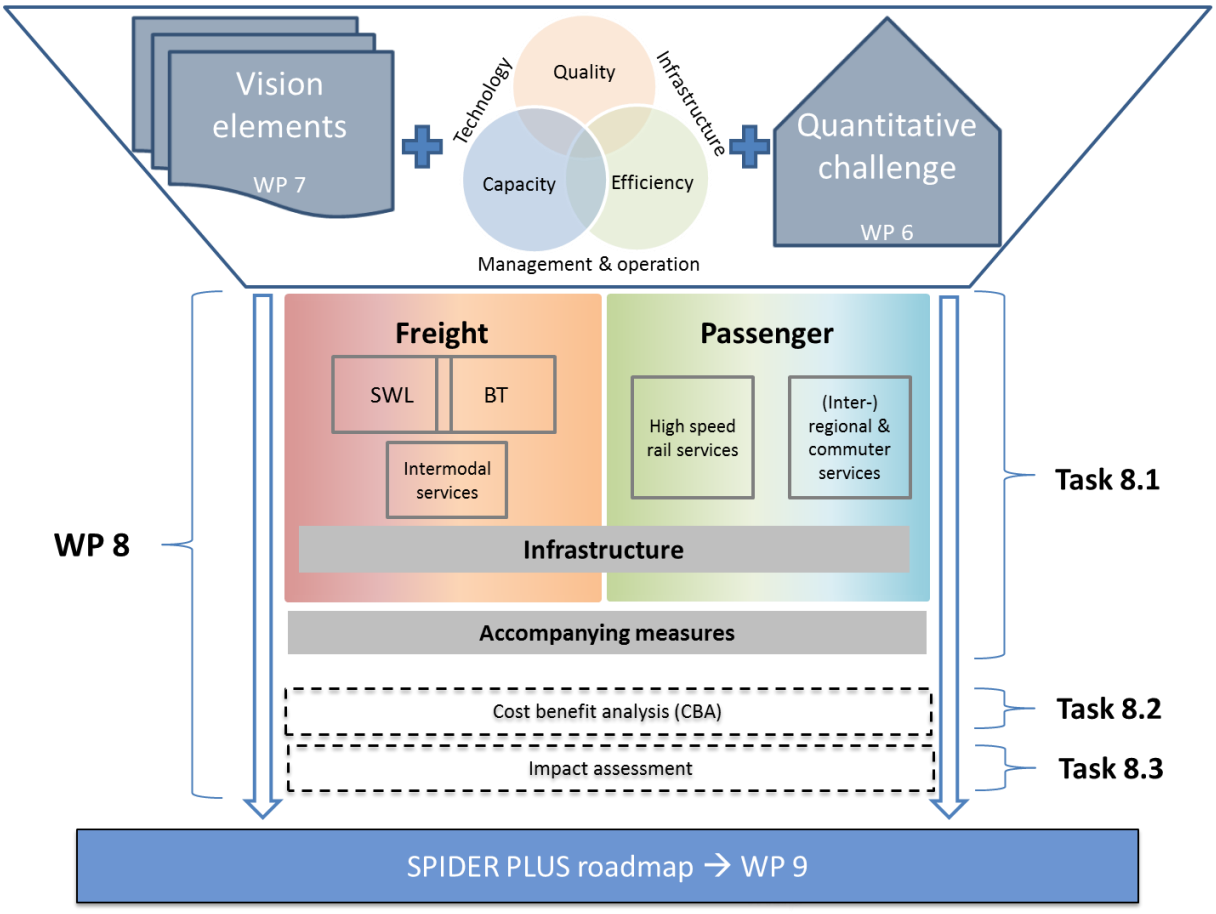


Figure 3: Elaboration of WP 8

Freight

There are three main objectives that determine the technological tools and solutions for freight:

1. Boost of efficiency of single wagon load (SWL) production.
2. Opening of BT for new market segments through modularisation of production.
3. Continuous industrialisation of Combined transport (CT) on European level.

On the basis of these objectives, the following technological tools and solutions for freight have been identified by a rough qualitative assessment (long-standing expert experiences under consideration of current trends without using a dedicated method; further impact analysis take place in Task 8.2 and 8.3) about their impact on quality, capacity and efficiency. The technological tools and solutions (or equivalent in this respect: measures) are listed below, their qualitative assessment is shown in Table 1:

- **Automatic centre buffer coupling** (ACBC) of wagons, wagon groups and train units
- **Automated marshalling yards** (central European SWL-"hubs")
- **Automation of handling of CT-units** in terminals and especially in hubs
- **Longer and heavier trains** on the European rail freight corridors
- **Continuous electric wire** (wagon-energy supply and data transfer for train control)
- **Hybrid Locomotives** (e.g. especially for seamless last mile services)
- **New designed freight wagons** (modular /multi-type, reduced tare weight and noise reduction)
- **Comprehensive ICT based management and operation** of production and customer Services

Table 1: Qualitative assessment of measures for freight

Measure	Impact on		
	Quality	Capacity	Efficiency
Automatic Coupling ACBC	+	++*	++
Automated marshalling yards	+	+	++
Automation of handling of CT-units	+	+	++
Longer and heavier trains	(+)	++	+
Continuous electric wire	++	(+)	+
Hybrid Locomotives	++	(+)	+
New designed freight wagons	++	(+)	+
Comprehensive ICT based management	+	+	++

Legend: ++ immense impact + high impact (+) smaller impact
*(through longer and heavier trains)

Passenger

The technological tools and solutions for passengers are based on the following three objectives:

1. Increase efficiency of services and capacity per train.
2. Increase frequency of services.
3. Increase attractiveness of service quality and travel assistance.

In this context, the following measures for passenger services have been elaborated, supported by the qualitative assessment as it is shown in Table 2:

- **Double stack wagons** for regional and long distance trains (including High speed rail).
- **New designed train sets** (modular /multi-type, reduced tare weight, maintenance on demand, on-board services and noise reduction).
- **Automated operation** (especially for commuter services in dedicated areas).
- **High frequent services and integrated timetable.**
- **Optimised connectivity of different types of services** (commuter, regional, interregional and HSR).
- **Introduction of comprehensive carefree travelling.**
- **Train coupling and sharing of train modules** (e.g. "Y-train services"), coupling on the run ("online").

Table 2: Qualitative assessment of measures for passenger

Measure	Impact on		
	Quality	Capacity	Efficiency
Double stack wagons	(+)	++	+
New designed train sets	++	(+)	+
Automated operation	+	++	++
High frequent services and integrated timetable	++	(+)	(+)
Optimised connectivity of different types of services	++	(+)	(+)
Introduction of comprehensive carefree travelling	++	(+)	(+)
Train coupling and sharing of train modules	+	+	+

Legend: ++ immense impact + high impact (+) smaller impact
*(through longer and heavier trains)

For passenger services the technological tools and solutions put the customers/ passengers in the centre of all activities. Once again, it is about quality, capacity and efficiency whereby operational boundary conditions play a major role.

Infrastructure

The future rail network performance will be the backbone of high quality rail services for passenger and freight in view of competition to other modes. A high-quality infrastructure is needed which meets the following objectives:

1. Remarkable increase of capacity by harmonisation of operation and upgrading of European main rail network including access and supporting facilities.
2. High performance in rail operation
    - first priority: reliable service quality
    - second priority: reduction of travel and transport times.

Regarding these objectives, the following measures have been identified (see qualitative assessment in Table 3) that could serve as resilient basis for successful rail services:

- **Increasing of train paths per hour** by innovative interlocking/signalling technologies (ETCS Level 3 - moving block).
- **Upgrading of network** (extension of HSR between European metropolitan areas, additional freight lines as bypasses in congested areas/corridor stretches) – also as a lever for extension of harmonised operation.
- **Optimisation of operation** (e.g. by extended passing tracks for flying overtaking of trains).

- **Realisation of European rail freight corridors in view of harmonised conditions for freight services** – e.g. train length, axle load, CT gauge (P400), interoperability for traction - including connections to freight access facilities (e.g. seaports, terminals and railports).
- **Extended and high performed European intermodal network of terminals and hubs.**
- **European railport network** covering main industrial /commercial areas.
- **Holistic integration of all modes in new designed stations and multimodal terminals.**

Table 3: Qualitative assessment of measures for infrastructure

Measure	Impact on		
	Quality	Capacity	Efficiency
Increasing of train paths per hour	(+)	++	(+)
Upgrading of network	++	++	(+)
Optimisation of operation	+	+	+
Realisation of European rail freight corridors in view of harmonised conditions	++	+	(+)
Extended and high performed European intermodal network of terminals and hubs	++	++	+
European railport network	++	+	(+)
Holistic integration of all modes in new designed stations and multimodal terminals	++	(+)	(+)

Legend: ++ immense impact + high impact (+) smaller impact
*(through longer and heavier trains)

In order to get the rail infrastructure into shape for 2050 with expected multi-fold transport volume, all kinds of improvements and extension have to be taken into account. The most obvious measure is the optimisation of operation. In a first step removal of existing, comparatively small bottlenecks, e.g. obstructions on the main European rail corridors can have a very positive impact on capacity. As a second step, big capacity boosts like ETCS Level 3 have to be implemented. In the light of the ambitious target, a remarkable upgrading of the main European network is a mandatory third step, including big measures like the ones that are under construction now (e.g. Gotthard Base tunnel, Brenner base tunnel and the link across Fehmarn belt. Regarding operation, the harmonisation and/or separation of rail services for freight and passenger on dedicated and/or mixed lines is a topic of high importance.

The success of all these measures can only be realised if in parallel the access for freight and passenger to this enhanced network is secured by the upgrading of e.g. private sidings, terminals and stations including innovative design feeding future co-modal solutions for multimodal transport chains.

Accompanying measures

Besides the main measures for freight, passenger and infrastructure, additional measures have been identified. On the one side there are additional solutions. These solutions are very specific and belong to a certain niche in which they can generate high impact. The overall impact is – compared to the main measures – smaller.

On the other side there are supporting strategies that are essential for the positive development of the European railway world. An innovation friendly environment has to be created that enables the successful implementation of required measures. Such an environment is based on

- research and development,
- financing,
- migration and implementation
- regional and urban planning.

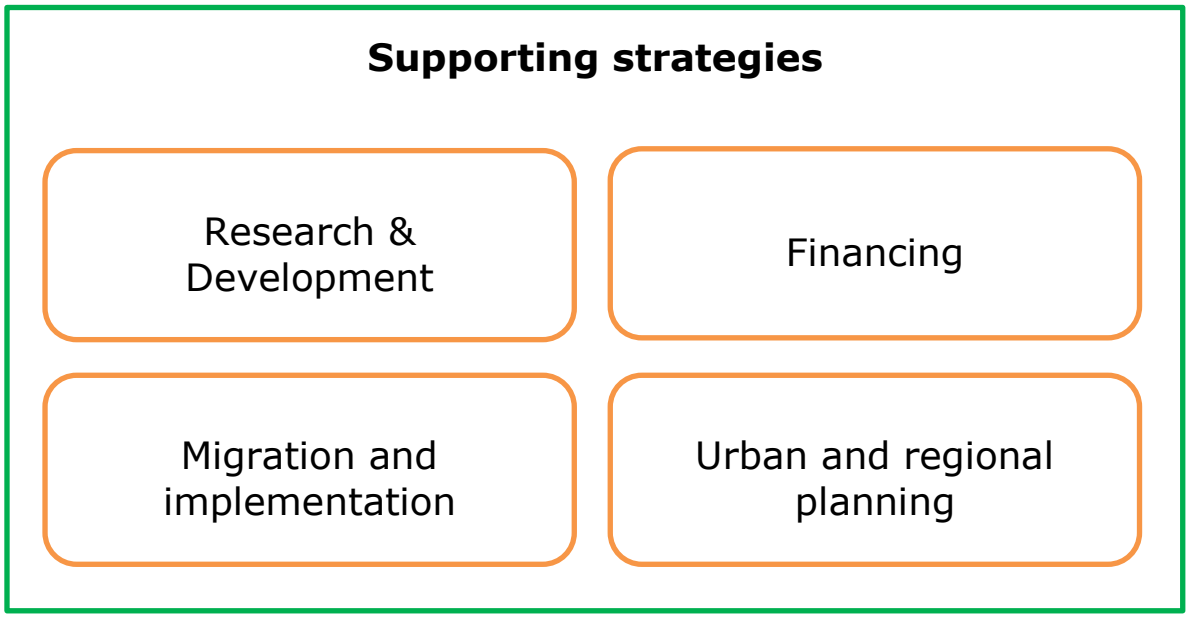


Figure 4: Supporting strategies for an innovation friendly railway world

The current and future success of the European railway industry and operators is based on comprehensive and high qualified research and development. The white paper or SPIDER PLUS targets require solid analysis, developments and their implementation. The EC has to stay on the right path of financing international projects like Shift2Rail.

In order not to stop research and development before the results come to market, it is vital to set up strategies for the financing as well as migration and implementation. Politicians have to coordinate and support the required processes. The differences in financing private or public investments have to be regarded and appropriate programmes have to be started. Several examples, e.g. the support of private sidings or combined transport proved their value.

Urban and regional planning will continue to gain significance. The European Commission has to play a coordinating role for the further integration of different modes and the reduction of negative impacts that occur in the frame of traffic planning.

The benefits of the measures and solutions described in this report do not only touch one specific issue. They rather trigger several improvements and realise their full potential in combination. Some technological tools and solutions can also be depending on each other, leading to a complex structure of preconditions and dependencies that needs a further analysis in the following work packages.

As part of the SPIDER PLUS network of expertise and network of academia, the identified solutions have been discussed with external experts. Several results of our Stakeholder Meeting have been integrated in this report and give a brief indication about the experts view.