Interim Evaluation of Shift2Rail Joint Undertaking (2014-2016)

Interim Evaluation Report

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Single European Railway Area – Safe, competitive and low-emission railways

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ABSTRACT

An Interim Evaluation of the EU Shift2Rail Joint Initiative (S2R JU) has been conducted by an Expert Group. It was found to be too early in the life of the JU to assess the quality and effectiveness of any research outputs, but it was noted that the JU has formulated a research programme, which will strongly support the Transport Policy of the EU as expressed in the White Paper of 2011. Both the management and membership of the JU are highly competent and enthusiastic and it is confidently anticipated that the research outputs will also be of high quality. The Expert Group has made several suggestions for improving, inter alia, the railway system wide coverage of the JU, which currently is dominated by the several manufacturers who were the founding members, to augment the scientist advice given to the JU by the inclusion of societal considerations and to clarify the role of external groups on the formation of strategic railway research. The Expert Group strongly supports the birth, objectives and initial workings of the S2R JU.

1. EXECUTIVE SUMMARY

This report is an interim evaluation of the Shift2Rail (S2R) Joint initiative (JU) of the European Union (EU). The S2R JU achieved autonomy in May 2016, and it is therefore too early for any research results to be included in this evaluation, as it has happened too soon to examine research outputs.

The report reviews the activities leading to autonomy, from 2010 up-to and including the call for proposals in late 2015 and their evaluation and selection.

The analysis complies with the requirements of the revised evaluation guidelines of the Better Regulation Package and takes into account the five main evaluation criteria - **relevance, efficiency, effectiveness, coherence** and **EU added value.** To make our evaluation, we undertook extensive reading of EU and S2R documentation, conducted surveys of stakeholders opinion, conducted interviews with members of the JU management team, beneficiaries and stakeholders, and relied on our railway and research expertise to make judgements of the evidence available.

The railway transportation system has some particular features, both of technology and organisation, which differentiates it from other forms of transport. However, there are some similarities, and these have been discussed in a comparison with the other transport related JUs which were being evaluated simultaneously with our own activities, namely the SESAR and Clean Sky JUs[1].

It is noted that the genesis of the JU came from an initiative of the major European rail manufacturers in discussions with the Association of European Railway Manufacturers, UNIFE. As a result, the Founding Members of the JU were six members of the manufacturing industry, together with two infrastructure managers. Associate Members were selected after an open competition and confirmed in December 2015. It is inevitable that given the manufacturing core of the founding members of the JU, a system-wide view of the railway is incomplete. We draw attention to the relative lack of urban rail, and the omission of some major operators. The current concentration on technology in the research priorities and agenda is acceptable within the current working programme but societal as well as operational issues should be better covered in the future.

During the formation of S2R, a decision was made to place the management of all EU funded railway research into the JU. We have noted that this calls into question the future role of the European Rail Research Advisory Council (ERRAC). We argue that ERRAC could play a vital role in developing a long-term strategic view of railway research if it were to be reformed with a strong membership, completely independent of S2R and inclusive of all railway transport market stakeholders.

The technical structure of the JU programme, as described in the Master Plan[2], is based around five Innovation Programmes (IP1-5), namely Cost-efficient reliable trains, Advanced traffic management, Sustainable and Reliable Infrastructure, IT Solutions and Technologies for Rail Freight. Across all five IPs are overlaid five cross cutting themes and activities (CCAs), which

[1] Single European Sky ATM Research JU, High Performing Aviation for Europe, CleanSky2

[2] Shift2Rail Strategic Master Plan, Version 1.0 , March 2015

are long-term needs, smart materials, system integration, energy and sustainability and human capital.

It is recognised that the IPs have been structured round the European legislation for railways and shaped by the interests of the founding members, six representatives of the manufacturing industry, and two infrastructure managers. Whilst we support the proposed programme of activities, we have some concern that new and emerging trends will influence the railways in the future. Ways need to be found to consider these trends as the research programmes are developed and certainly need to be taken into account as a successor JU emerges. Maximising the impacts of transport research and innovation requires supporting solutions that are closer to the market and bridging the gap to large-scale deployment of innovation. We anticipate that the JU will strengthen its deployment agenda as research proceeds.

When we analysed the *state of play,* we saw that the 8 Founding Members have been joined by 19 Associate Members. There were 43 applicants from which the Associates were selected. The process appeared to be conducted in a fair and transparent manner resulting in a satisfactory but not perfect outcome. Representation for the Eastern European countries remains very limited and there is incomplete coverage of the whole railway sector: operators and the urban sector are not prominent. More generally, the process that was followed was the Horizon 2020 (H2020) one for selection of research projects and probably did not sufficiently focus on the optimum completion of expertise within the JU membership. It is inevitable that some applicants for Associate membership were disappointed. Based on the evidence provided and in the experts opinion this was due to process rather than content of their application. It is suggested that a solution is found in the short term, which may include considering launching a second call at an appropriate moment or making some other adjustments to all the gaps in expertise to be filled

Smart, green and integrated transport becomes increasingly relevant for tackling new and international challenges such as digitalisation, security and the fight against climate change. Compared to previous Framework Programmes, H2020 is more focused on innovation and demonstration. This approach is widely supported by stakeholders in the transport arena, who appreciate support being provided towards achieving concrete results, deployment and thus towards increasing the impact on solving societal challenges, in addition to promoting excellence in science.

Our review concludes that the S2R JU has already achieved positive effects by bringing many players to work together towards these common goals, helping to overcome fragmentation in the market and create continuity of research goals. Much of the research being undertaken would not have happened if the JU had not existed, and there is wide agreement of the value of JU when it comes to large-scale demonstration projects. Therefore we **strongly support** its creation, and the programme of research it has set out.

Nevertheless, we have suggested in our recommendations some ways in which we think the current JU could be improved and how a continuation of it could be further developed. In particular in order to make a real impact on the railway of the future, a better understanding of societal needs, and a more outward looking view of emerging technologies need to be adopted and the membership (or active participation in S2R) needs to be broadened.

2. INTRODUCTION

2.1 Purpose of the evaluation

This report on the Shift2Rail Joint Undertaking has been produced by the Expert Group appointed by the Commission. Its purpose is to assess the progress and mid-term achievements of the newly established Joint Undertaking Shift2Rail (S2R) during the period 2014-16. The analysis complies with the requirements of the revised evaluation guidelines of the Better Regulation Package and takes into account the five main evaluation criteria - **relevance, efficiency, effectiveness, coherence** and **EU added value**. As stipulated in Article 32(3) of the Council Regulation 1291/2013, the interim evaluation of S2R JU focuses on the following aspects:

- **Openness**: The extent to which the JUs enable world-class research that helps Europe achieve a leadership position globally, and how they engage with a wider constituency to open the research to the broader society.

- **Transparency**: The extent to which the JUs keep an open non-discriminatory attitude towards a wide community of stakeholders and provide them with easy and effective access to information.

- **Effectiveness**: The progress towards achieving the objectives set, including how all parties in the public-private partnerships live up to their financial and managerial responsibilities.

- **Efficiency** (a requirement set in Article 25(3) of the Council Regulation 1291/2013): will consider the relationship between the resources used by an intervention and the changes generated by the intervention.

These evaluation aspects have been integrated in the overall evaluation framework and the evaluation questions provided by the European Commission. The Expert Group has used these evaluation aspects to guide their analysis, and to draw their conclusions and recommendations.

The evaluation includes an analysis of the contribution of the Shift2Rail JU to the EU's general transport policy objectives and to the implementation of Regulation (EU) No 1291/2013 and, in particular, aspects of the Smart, Green and Integrated Transport Challenge under the Societal Challenges pillar (Council Decision 2013/743/EU) that established the programme to implement Horizon 2020 — the Framework Programme for Research and Innovation (2014-2020).

An interim evaluation of the S2R JU is a key requirement both in the S2R basic act and in the regulatory framework of Horizon 2020. Specifically, Article 11 of the S2R Regulation requires the Commission to carry out an interim evaluation of the S2R Joint Undertaking with the assistance of independent experts. The evaluation is to be completed by 30 June 2017 and the Commission will prepare a report on the evaluation conclusions, along with the Commission observations, that will be sent to the European Parliament and the Council by 31 December 2017.

2.2 Scope of the evaluation

The objective of this interim evaluation is to assess progress and mid-term achievements of Shift2Rail during the period 2014-2016. However, this is particularly challenging, as there are no completed projects. Therefore on account of this, the evaluation also considered the Shift2Rail 'lighthouse projects'. These are four rail projects with grants signed under the general Horizon 2020 Transport Work Programme (within the Challenge "Smart, green and integrated transport" call "Mobility for Growth", topic 2. Rail).

These four projects have a total value of €52M and can be considered to be precursor projects to Shift2Rail. However, even though these projects were expected to be transferred to the JU, a decision was taken to keep them under the management of DG MOVE and DG RTD. As such, they are not under the direct management of the S2R JU but are still part of the S2R initiative. They were considered to be of relevance for the evaluation of effectiveness and efficiency with regard to topic definition and cross project integration.

In addition, the contribution of the JUs as an instrument towards achieving the EU's general transport policy objectives have been taken into account, including considering the findings of the interim evaluations of all the Joint Undertakings funded under this Challenge, namely the S2R JU, the SESAR JU and the Clean Sky JU, hereinafter collectively referred to as the 'Transport Joint Undertakings' (TJU), looking at learning that could be transferred and how they can be improved. It is foreseen that the results of this interim evaluation will be used to improve the implementation of the JUs in general and of the S2R JU in particular under Horizon 2020, to contribute to the formulation of the future S2R JU Annual Work Plans and to serve as a basis for the ex-ante impact assessment of possible next generation JUs and future work programmes.

The main sources of evidence of this assessment have been:

- Interviews carried out over the period January to June 2017.
- Experts relied on:
  - Surveys
  - Consultations
- Analysis of Horizon 2020 Regulation, Joint Undertaking Regulations, and of relevant strategy and policy documents.

3. BACKGROUND TO THE INITIATIVE

3.1 Overview of relevant European Transport Policy

There are a number of European policy areas that involve transport and rail. The policy and regulatory framework helped to provide the context and set out the relevance for the creation and setting up of the S2R Joint Undertaking. The following section covers the main policy areas relevant to S2R.

3.1.1 A Roadmap to a Single European Transport Area

In 2011 the European Commission published their White Paper "A Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system" which stresses the need to achieve a more competitive and resource efficient, European transport system and address major societal challenges relating to rising traffic demand such as congestion, energy supply and climate change. The Roadmap sets out to remove major barriers and bottlenecks in many key areas across the fields of transport infrastructure and investment, innovation and the internal market. The Single European Transport Area includes a Single European Railway Area (SERA) and a fully integrated transport network that links the different modes and allows for a profound shift in transport patterns for passengers and freight.

The Transport White Paper sets out a number of key goals and initiatives to build a competitive transport system that responds to European citizens' and businesses' needs for increased mobility and contributes to more growth and jobs. It at the same time also sets out the context to reduce Europe's dependence on imported oil and cut carbon emissions from transport by 60% by 2050. To meet these goals appropriate infrastructures, technologies and services will need to be developed and targets have been set for this. For example, the length of the existing high-speed rail network should be tripled by 2030 and all Member States should have a dense railway network, and the European high-speed rail network should be completed by 2050. The

EU-wide multi-modal TEN-T 'core network' should be fully functional by 2030, and by 2050 this should be enhanced in quality and capacity and have better information services. By the same time (2050), all core network airports should be connected to the rail network, preferably high-speed and all core seaports should also be sufficiently connected to the rail freight and, where possible, the inland waterway system. In addition the efficiency of transport and infrastructure should be increased with information systems and market-based incentives including the deployment of transport management systems (such as ERTMS3 for rail) and the deployment of the European Global Navigation Satellite System (Galileo).

There are a number of user-focussed goals as well and by 2020, a framework for a European multi-modal transport information, management and payment system should be in place and moves towards full application of "user pays" and "polluter pays" principles to eliminate distortions, including harmful subsidies, generate revenues and ensure financing for future transport investments are expected to be addressed. It is expected that this will include greater private sector engagement.

The ambition of the EU is to retain and maintain its world leader position in safety and security of transport in all modes of transport. By 2050, the EU goal is to be close to zero fatalities in road transport, and in line with this goal, road casualties should be halved by 2020.

3.1.2 4th Railway Package

In January 2013, the Commission adopted its proposal for the fourth railway package to complete a single European railway area. The Fourth Railway Package, is designed to strengthening the role of rail in the transport system, especially given its inherent advantages of environmental performance, land use, energy consumption and safety. A key initiative in achieving this goal is the creation of a Single European Railway Area (SERA) [4], and to remove the remaining administrative, technical and regulatory obstacles holding back the opening of the European market and achieving interoperability (with the associated reduction of passenger and freight operating costs). The SERA focuses on increased interoperability within the European railway system and a better use of inter-modality between road, rail and water-borne transport.

The Fourth Railway Package is comprised of two 'pillars', which have been negotiated largely in parallel. The 'technical pillar', adopted by the European Parliament and the Council in April 2016, includes:

- Regulation (EU) 2016/796 on the European Union Agency for Railways and repealing Regulation (EC) n° 881/2004
- Directive (EU) 2016/797 on the interoperability of the rail system within the European Union (Recast of Directive 2008/57/EC)
- Directive (EU) 2016/798 on railway safety (Recast of Directive 2004/49/EC)

The 'market pillar', adopted in December 2016, includes:

- Regulation (EU) 2016/2338 amending Regulation (EU) 1370/2007, which deals with the award of public service contracts for domestic passenger transport services by rail ('PSO Regulation')

[3] In accordance with the European Deployment plan for ERTMS: cf. Commission Decision C(2009)561.

[4] Directive 2012/34/EU, establishing a Single European Railway Area, merged previous Directives (the first Railway Package) and their successive amendments into one act. It also adds important substantive changes to tackle the lack of competition, poor regulation and low investment observed in the rail market in the last decade. It applies to the rail freight and international passenger market segments. This directive was amended by Directive 2016/2370/EU as part of the Fourth Railway Package. In more technical terms the acronym SERA is also often used to designate the single European railway system, as regulated by the interoperability and safety directives and on which TSI and other regulations under these two directives apply.

- Directive 2016/2370/EU amending Directive 2012/34/EU, which deals with the opening of the market of domestic passenger transport services by rail and the governance of the railway infrastructure ('Governance Directive')

- Regulation (EU) 2016/2337 repealing Regulation (EEC) 1192/69 on the normalisation of the accounts of railway undertakings

The new text strengthened the criteria for the financial and managerial independence of the rail infrastructure managers; putting the infrastructure manager at the centre of each Member State's railway system, at a similar level as all infrastructure users.

The revision adapted the wording of all articles pertinent to market opening, by stating that domestic rail passenger markets will have to be opened to competition, and that, at the same time, the entrance of new operators will not be to the detriment of all the operators that serve regional markets via public service contracts. The revision of Regulation (EC) 1370/2007 provided a text on the principles of market opening.

The governance and market opening pillar strengthens, in particular, the role of infrastructure managers and the opening of domestic passenger markets. The objective of the market pillar is to deliver more choice and better quality of rail services for European citizens. The role therefore of infrastructure managers in S2R is therefore critical and although some aspects of the market pillar are being addressed in the JU, a broadening of active participation is needed to fully respond to this objective.

The technical pillar, among other things, enhances the role of the European Union Railway Agency (ERA), to become the body responsible for issuing safety certificates for railway undertakings and vehicle authorisations in all Member States. The technical pillar is designed to boost the competitiveness of the railway sector by significantly reducing costs and administrative burden for railway undertakings wishing to operate across Europe. This is in-line with the creation of S2R as a support for maintaining the competiveness of the European railway sector and it work programme is based on the technical aspects of this pillar.

In terms of competiveness, the European rail supply industry is increasingly being challenged by overseas suppliers, mainly from Asia, (see Section 10.1 & Appendix 2) who are investing massively in research and innovation, as well as in human capital. A growing number of non-European operators are also looking to enter the European markets as they become open to them so the long-term competitive success of European rail, vis-à-vis both other land-transport modes as well as against foreign competition depends largely on continuous product, service and process innovation, and profitable business models. S2R has been set up to help maintain and increase the competiveness of the sector and its industrial players.

3.1.3 Overview of Horizon 2020

The European Commission is committed to its "Europe 2020" strategy based on smart, sustainable and inclusive growth. The strategy looks to find ways of decoupling economic growth from resource and energy use and encourages a shift to a resource-efficient, low carbon, growth economy, avoiding transport pollution and congestion. This calls for a massive technological improvement and a radical systematic change. Rail is seen as being an important part of the solution.

> ***Horizon 2020 is the European Union's Research and Innovation Framework Program for the period 2014-2020. It aims to contribute to building a society and an economy based on knowledge and innovation across the Union by leveraging additional research, development and innovation funding and by contributing to attaining research and development targets, including the target of 3% of GDP for research and development across the Union by 2020. Horizon 2020 supports the implementation of the Europe 2020 strategy and other Union policies, and is expected to contribute to the***

Commission's top priorities for strengthening Europe's competitiveness and stimulating investment for the purpose of job creation.3.1.4.Priorities and Specific Objectives in Horizon 2020.

In the light of this ambitious agenda, and to assist global leadership for the European transport industry, the EU earmarked EUR 6.3 billion of its EUR 77 billion new Framework Programme for Research and Innovation covering the period 2014-2020 – Horizon 2020 – towards transport research and innovation, under the heading "Smart, green and integrated transport". This is an increase of 50% compared with the previous funding period. In this context, the EU also decided to step up a number of partnerships with the transport industry, in order to overcome fragmentation, to better target research and innovation (R&I) and to help to accelerate the market uptake of innovative solutions by ensuring industry buy-in.

The first priority of Horizon 2020 is *Excellent in Science*, which aims to reinforce and extend the excellence of the Union's science base and to consolidate the European Research Area in order to make the Union's research and innovation system more competitive on a global scale. The second priority is *Industrial Leadership*, which aims to speed up the development of the technologies and innovations that will underpin tomorrow's new technology and help innovative European SMEs to grow into world-leading companies. The third priority *Societal Challenges* responds directly to the policy priorities and societal challenges that are identified in the Europe 2020 strategy and which aim to stimulate a critical mass of research and innovation efforts needed to achieve the Union's policy goals.

Within Horizon 2020, the specific objective of the Transport Challenge 'Smart, Green and Integrated Transport' is to boost the competitiveness of the European transport industries and "to achieve a European transport system that is resource efficient, climate and environmentally friendly, safe and seamless for the benefit of all citizens, the economy and society".

The Specific Programme is structured in four broad lines of activities aiming at:

a) Resource efficient transport that respects the environment. The aim is to minimise transport systems' impact on climate and the environment (including noise and air pollution) by improving their efficiency in the use of natural resources and by reducing their dependence on fossil fuels.

b) Better mobility, less congestion, more safety and security. The aim is to reconcile the growing mobility needs with improved transport fluidity, through innovative solutions for seamless, inclusive, affordable, safe, secure and robust transport systems.

c) Global leadership for the European transport industry. The aim is to reinforce the competitiveness and performance of European transport manufacturing industries and related services including logistic processes and retain areas of European leadership (such as aeronautics).

d) Socio-economic and behavioural research and forward looking activities for policy making. The aim is to support improved policy making which is necessary to promote innovation and meet the challenges raised by transport and the related societal needs.

H2020 differs from previous framework programmes as it brings together all EU funded R&I with one set of rules and coherent funding for taking ideas to market with a strong accent on partnerships. In this respect the Transport JUs, and S2R, as one of them fits perfectly with this concept.

3.1.5 Overview of policy implications and Shift2Rail

Overall transport activity in the European Union is expected to grow substantially by 2050, with freight volumes increasing by more than 80% and passenger volumes by more than 50%. The majority of this growth is likely to go to road but this also implies increased externalities such as congestion, traffic accidents, poor air quality and increased Green House Gas (GHG) emissions. The development of new technologies and innovative approaches in business models, services and products, is recognised as playing an instrumental role in achieving a faster and cheaper transition to a more efficient and sustainable European transport system. In particular by improving vehicles' efficiency through new engines, materials and design; cleaner energy use with new fuels and propulsion systems; better use of networks; and safer and more secure operations through information and communication systems.

Public-private partnerships are one of the Horizon 2020 implementation tools, where all involved partners commit to support the development and implementation of industrial research and innovation activities of strategic importance to the Union's competitiveness and industrial leadership or to addressing specific societal challenges.

The S2R JU is part of the Smart, Green and Integrated Transport Challenge under the Societal Challenges pillar of Horizon 2020, alongside the SESAR JU, the Clean Sky JU and the FCH JU. As mentioned the Smart, Green and Integrated Transport Challenge aims to boost the competitiveness of the European transport industries and achieve a European transport system that is resource efficient, climate-and-environmentally-friendly, safe and seamless for the benefit of all citizens, the economy and society, in accordance with the Europe 2020 Strategy. It should also meet the 2030 and 2050 targets set out in the Transport White Paper, as well as those of other policy initiatives.

Ambitious EU goals on climate change, energy use and environmental protection mean the railway sector will be required to take on a larger share of transport demand in the next decades. Part of this will be delivered with improved infrastructure, new rolling-stock and cleaner fuels but modal shift will also play a defining role in achieving the EU ambitions and it is clear that the take up of new processes and innovative technologies needs to be accelerated.

However, actual trends in overall transport growth are not yet in line with the European policy goals despite recent public and other significant investments in infrastructure and services. The reality is that the modal share of passenger rail has remained constant and the modal share of rail freight in Europe has decreased in the past decade. Rail needs to become more attractive to the end user and these trends need to be reversed if the rail sector is going to remain competitive and fulfil the policy ambitions of Europe.

Innovation and research is seen as key instrument to deliver policy goals, as set out the White Paper and SERA. In this respect S2R is responsible for managing all direct rail research and therefore integrates and coordinates all R&I activities specific to rail. Compared to previous FP research this will help to avoid fragmentation and ensure continuity. In addition, in terms of EU added value the leverage effect brought by the members participation through in kind contributions and long-term commitment is considered to be higher than before.

3.2 Overview of the structure of railway systems

It is worth setting out the structure of the railway transportation system in Europe to put this interim evaluation in context. Rail differs from many other sub-sectors of transport, such as aviation or road, in the sense that it is more constrained by a higher number of technical sub-systems rigidly interfacing with one another. These rigid interfaces are subject to regulation for reasons of compatibility and safety.

The whole railway system comprises of several sub-systems that exchange, through their various interfaces, both productive interactions (services and functions), and unproductive ones

(constraints), the majority are of a highly technical nature (reflected in the high numbers of highly skilled engineers that are required for any rail network to function properly).

The rail sub-systems are recognised by the European regulations[5], and different Technical Specifications for Interoperability (TSI)[6] are allocated. These are divided into two main areas:

Structural sub-systems:

- Rolling stock (rail vehicles)
- Control-command (ATP, ATC, ATO[7]) and signalling
- Infrastructure (including tracks and their sub-structure, bridges and tunnels, stations etc.)
- Energy feeding system (electrification)

Functional sub-systems

- Operations
- Maintenance
- Telematics applications for freight and for passengers (this being th only part of a wider telecommunications subsystem that is considered by the interoperability directive)

All aspects of Rolling stock, control-command and infrastructure are dealt with by the three first innovation programs of S2R (IP1, IP2, IP3 respectively), telecommunications are partly dealt with by the fourth innovation program (IT solutions). It is noted at this stage that one structural sub-system is not dealt with by the JU (electrification) and that operations and maintenance are also not dealt with to any extent in the current innovation programs, except to a small extent in the freight dedicated program (IP5).

The railway transport ecosystem is further complicated by its fragmentation into a number of transport services that interconnect to some extent but have different profiles, regulations and standards:

- urban rail services (outside the scope of the EU Interoperability and Safety Directives and outside of the SERA)
- suburban and regional services
- intercity services (including high speed)
- freight services

These service categories bring in a number of different players into this ecosystem:

- urban operators,

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5 System breakdown proposed by the Interoperability Directive, 2008/57/EC.

6 The Technical Specifications for Interoperability (TSI) are Commission regulations under the Interoperability directive. There is generally one TSI per subsystem, the objective of the TSI being to alleviate the technical barriers to interoperability of the European railway system, in particular in terms of harmonisation of interfaces between the different subsystems

7 ATP : automatic train protection, ATC : automatic train control, ATO : automatic train operation. The ETCS is the ATC component of the ERTMS, the European Rail Traffic Management System.

- main line railway undertakings (passengers and/or freight), either incumbent national operators, regional operators or freight transport "new entrants"[8]

- main line infrastructure managers, generally in charge of a national network at the scale of the territory of a Member State

- maintenance companies

- rolling stock owners and lessors etc.

Any initiative taken to improve the overall performance and attractiveness of the European railway system should therefore also involve a broad range of market players representing the 'ecosystem' of the European railway sector. In addition, although this is slowly changing, there is a historic legacy of local suppliers meeting the needs of national state run rail systems that extend this 'ecosystem' unnecessarily. S2R is seen to play an important role in bringing all these players together, and thus aligning developments for the European rail system. Amongst others, its objectives are to reduce costs and speed up the deployment of innovations.

The generic risks in innovation cycles are heightened in the rail sector by:

- Complex interactions between different rail segments and the need for synchronicity between innovations.

- Long product life-cycles (of 30 years or more), inhibiting the rapid deployment of new rail technologies.

- Unequal distribution of innovation benefits between stakeholders, reducing incentives to invest in new technologies.

- Lack of synergies with other industrial sectors, especially in emerging technologies.

There are also a large number of other stakeholders and interested parties who are indirectly involved, whose needs or opinions must be considered (namely, public authorities, workers unions, associations of freight forwarders and passengers, academia and research organisations etc.).

3.2.1 Background on Shift2Rail

Prior to the creation of S2R, the majority of EU funded research was undertaken under the Framework Programmes, and latterly as part of H2020. In the Commission Staff Working Document and summary of the impact assessment (COM(2013) 922 final) to accompany the Proposal for a Council Regulation to establish the Shift2Rail Joint Undertaking the following four key drivers were noted as being barriers to achieving the SERA:

- Fragmentation among railway ecosystems**,** with a patchwork of disparate regional and national systems, networks and technical operating standards. The industry has to develop tailored vehicles/and rolling stock, designed to meet the unique constraints of relatively small national markets. This high level of product customisation constitutes a barrier to the SERA, but it also results in increased production costs.

- Fragmentation among the subsystems of the rail sector. Complex interactions between subsystems (infrastructure, rolling stock and signalling equipment manufacturers, railway undertakings and infrastructure managers) limit the potential of improving one

[8] The term « new entrant » is used to designate new railway undertakings, generally specialising in freight transportation, who are benefiting from the European directives on market opening to come on the market and compete against « incumbent » national operators.

specific part of the system or of proposing breakthrough solutions that have an impact on the whole system and that can be deployed in the complete SERA. To give one example: there are something like 14 different signalling systems across Europe that have to be brought together. This is time consuming as well as expensive as firstly a consensus needs to be reached, then common standards agreed and finally the national systems need to change.

- Fragmentation along the innovation life cycle. In FP7, EU research efforts focused primarily on pre-competitive innovation research at low Technology Readiness Levels. There have been few large-scale demonstration projects (now a major component of S2R) and a significant part of knowledge generated by the European R&I projects have not been taken to market.

European Technology Platforms (ETPs) are industry-led stakeholder fora recognised by the European Commission as key actors in driving innovation, knowledge transfer and European competitiveness. ETPs develop research and innovation agendas and roadmaps for action at EU and national level to be supported by both private and public funding. They mobilise stakeholders to deliver on agreed priorities and share information.

There are five transport related ETPs, ACARE (aviation), ALICE (logistics), ERRAC (rail), ERTRAC (road) and waterborne. ERRAC was set up in 2001 to help create a single European body with both the competence and capability to help revitalise the European rail sector and make it more competitive, by fostering increased innovation and guiding research efforts at European level. All major rail stakeholders are gathered within ERRAC and it comprises of 45 representatives from each of the major European rail research stakeholders: manufacturers, operators, infrastructure managers, the European Commission, EU Member States, academics and users' groups. ERRAC covers all forms of rail transport: from conventional, high speed and freight applications to urban and regional services.

Since its launch in 2001, ERRAC has produced a number of important and influential documents, such as the Joint Strategy for European rail Research – Vision 2020, and the most recent document published by the platform, RailRoute 2050, the sustainable backbone of the Single European Transport Area, an initial update of the strategic vision of ERRAC, in preparation of Horizon 2020. The European vision for railway research and innovation outlined in 'Railroute 2050' illustrates the research pillars that need to be supplemented by the corresponding investment pillar. ERRAC also developed a set of roadmaps via the EU funded (FP7) projects such as FOSTER RAIL (2013-2016), which developed a Rail Business Scenario and newer Strategic Rail Research and Innovation Agenda.

ERRAC is designed to focus on:

1. Define and implement steps to achieve a joint European rail research and innovation strategy

2. Enhance collaborative European rail research and innovation and

3. Advice on future rail research needs to the European Commission for Horizon 2020.

ERRAC's role is to define the research needs in order to realise the objectives of the Europe-2020 strategy, support the development of the future European Framework Programme, Horizon 2020 and the objectives of the 2011 White Paper.

It is therefore perfectly set up to help provide guidance to S2R, however many of the members of ERRAC are also supporter of S2R and this has had the unforeseen consequence of making ERRAC somewhat redundant. The experts are convinced of the need of a body that provides foresight into the future research needs and aligning these with the H2020 and other EU policy, but the current structure of ERRAC does not provide this.

3.3. The initiative and its objectives

3.3.1 Origin of the Joint Undertaking

The association of the European railway manufacturing industry (UNIFE), initiated discussions with the European Commission on the possibility of launching a European railway Joint Technology Initiative (JTI) in 2010. This was the result of having taken part in the coordination of numerous EU funded collaborative research projects, under successive Framework Programs. Notwithstanding the excellent technical results of most of these projects, the European manufacturing industry realised that for participating in collaborative European research in railways was limited by the processes for determining the research topics, the formation of consortia and selection of projects under that system and the results were not being adopted quickly enough by the industry. This was due in particular to the following reasons:

- The project topics proposed by the EC lacked continuity from one call to another, notwithstanding the coordination efforts made by European Railways Research Advisory Council (ERRAC)[9].

- The Framework Programme rules for research required the creation of different consortia from project to project, jeopardising the chances of continuity of consortia to continue to work together from one call to the next, as well as to make progress towards actual implementation of innovation and build on knowledge created.

- As a result of this lack of overall coherency, the fragmentation of the research efforts and the fragmentation of the industry itself, the shared interests of the industry members was generally limited to pre-competitive subjects. The projects were therefore either "blue sky" (TRL 0 or 1) or, the opposite, such as to support regulation and standardisation (e.g. closing TSI open points).

- The deliverables of the standardisation projects have generally been transferred into either industry standards (e.g. FP6 Modtrain or Modsafe or FP7 Safe interiors or Cleaner-D etc.) or to European standards and regulations (e.g. FP7 Trio-train projects), but the industry understood that there would be soon no other subjects to explore in these domains, apart from any changes in standards and regulations that would result from breakthrough innovation.

- The deliverables of low TRL projects generally encountered a low and slow market uptake and impact due to the fragmentation of the railway transport ecosystem.

- The amount of EC funding available for the railway industry was also quite limited[10] and there was no continuity in the medium term. Therefore there were insufficient incentives to create momentum towards actual collaborative innovation between the various actors of the sector.

As a result, the market uptake of EU research projects outputs was generally lower than the ones on standards and regulations. Thus the industry realised that the conditions under the FP's research programmes constrained them from gaining much in the way of benefit from future collaborative programmes, especially in terms of achieving the goal of building the Single European Railway Area (SERA) or towards the objective of shifting a large amount of passenger travel and freight to rail, as set up by the EC White Paper on transport, published in 2011.

[9] See paragraph 3.2.1

[10] The European Union contributed to an amount of about 150 M€ to the railway related projects in the scope of the FP7 (2007 to 2013), to be compared with about 2.3 billion allocated to aeronautics and aviation during the same period and a foreseen amount of 450 M€ to be invested in the S2R JU as part of H2020 (2014 to 2020).

Therefore they initiated the idea of creating a joint technology initiative, under the leadership of UNIFE, as a more stable organisation to foster long-term collaborative research and innovation and which would also justify higher funding levels from both the industry and the European Union. The concept was also welcomed by two major infrastructure managers, who both shared the same high level of interest in participating in European wide, collaborative research and who had the same strategic needs to become more customer focussed. This led to an initial proposal (the SHIFT2RAIL JTI proposal), submitted to the EC in July 2012, and completed in November 2013 by a finalised "Technical Programme to the Proposal"[11].

Several options were examined by the initial promoters and the European Commission, with a view to overcoming the fragmentation of the railway ecosystem and the lack of continuity of research, leading to the decision to create an institutional PPP. The rationale for it was that the development of a long-term strategy, in close cooperation with all market players, that would ensure that R&I projects support the competitiveness of the rail sector, while the Commission's leading role would ensure the alignment of the R&I agenda with SERA objectives. The stable nature of the iPPP, the clear definition of intellectual property rules, and the firm commitment from the EU gave increased confidence to public and private partners, stimulating higher investment levels. Legally binding commitments from industry to match EU funds would help ensure a direct leverage effect that was estimated as being at least 30% higher than other options. As the conditions for participation could be managed in a flexible and transparent manner, the iPPP structure would allow broad stakeholder participation and a targeted approach towards SMEs.

After two years of negotiations between the European Commission, the industry promoters and the Member States and intensive legal investigations by the Commission to set up the JU regulation in agreement with the Council, the S2R JU was finally established by the Council regulation No 642/2014 of 16 June 2014.

The creation of its structures and processes were heavily influenced by other transport JUs, especially Clean Sky. It took a further two years to properly enact all the legal and management requirements and to appoint a permanent Executive Director. This means that it has only been operational for less than two years at the time of this evaluation. It should be noted that despite this its strategic Master Plan does not significantly differ in technical content from the initial proposal. In addition, this other JUs such as Clean Sky 1 also experienced similar time lags between regulation and implementation.

Discussions with both manufacturers and operators, as well as with the European Commission, has shown that, overall, the rational for setting up S2R can still be considered to be valid.

3.3.2 Description of the creation of the Joint Undertaking

The Joint Undertaking Shift2Rail (S2R) was created to respond to the objectives defined in the White Paper and in the Fourth Railway Package, namely the goal of strengthening the role of rail in the transport system, given its inherent advantages in terms of environmental performance, land use, energy consumption and safety. A key initiative in achieving this goal is also the creation of a Single European Railway Area (SERA). It is recognised that there is need for A lot significant progress to be made by the sector in terms of efficiency, reliability, sustainability and more generally, user friendliness and attractiveness.

[11] At the date of submission of the Technical Programme to the Proposal, the SHIFT2RAIL JTI MOU signatories were : Acciona, Alstom, Amadeus, Ansaldo Breda, Ansaldo STS, AZD, Bombardier, CAF, Faiveley, HaCon, Knorr-Bremse, MerMec, NetworkRail, Oltis, SelexES, Siemens, SNCF, Strukton Rail, Talgo, Thales, Trafikverket, Vossloh, soon joined by DB, FS and Indra. These have largely remained unchanged in the S2R although not all became founding members.

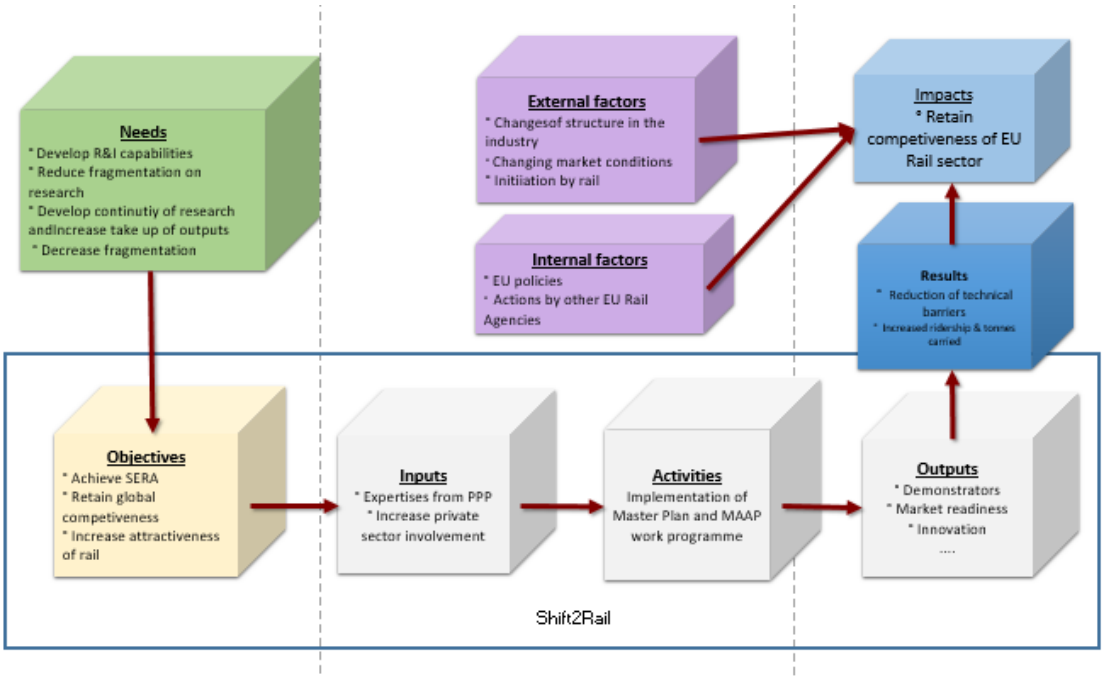


Figure 3: Intervention logic diagram

The European rail sector and especially the industry was also aware of the competitive threat to its global positioning, especially from Asia, linked in particular with the massive Chinese railway investments in infrastructure and their rolling stock production capacity.

The S2R JU is tasked with implementing a strategic Master Plan, which identifies the major objectives of Shift2Rail as follows, closely related to the above-mentioned strategic context and EU policies:

- Supporting the achievement of the Single European Railway Area (SERA) through the development of solutions facilitating the removal of remaining technical obstacles in terms of interoperability; and make the transition to a more integrated, efficient and safe EU railway market, guaranteeing the proper interconnection of technical solutions.

- Radically enhancing the attractiveness and competitiveness of the European railway system to ensure a modal shift towards rail through a faster and less costly transition to a more attractive, user-friendly (including for persons with reduced mobility), efficient, reliable, and sustainable European rail system.

- Helping the European rail industry to retain and consolidate its leadership on the global market for rail products and services by ensuring that Research & Innovation activities and results can provide a competitive advantage to EU industries and by stimulating and accelerating the market uptake of innovative technologies.

The intervention of S2R along these lines is summarised in the Figure 4 below, extracted from the Master Plan:

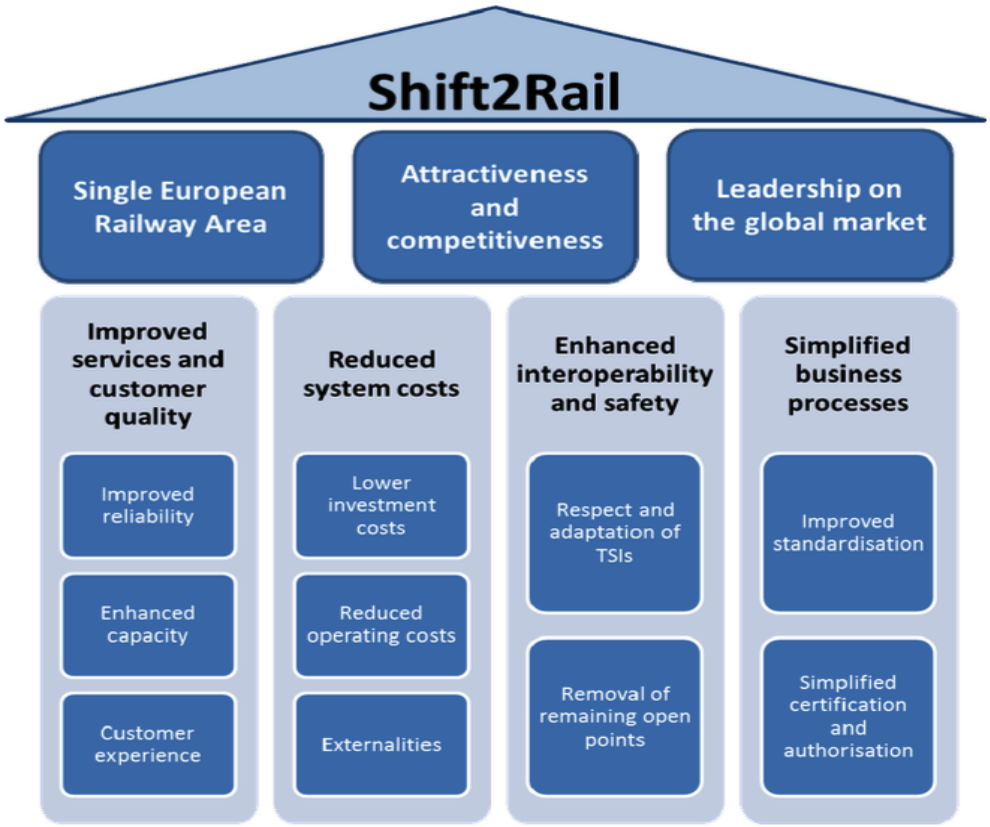


Figure 4: S2R diagram (source: S2R JU governance and process handbook)

3.3.3 S2R governance structure

The management structure shown in figure 5 has been created in line with the regulation establishing S2R, complemented by 'Rules of Procedures of the Governing Board of the S2R JU'[12]. The Governing Board is made-up of the European Commission, the founding members, representatives of the associate members and observers.

The JU day-to-day management is ensured by an Executive Director, who is a staff member of the JU, nominated by the Governing Board following a proposal by the European Commission. The Executive director is assisted by a Secretariat and a Programme management department. The programme office is led by the Head of research and innovation, and programme managers are in charge of one or several IPs and CCAs. They assist in the management, monitoring and evaluation of all aspects of the JU IPs and their specific projects.

The research and innovation activity of each IP and CCA is lead by a steering committee of representatives of the JU members involved in that IP and each steering committee is chaired by an IP or CCA coordinator.

[12] http://ec.europa.eu/transport/sites/transport/files/modes/rail/doc/2014-07-30-rules-of-procedure-of-the-governing-board-of-the-shift2rail-ju.pdf

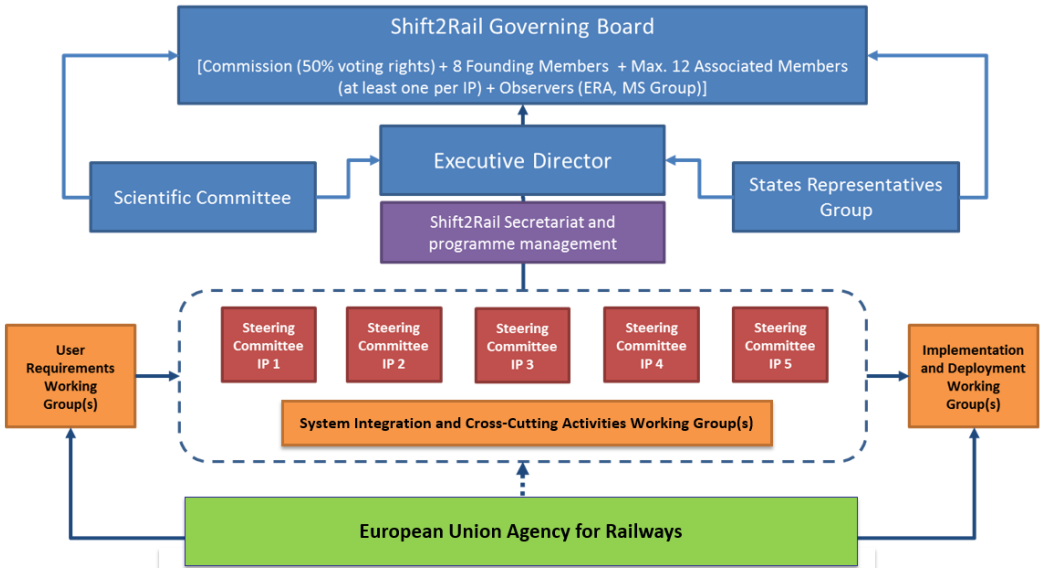


Figure 5: The S2R JU governance

There is a general agreement amongst stakeholders that the current management structure of the JU is well adapted to the needs (in the present scope of work as defined by the strategic work plan), The team is seen to be well organised and fully dedicated to the success of the initiative and any gaps are in the process of being filled as several new programme managers have been recently recruited.

Each and every project reproduces the general JU management structure and a number of internal project management "groups" (SMC, TMC, end users group, advisory boards and many others) are created at each time.

3.3.4 Technical structure of the program[13]

In order to reach the S2R JU major objectives, the Master Plan identifies the main operational and technological innovations that will be required to achieve the overall objectives of the JU. These are structured around five asset-specific Innovation Programmes (IPs) and five crosscutting themes and activities (CCA), which constitute the S2R strategic action plan and are further elaborated in the S2R Multi-Annual Action Plan (MAAP), presently under revision.

Originally, the promoters of the S2R programme proposed three Innovation Programs, the scopes of which were strongly related to the structural subsystems identified by the European regulations for railways, the electrification system being the only one that was not considered as a subject for collaborative research. These were:

- Innovation Programme 1 (IP1): Cost-efficient and reliable trains, including high capacity trains and high speed trains
- Innovation Programme 2 (IP2): Advanced traffic management and control systems
- Innovation Programme 3 (IP3): Cost Efficient, Sustainable and Reliable High Capacity Infrastructure

Two other programs, and the need for cross-cutting activities, were later identified after discussions with the European Commission and were included in the proposal that was officially submitted in July 2012:

[13] The management structure is depicted in 7.1.1.

- Innovation Programme 4 (IP4): IT Solutions for attractive railway services
- Innovation Programme 5 (IP5): Technologies for sustainable and attractive European rail freight. It should be noted that IP5 is the only IP that is not linked with a specific subsystem.
- Cross-cutting themes and activities (CCAs)

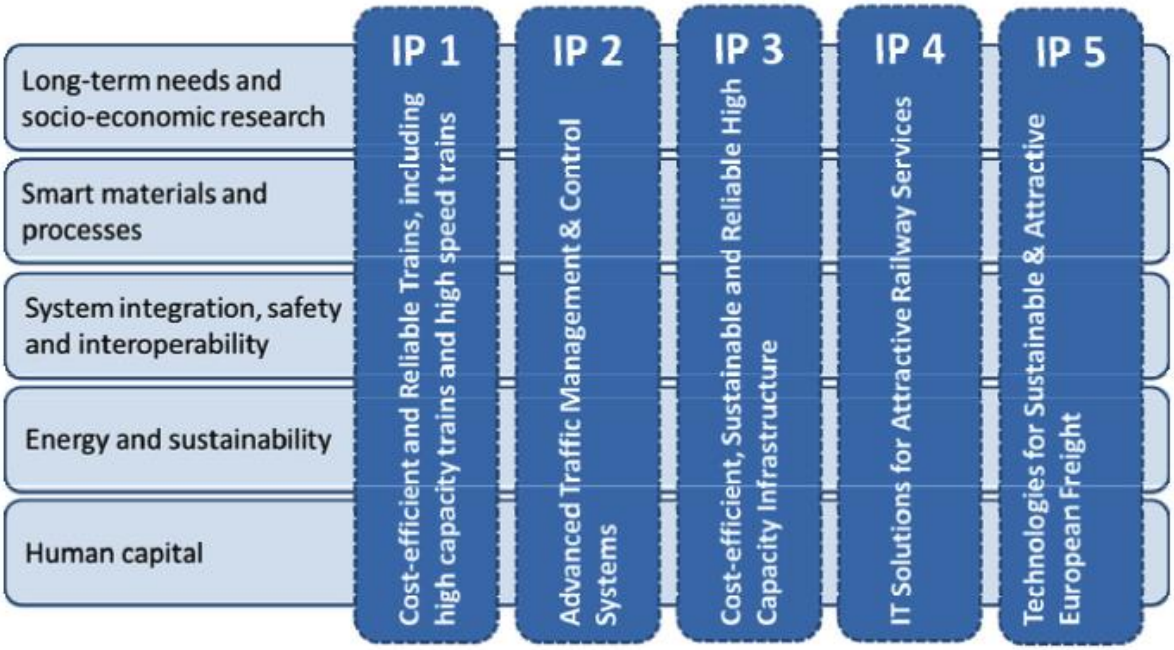


Figure 5: Technical structure of the S2R work plan (source: S2R JU governance and process handbook)

3.3.5 Relevance of the working programme

The content of the S2R Master-plan, structured into 5 innovation programs is highly influenced by the technical scope of the European legislation for railways, recently consolidated by the technical pillar of the Fourth Railway Package.

Despite the Master-plan being developed a number of years ago it is still considered to be relevant. However, it is also recognised that new and emerging trends in the transportation market (driver-less cars/ on demand travel, Uber/ Bla Bla car/ car pooling / car sharing platforms/ mobility as a service) were not identified 5 years ago during the elaboration of the program and that they may significantly impact the attractiveness of European Rail. This was pointed out in several of the interviews. These changes might generate new needs for innovation to be incorporated into S2R-2 as additions rather than replacement of research objectives at the current time. The remaining time to the end of the present programme and obvious budgetary constraints will not allow any major changes to cope with these emerging topics, except in the form of some open calls.

3.3.5.1 Detailed technical content (from the Master plan)

The technical scope of the innovation programs, as summarised in the table below, was determined in consideration of two main criteria:

- the expected contribution to the fulfilment of the high level objectives

- the agreement between the future members of the JU that only a strong and long term collaboration scheme would allow them to take innovation risks that they would possibly not have taken alone

Areas of activity	Main objectives[14]
IP1 (indicative budget: 225 M€)	
Train interiors	Customer experience
Doors and intelligent access systems	Capacity, customer experience, improved reliability, removal of open points
Traction	Reduced operating costs, externalities, improved reliability, improved standardisation
Train control and monitoring system	Improved reliability and safety, lower investment costs, improved standardisation
Lighter car-body shell	Reduced operating costs, externalities,
Running gear	Reduced operating costs, improved reliability, externalities,
Brakes	Reduced operating costs, externalities, removal of open points, improved standardisation
IP2 (indicative budget: 195 M€)	
Smart, fail-safe communication and positioning systems	Lower investment costs, improved reliability
Traffic management evolution	Improved reliability, enhanced capacity
Automation	Reduced operating costs, improved capacity
Moving blocks and train integrity	Improved capacity
Smart procurement and testing	Improved standardisation, simplified certification and authorisation
Virtual coupling	Reduction of operating costs, improved capacity, customer experience
Cyber security	Improved security
IP3 (indicative budget: 153 M€)	
New directions in switch and crossing	Improved reliability, reduced operating costs, externalities, removal of open points, improved standardisation

[14] Note that respecting and adoption of TSI is a common objective to all items.

Innovative track design and materials	Reduced operating costs, externalities, removal of open points, improved standardisation
Cost effective tunnel and bridge solutions	Lower investment costs, reduced operating costs
Intelligent system maintenance	Reduced operating costs, improved standardisation
Improved station concepts	Customer experience, improved security
Energy efficiency	Reduced operating costs, externalities

IP4 (indicative budget: 86 M€)	
Technical framework	Improved reliability, improved standardisation, customer experience, enhanced capacity
Customer experience applications	Customer experience
Multimodal travel services	Customer experience, improved standardisation, reduced operating costs
IP5 (indicative budget: 83 M€)	
Implementation strategies and business analytics	All major objectives
Freight electrification, brake and telematics	Enhanced capacity, reduced operating costs, externalities, improved standardisation
Access and operation	Reduced operating costs, enhanced capacity, customer experience
Wagon design	Enhanced capacity, customer experience, externalities, reduced operating costs
Novel terminal, hubs, marshalling yards, sidings	Enhanced capacity, reduced operating costs
New freight propulsion concepts	Enhanced interoperability, reduced operating costs, externalities
Sustainable rail transport of dangerous goods	Improved safety
Long term vision for an autonomous rail freight system	Reduced operating costs, enhanced capacity, customer experience

Table 1 Summary of the S2R Master Plan

It has to be noted that the above brief description of the technical content is subject to adaptation and improvement through the revision of the multi-annual action plan (MAAP), and as a result of the calls for projects to members, as well as to external partners (open calls).

3.3.5.2 Demonstration and implementation

The demonstration and implementation plan is based on different technology readiness levels (TRL) of projects from the lowest to the highest, as summarised in the diagram below:

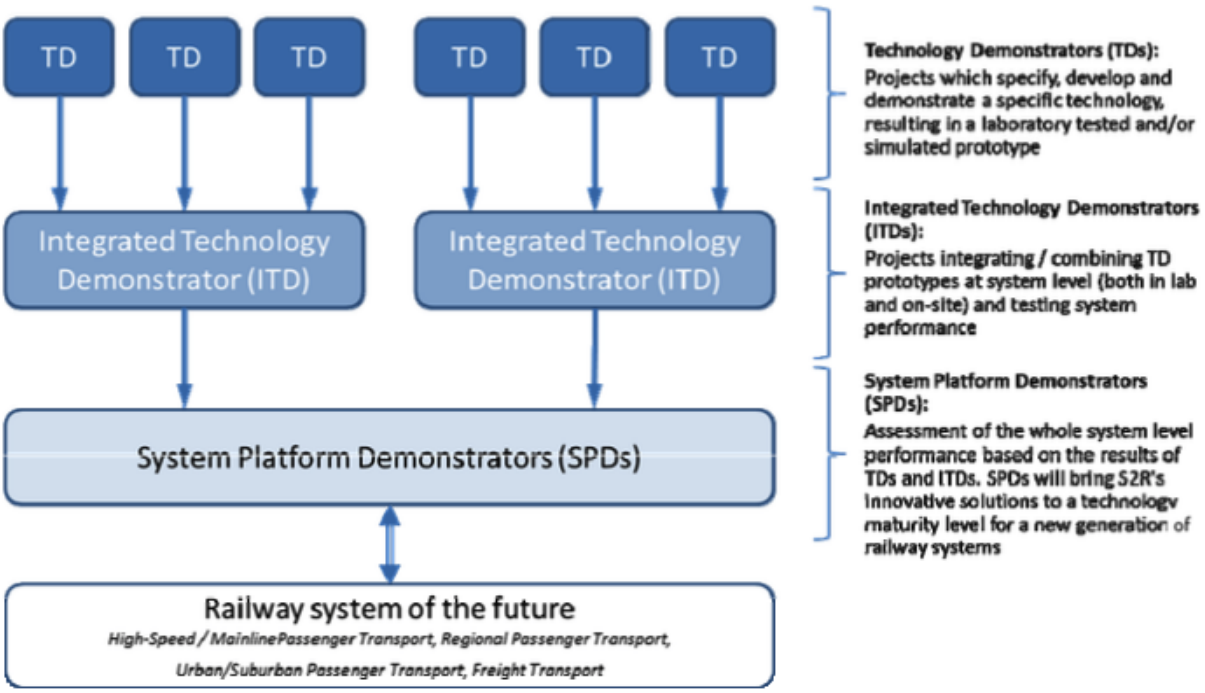


Figure 6. Overview of the technical demonstrators (source: S2R JU governance and process handbook)

4. EVALUATION QUESTIONS

This S2R evaluation has taken the following aspects into consideration:

- **Effectiveness:** Progress towards meeting the objectives set for the JU, including how all parties in the PPPs live up to their financial and managerial responsibilities and keep an open non-discriminatory attitude towards a wide community of stakeholders.
- **Efficiency:** The extent to which the SJU is being managed and operated efficiently.
- **Openness** The extent to which the SJU enables world-class research, establishing Europe in a leadership position globally, and how it engages with a wider constituency to open the research to the broader society. (In the case of S2R the potential of the outputs are the only indicators available as no projects have been completed at the time of this evaluation).
- **Transparency**: The extent to which the JU keeps an open non-discriminatory attitude towards a wide community of stakeholders and provides them with easy and effective access to information.

5. METHODOLOGY AND PROCESSES FOLLOWED

5.1 The approach

The specific tasks of the experts were to:

- Collect, analyse, judge and present data including both quantitative and qualitative evidence that address the evaluation questions.

- Answer the evaluation questions through a qualitative assessment based on robust evidence and supported by quantitative analysis, and to

- Formulate conclusions and recommendations in relations to the purpose of the evaluation exercise.

The following actions were undertaken:

- A review of existing literature (from the list provided by the Commission and using their own resources). A list can be found in the Bibliography, individual items are referenced in footnotes where used.

- A series of semi-structured interviews with key stakeholders and interested parties. A full list of those who have been interviewed and the interview notes are available as annexes in CIRCA.

- Two questionnaires. One organised by the commission open to the all beneficiaries and one designed for the evaluation that was sent to 145 email addresses of stakeholders and interested parties, including the S2R Governing Board. A total of 55 responses were collected between March and June 2017 with respondents from both beneficiaries and those not involved with S2R[15]. The EU initiated stakeholder survey was undertaken in late 2016 and early 2017. 73 responses were received and the majority of the answers came from those answering in a professional capacity or on behalf of their organisation (69%). 37% came from the private sector (private for profit excluding education) and 27% (combined) came from research and academia with little input from SME's (only 6% answered yes while 60% did not answer this question). The majority have applied for funding from the JU (64%). The majority are involved in the JU (58.9%) while 35% are not (all respondents answered this question).

- Meetings and focus groups. A number of meetings were arranged to collect information including interim meetings with the European Commission, the ERA, the JU management and the project coordinators (both for the JU and for the Lighthouse Projects).

5.2 Limitations – robustness of findings

The experts considered the data collected to be sufficient for the tasks and had no reason to doubt the robustness of their findings based on this study and data.

6. IMPLEMENTATION: STATE OF PLAY OF THE S2R JU

6.1 JU membership and selection of associate members

Before examining the associate membership, it is worth recalling who are the founding members of the S2R JU.

The members of the initial group of promoters of the S2R JU[16] were six members of the manufacturing industry:

- Alstom (system integrator[17])

[15] See annex for breakdown of respondents.

[16] This initial group was later join by a dozen of other organisations for the submission of the final proposal to the European Commission. Most of these later ones became associate members, either directly or through their participation in consortia.

- Ansaldo STS (control command and signalling)
- Bombardier (system integrator)
- Construcciones y Auxiliar de Ferrocarriles (CAF) (rolling stock)
- Siemens (system integrator)
- Thales (control command and signalling, communication systems)

and two infrastructure managers:

- Network Rail (UK) and
- Trafikverket (Sweden)

All these companies committed to each put a minimum value of 30 M€ of their own resources, mostly in kind, over a seven years period, to join the initiative. These companies are referred to as the founding Members of the S2R JU. No railway undertaking wished to participate as a founding member, mainly due to the difficulty for them to commit to this long-term requirement. It is nonetheless recognised that the operators' expertise remains essential upstream to the identification of the needs, definition of objectives and downstream in the demonstration of results of S2R.

The selection of Associated Members, which occurred before the JU gained its autonomy, was made under control of the EC, in accordance with the JU regulation. The call for expressions of interest was launched in October 2014 and a two-stage process was followed, ending in a presentation of the results to the JU Board.

The Commission received 43 applications. These included 27 applications by single legal entities (SLEs) and 16 applications on behalf of consortia, making a total of 127 entities.

Seven applications were made by stakeholders from the rail operating community (ROC), i.e. railway undertakings (RU), infrastructure managers (IM) or urban operators (URBAN) either as Single Legal Entities (SLEs) or as consortia. The research community (research centres or universities) was also rather well represented either as SLEs or consortia. Finally, there were 4 applications from SMEs as single entities and a further 18 SMEs were involved in consortia.

The following table provides information on the representation of SMEs, the research community, the rail operating community and industry from those that applied.

Organisation Type	SME	ROC (RU/IM/ Urban)	Research /University	Large Industry	Total
Total number of entities	22	23	33	49	127
Share of total applications	17%	18%	26%	39%	100%

Table 2 Representation of the applications to be Associate Member

In terms of geographical representation, there were significantly more applications from entities established in EU-15 countries than in the central and eastern Member States.

[17] A system integrator is a company involved in the design and manufacturing in most if not all sub-systems of the railway transportation system and able to offer integrated railway transport solutions.

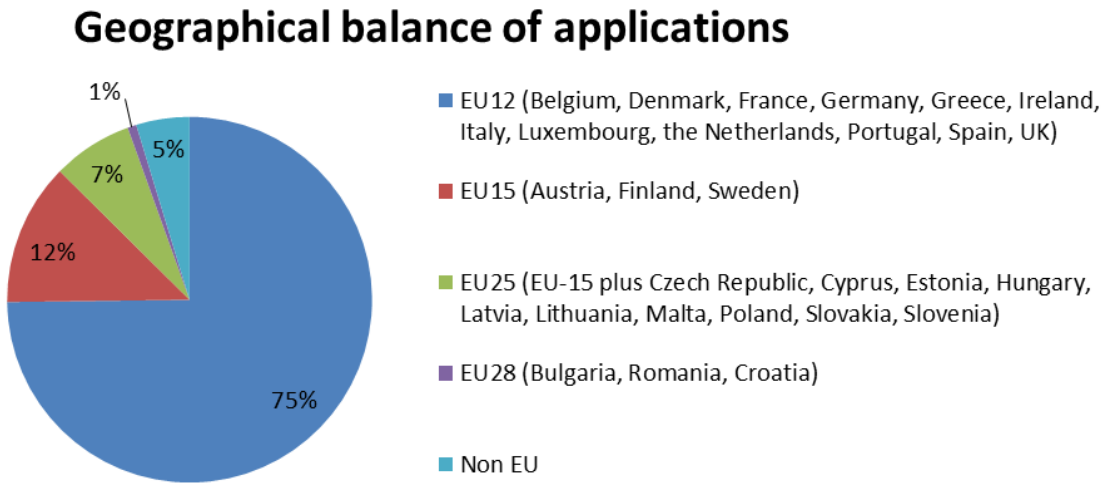


Figure 7 Geographical balance of applicants to become Associate Members

A pre-selection was made on financial[18], economic and capacity criteria. Then the preselected applicants were invited to submit a detailed technical proposal on the basis of two documents of reference:

- The S2R JU Master plan
- A draft multi-annual action plan, including in particular more details on the expected technology demonstrators and system demonstrators and in which the founding members had indicated some needs for complementation of their expertise.

Candidates were invited to submit proposals in areas:

- that were described in the draft multi-annual action plan and complementary to the activities proposed by the founding members;
- that were not yet identified in the draft multi-annual action plan, so long as they clearly justified their contribution to the draft S2R Master Plan and their relevance to the Shift2Rail objectives;
- that were identified as being of interest to the founding members. In this case, the relative merits of the proposals of the founding and associated members would be subject to a competitive review carried out under the responsibility of the Executive Director with a view to pursuing the proposals best meeting the objectives of the S2R initiative.

This technical selection was conducted in June 2015, following the usual evaluation process for H2020 research project and with similar questions asked to the evaluators that are usually asked for evaluation of R&I projects proposals. The added value that new members would possibly bring to the innovation programs in which they applied for participation, beyond the pure technical and scientific quality of their proposals, was therefore not really evaluated and the experts were not fully briefed to do so.

The process for selection was conducted in a fair and transparent manner as applicants were clearly informed of the process and as this process was carefully followed. It also produced

[18] The minimum financial commitment for accession to the status of associate member was a contribution fixed at 2,5% of the budget of each of the Innovation Program in which the applicant proposed to participate, i.e.between 2 and 6 M€ depending on the IP considered.

broadly acceptable results in pure terms of balancing the S2R membership between the different categories of economic actors. The following list of associate members was finally published in the implementing decision of the Commission of December 8, 2015:

- AERFITEC consortium
- Amadeus IT Group SA 3.
- AZD Praha s.r.o.
- CFW consortium
- Deutsche Bahn AG
- DIGINEXT
- EUROC consortium
- Faiveley Transport
- HaCon Ingenieurgesellschaft mbH
- Indra Sistemas S.A.
- Kapsch CarrierCom
- Knorr-Bremse GmbH
- MER MEC S.p.A.
- Patentes Talgo S.L.
- Railenium Swi'TRACK'EN consortium
- Smart DeMain consortium
- SmartRaCon consortium
- SNCF
- Virtual Vehicle Austria consortium

The size and scope of the organisations involved as founding or associate members in S2R can overall be considered as sufficiently representative of the major players and best organisations in the field to fulfil the short-term research objectives of S2R. However there are still gaps that should be filled both in the medium term and certainly in the long term as the final line up of associate members is considered to be suboptimal by many of the founding members and rail community. This is more fully developed in the effectiveness section of this report, where the evidence for this statement is given.

6.2 Participation patterns in JU membership

6.2.1 Participation per country

In the graphic below representing the nationalities of the JU members (15 Member States of the EU plus Switzerland and Turkey), the 6 consortia among the 19 associate members have been each accounted for as a single company, and listed under the nationality of the consortium coordinator. This is to avoid distortions effects that would result from, for example, accounting individually the 11 Austrian members of the Virtual Vehicle Austria. A country that is indicated but with no company represented means that it is a consortium member, but with a low contribution. This includes, in particular, railway undertakings and infrastructure managers, members of the EUROC consortium (in two cases coming from countries outside of the EU)

Companies with industrial activities in several countries have been considered as belonging to the country where their headquarters are established.

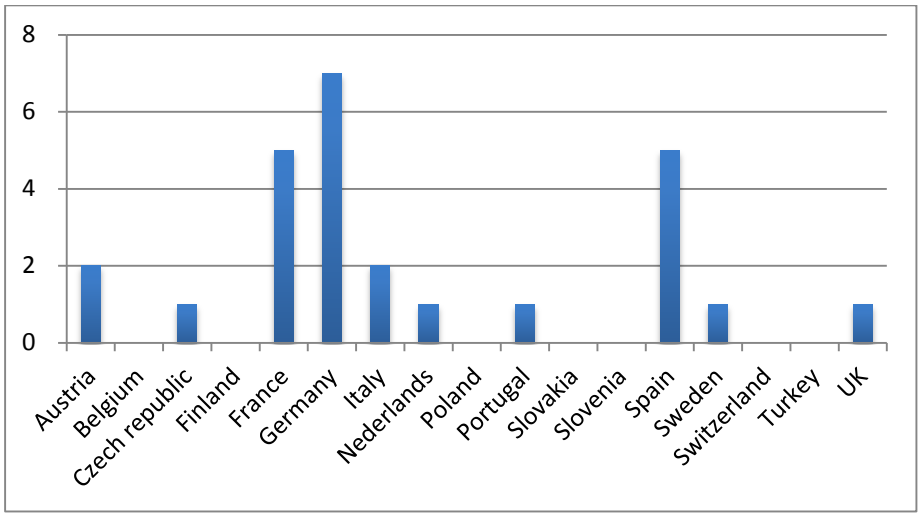


Figure 8: S2R JU Membership: number of members by country.

It can be seen that the S2R JU members with a significant activity belong to only 10 European countries. The experts further analysed this in order to give more insights into the contribution per country to the S2R program weighted by the financial contribution representing the status of the S2R members. In the absence of any definitive value the final contribution of each of the members, we took for this exercise the average contribution of a founding member, which is 25 M€, the average contribution of an associate member (7.9 M€) and for the consortia, we divided this latter amount by the number of members of the given consortium. As it is also the case for the direct distribution, we were not able to take into account the way in which big international manufacturing companies will possibly spread their participation amongst their affiliates in other countries than the ones in which they have established their headquarters. However, as we are often speaking of Western Europe countries already well represented (France, Germany, Spain, Italy, Austria etc.), it is not expected to produce a significant change in the general shape of the distribution.

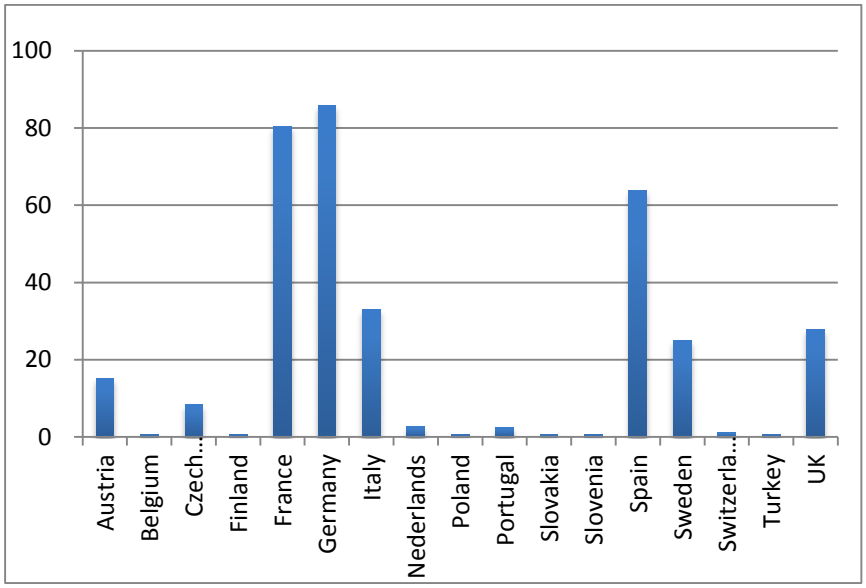


Figure 9 S2R JU membership: evaluated contribution per country in M€ (see above the explanations on weighting)

6.2.2 Participation by sector

The diagram below represents the distribution of the JU membership (all consortium members being accounted) per business sector.

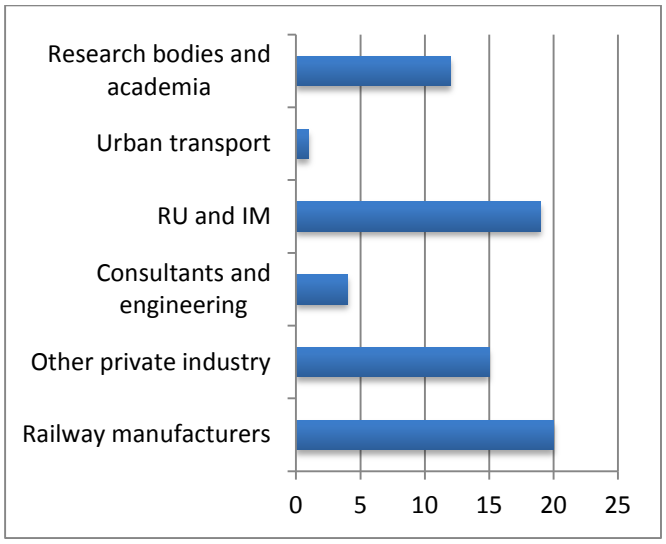


Figure 10: Direct distribution of the number of JU Members by sector of activity.

Using the same weighting factors in M€ as above, a picture of the actual contribution by economic sector can be seen.

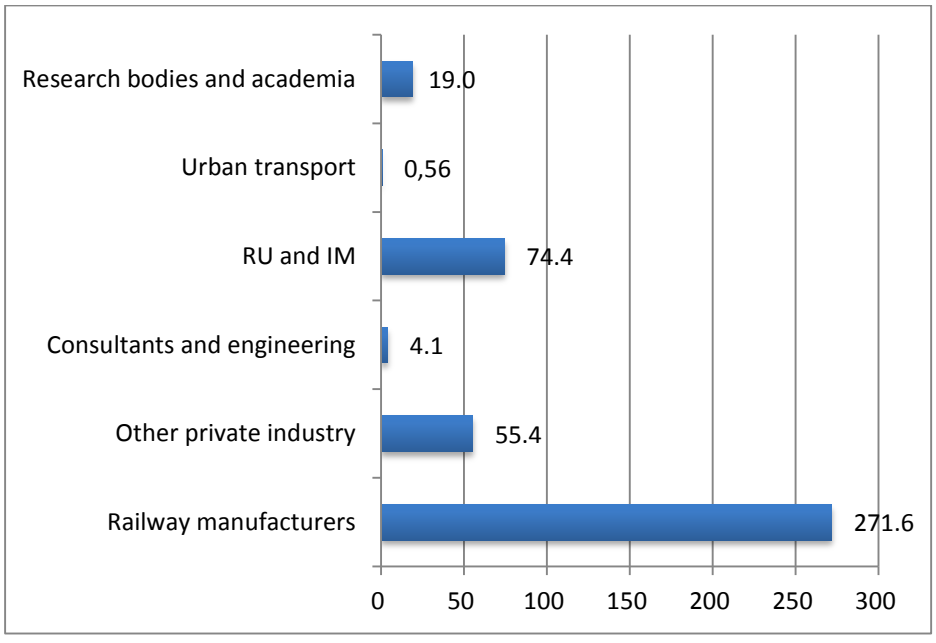


Figure 11: Approximate contribution in M€ by economic sector

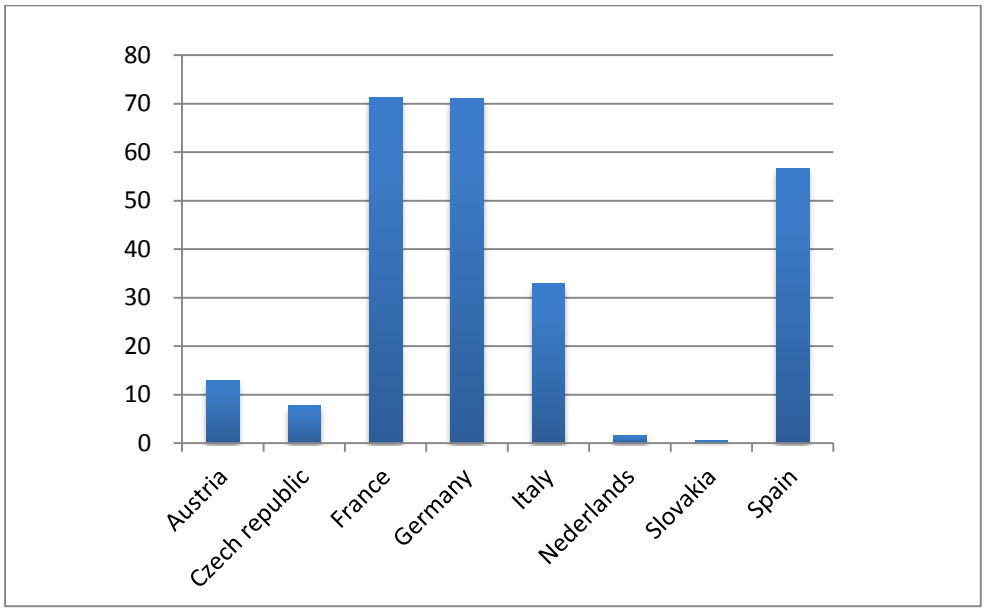


Figure 12. Distribution of the approximated contribution per country, private sector alone (M€)

It can be seen that S2R has good support from the private sector from four countries (France, Germany, Spain and Italy). The largest contribution from the other countries is around a third of smallest contribution of the group of four (Italy).

6.2.3 Trends and specificities in participation

Given the present state of play, this analysis of the participation is essentially based on the JU membership, even though some interesting evolution can be foreseen as a result of the first open calls.

As already mentioned the membership of the JU has been correctly balanced between the manufacturing industry and the operators, in consideration to the present technical content of the programme, since the arrival of associate members. It is particularly true if one considers that the manufacturing industry (about 77% of the evaluated contribution, of which 64% for the railway industry alone) is in charge of technology development and manufacturing, whereas the operators (about 18%) are rather involved in specification and demonstration.

The distribution diagrams also confirm the predominance of EU-15 countries in the participation to S2R and the almost total absence of the urban transport sector. The Czech republic is the only central European country where a member of the JU is established. The participation per country is very much linked with the implantation of the railway manufacturing industry, with a significant contribution of German, French and Italian companies and a particularly noticeable contribution of the Spanish industry.

The participation of railway undertakings is essentially from French and German national railways, discounting the rather symbolic presence of 10 others as members of the EUROC consortium. This imbalance in the geographic participation of RUs, as compared to the involvement of their own national manufacturing industries is considered to be a weakness in terms of opportunities for demonstration in service of the JU results. This issue should be given attention in the coming months by the JU management, its supporting bodies and the sector organisations, so as to determine in advance the possible shortcoming to be compensated and prepare open calls accordingly.

The opposite can be seen in the British and Swedish contributions, which come entirely from railway operating companies, through the participation as founding members of their two national infrastructure managers.

In most of the central European countries the absence of any significant JU membership can be considered as a logical result of the very limited financial capabilities of their railway operators and of the absence of any strong national railway manufacturing industry. Poland is however noticeably poorly represented, if one considers both the importance of its railway transport system in the national economy and the significance of its railway manufacturing industry. As already mentioned, a strong lobbying of the Polish railway sector by the promoters of the initiative unfortunately did not succeed in raising the interest of Polish companies. The participation of the Polish industry should therefore again be encouraged at the occasion of the launch of a possible S2R-2. It has however to be noticed that project grants following the first series of open calls in 2015-2016 has started to widen the participation to the programme to a larger number of Member States, including from Central and Eastern Europe.

The participation of research bodies and academia, as indirect JU members through consortia, is relatively modest (about 4%). The status of JU member was not foreseen for them and it is expected that they will get a higher share of the work program through successive open calls for proposals. It can already be observed with the results of the first open calls (66% in total). Therefore while recognizing that it is suboptimal in terms of JU membership, it is expected to be higher as more open calls are launched. A mere extrapolation of the first calls results would lead to a 20% share of the Union's contribution allocated to research bodies, academia and SMEs.

Answers to the Web questionnaire that was launched by the evaluation experts group show that less than half of stakeholders (47%) agree or fully agree that the JU is properly inclusive of all rail sector players, nearly one third would like to see improvements and 15% are really not satisfied (see diagram below).

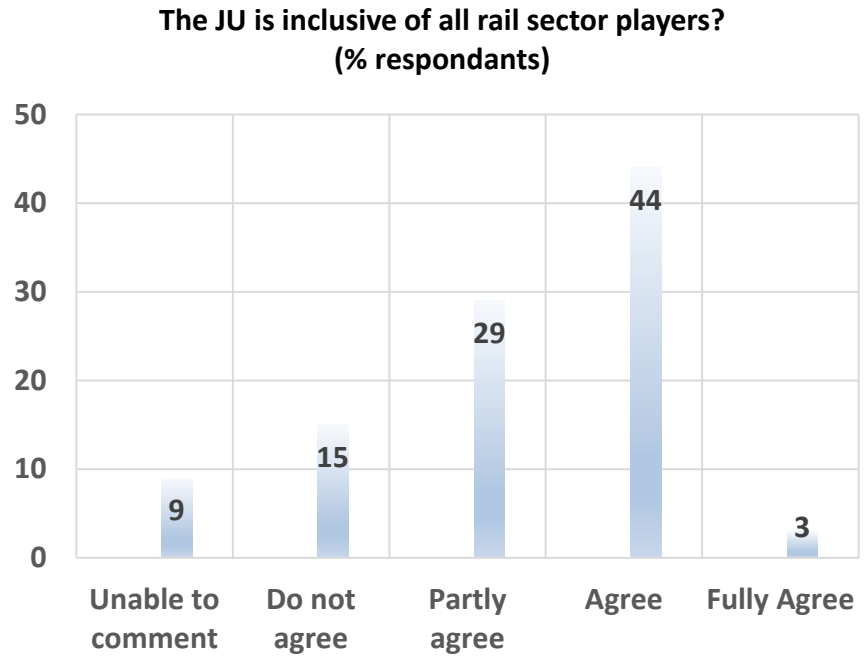


Figure 13: Responses from the Internet questionnaire on the extent that the JU is inclusive of all rail sector players

From the profile of the respondents to the Internet questionnaire despite 47% agreeing that the JU is inclusive of all rail sector players, the experts feel that 44% only partly or not agreeing with this proposition is high enough for this evaluation to consider. This was also widely

confirmed in the interviews. In other words, we do not say that not all players are there but that there are still gaps in the membership that need to be addressed.

As already mentioned, the JU might have to think about possible ways of better balancing its technical and political membership, possibly through some sort of second call for Associated Members. Another explanation for this relatively poor perception of the inclusiveness of all sector players by the stakeholders (from the survey and interviews) is that they build their judgement, not only on the basis of the present scope of work, as proposed by the founding members in 2012, but in the scope of the responsibility of the JU in its role of managing all European railway focused research. This is a critical point that is going to be developed further below.

Last but not the least, the evaluators have not received any sufficiently detailed information to assess gender balance in any detail.

6.3 Overview of calls for proposals launched during the period 2014-2016

6.3.1 Analysis of the results of the first calls

In June 2016, the S2R JU awarded 27 grants (13 to proposals from its members other than the EU and 14 open calls) as a result of the 2015/2016 calls launched on 17 December 2015. The corresponding grants agreements were signed between July and October 2016, allowing the start of the first projects in September 2016. The total value of the Research and Innovation activities amounted to 167.3 M€. This total value was split between 142.4 M€ for proposals submitted by JU members (co-funded at up to 63.3 M€) and 25 M€ for proposals submitted by consortia of non members (co-funded at a level of 24.7 M€).

Only the results of open calls (OC) are analysed here under, as the results of calls to members (CFM) are the direct results of agreements between the members that have either existed since the creation of the JU for the founding members or since the selection of the associated members. The results of the CFM (Call for Members) come therefore only as a partial confirmation of the participation patterns expected for the whole duration of the programme as shown in the preceding paragraphs.

The distribution of awarded projects per country to non-JU members, in terms of number of projects and number of beneficiaries, is given by the diagrams below:

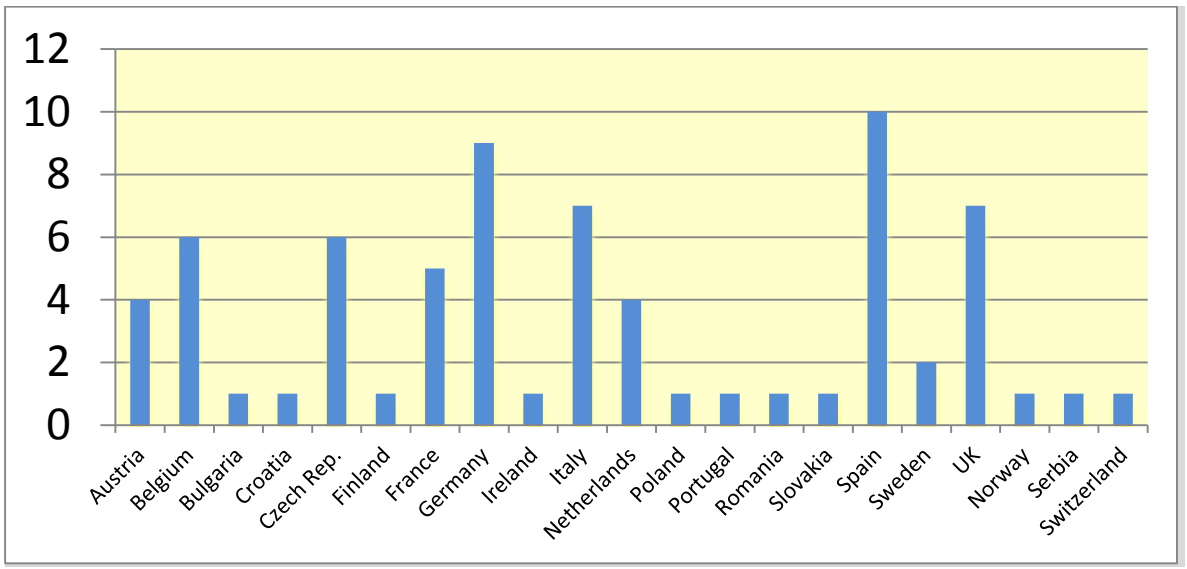


Figure 14 Distribution of number of projects to non-JU members by country involvement

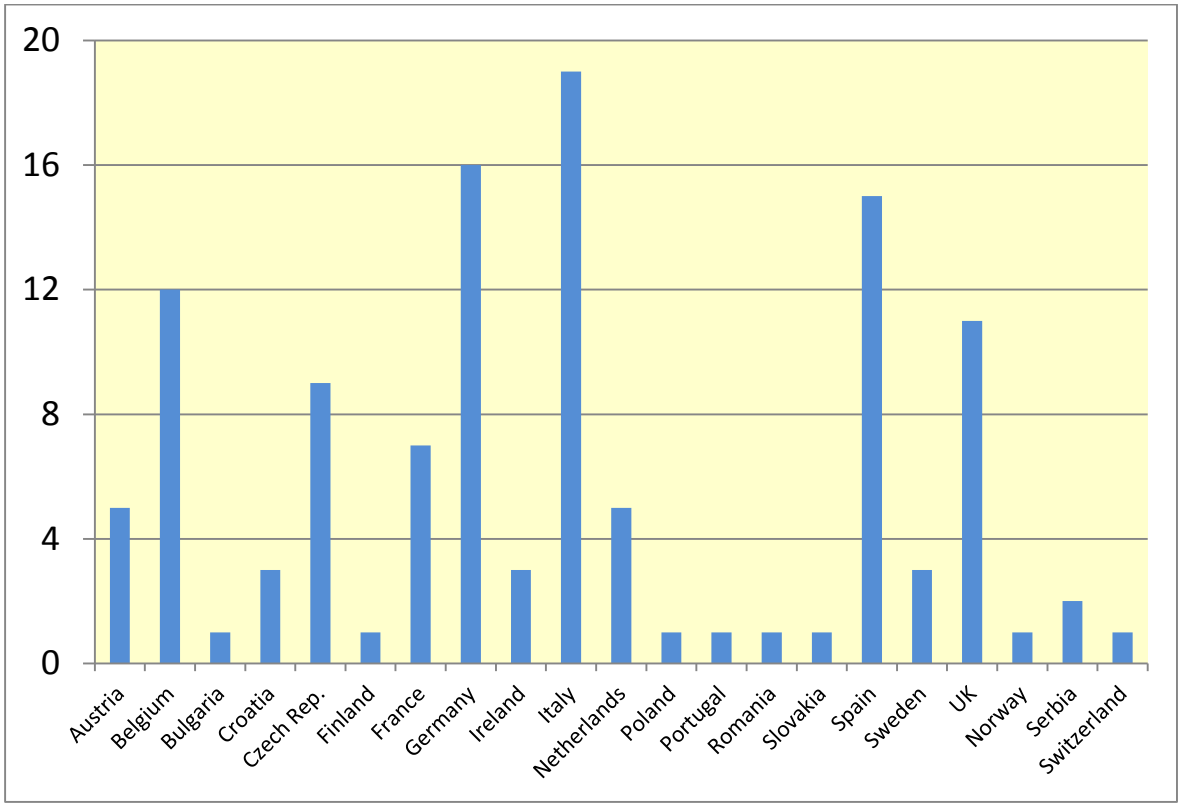


Figure 15. Distribution of number of beneficiaries (source: JU management statistics)

The distribution per economic sector is given by the two following diagrams, first in terms of number of allocated projects, two in terms of funds granted. It can be seen at first glance that a major objective of open calls, which is to largely open the participation to the JU works to research organisations and SME has been reached.

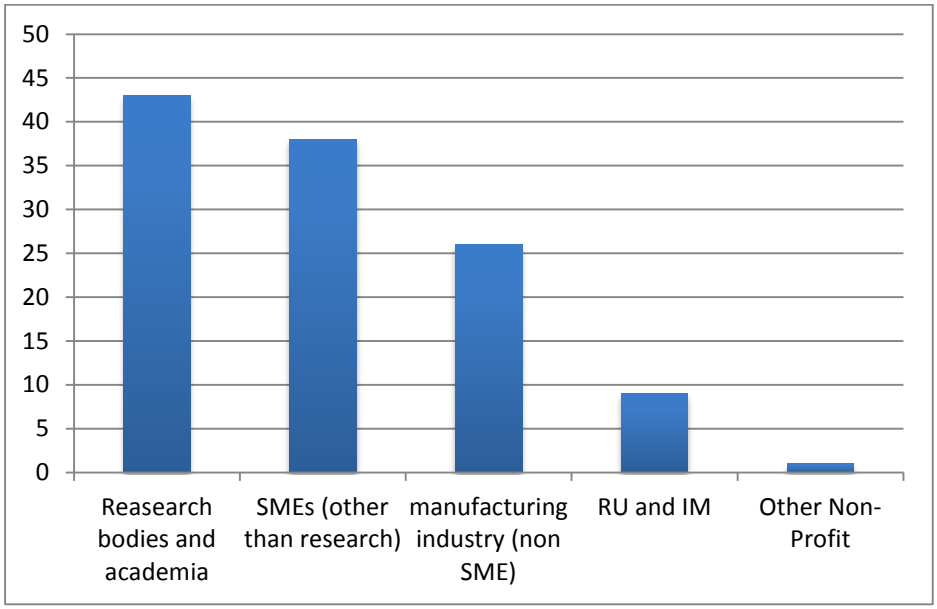


Figure 16. Distribution of the beneficiaries of 2015-2016 open calls by economic sector (source: data provided by the JU management)

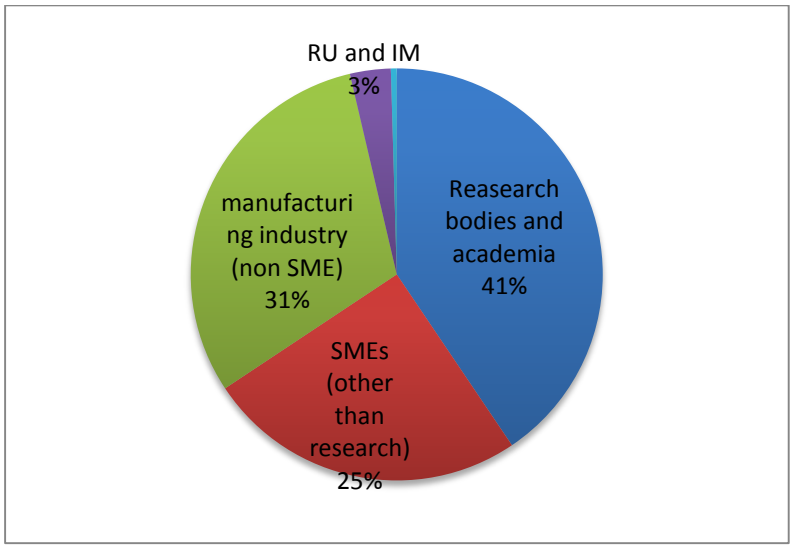


Figure 17. Distribution by economic sector of the funds allocated as a result of 2015-2016 open calls (source: data provided by the JU management)

In November 2016, the JU issued its 2017 calls for proposals, for a total funding budget of 60,8 M€, of which 19,5 M€ allocated to open calls. A significant increase of the number of responses per topic (see below, 6.5 competition for funding) is taken as a positive indication of the interest for the S2R JU activity. It is of course too early to give any indication of what are going to be the results of this call as the deadline for submission of proposals was March 30th.

6.3.2 Allocation of funds per IP

The diagram below shows the distribution of funds allocated so far under H2020, first by the EC in the frame of the lighthouse projects and then by the JU through its projects grants of both types resulting from the first calls (grants to members and grants following open calls). The total amount of this present EU contribution to the S2R program is of 139 M€[19], i.e. about a third of the multi-annual total budget. The distribution per IP is rather similar in proportions to the one that is foreseen for the whole project in the MAAP.

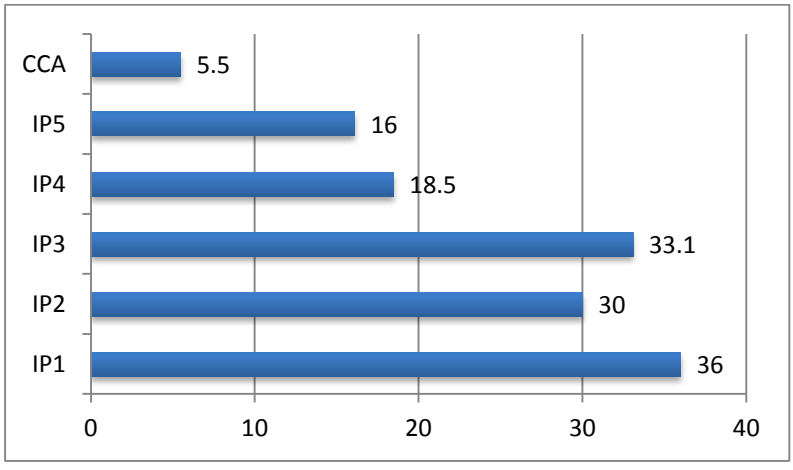


Figure 18: Allocation of EC funds per IP and CCA at the date of completion of the present report M€

[19] Of which 52 M€ allocated to lighthouse projects (100% founding), 61 M€ to the projects presented by JU members (corresponding to approximately half of the projects costs) and 26 M€ allocated to projects granted following open calls (100% founding).

This distribution does not vary significantly in proportions if the in kind contribution by JU members is taken into account (distribution of the about 200M€ total given by the total budget diagram below).

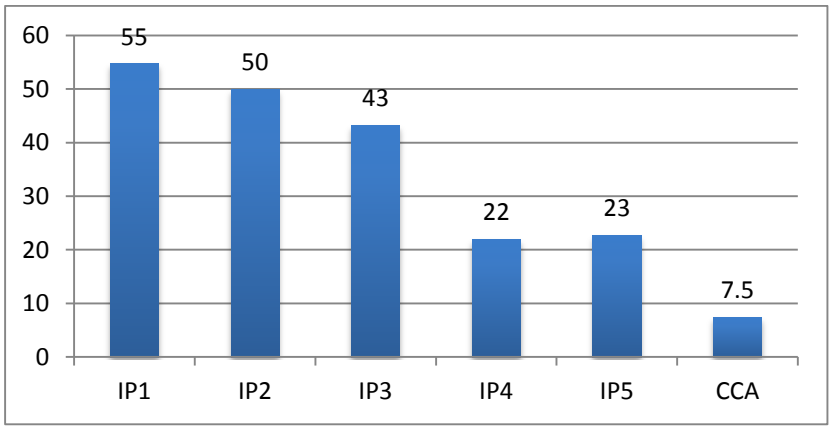


Figure 19: Total budget M€ per IP and CCA at the date of completion of the present report

6.4. Participation per topic and expected results

The process of selection of associate members resulted in certain imbalances of participation between industry sectors in a couple of IPs. It is particularly the case with the two IPs that were not included in the original plans of the manufacturing industry, as well as, to a lesser extend and more facility to compensate, with some cross cutting activities[20].

In IP4 the disappearance of the railway undertakings that were members of the corresponding "lighthouse project" (see below) is putting the program in a difficult position. The IP management will not be able to compensate rapidly for this absence and for the moment the lighthouse project continues on 100% of the common scope, while IP4 is going to introduce technological "bricks" in the system. This partnership of this IP should be given particular attention by the JU management and its supporting bodies, considering also that the scope of this IP is not rail transportation only, but multi-modal passenger transportation.

It is the opposite case in IP5 (freight) with the total absence of any manufacturer. This IP obviously suffers from the fact that the initial promoters of the JU had little interest in it (only one founding member, an infrastructure manager, is participating). It is most likely that this is based on a general opinion among the manufacturing industry that it is not by technological innovation that railway freight will be revitalised in Europe. It is only after the selection of the associate members that the IP leadership was given to DB AG, who had to define a technical scope and program for it and has now to develop partnerships with other members of the JU. Furthermore, as we will see below, this is also the only IP that will not benefit at all from the results of the corresponding "lighthouse project". The progress of this IP and its expected results should therefore be given particular attention in the coming months by the JU management supported by the representative bodies of the sector.

It is recognised that rail freight transportation is a sector where margins are small and there is little interest from those in the market to invest in European research and development. That said it is a sector that also suffers from being considered marginal and therefore S2R presents a good opportunity for it to gain more attention. The existence of IP5 is by itself a good progress as compared to the situation that prevailed before the creation of the JU, as the IP5 budget is very significant as compared to any other research program engaged under previous FP and as it ensures continuity of innovation efforts for a significant period of time. It is certainly an area

[20] CCAs : weakness signalled by the SRG chairman

in which the JU efforts will help achieve European policy ambitions for a major shift from road to rail.

6.5 Competition for funding, Distribution of funds and Grant sizes

It is probably worth reminding here what are the principles of funding under the S2R JU has they have been set up by the article 17 of the JU regulation. The Union financial contribution to operational costs (i.e. administrative costs excluded) shall be allocated as follows:

a) up to 40 % shall be allocated to founding members, other than the Union, and their affiliated entities

b) up to 30 % shall be allocated to associated members and their affiliated entities

c) at least 30 % shall be allocated by way of competitive calls for proposals and calls for tenders.

In the cases a) and b) (JU members and their affiliates) the EU funding cannot be higher than 50% of the operational costs of the projects, for projects awarded as a result of « open calls » (case C) the EUY funding may reach (end will generally) reach 100% of the projects' costs.

In all cases, the EU funding shall be allocated after evaluation of proposals received by the JU as a result of « calls for members » (CFM) in cases a) and b) and open calls (case c)). This selection is made on the basis of an evaluation made by independent experts.

JU members (both direct members and consortia members) cannot take part in any proposal answering OC.

As a result of the above, a clear distinction has to be made between competition for funding under CFM and under OC.

In the first case, CFM are launched as a direct result of the original technical and financial commitments of the concerned JU members. Except in possible cases of failure by any JU member, the final result of the CFM is therefore expected to simply confirm these original commitments. For the moment it resulted in the 20 topics of the 3 first CFM (2015/2016/2017) having been subject to only 20 proposals considered as valid, and to the projects being allocated to the corresponding 20 project consortia. It is felt that the evaluation and selection process is somewhat limited to a scientific and technical quality check.

In the second case (OM) the process of selection is identical to the one of selection of proposals coming in response to the usual H2020 calls (except that the selection process is managed by the JU team and not by the EC services). The level of competition for these grants is deemed has having been satisfactory, with a total number of 43 proposals received in answer to the 2015-2016 OC (15 topics)[21]. In both cases the calls have attired among the most prestigious research bodies in Europe and have also resulted in satisfactory results in terms of participation of SME (see fig. 15), with a geographic distribution that is better than the one of the JU members.

It is however too early to go any further in statistics, with only 25 M€ grants having been allocated so far. The average grant size for the 2015-2106 OC was 1,7 M€ per topic, it is going to be of about 2 M€ as a result of the 2017 call. It can be seen as a (modest) result of the

[21] This year (call 2017) the number of proposals for 10 topics only has been 51. As far as CFM are concerned, the number of proposals received (7 for this 2017 call) remains equal to the number of topics, for the same reason than in the preceding ones.

decision has also been taken by the JU management to reduce the number of topics while increasing their individual budget, for the sake of simplification of the management of the projects and to avoid having new partners in consortia with a too small budget share.

7. ANSWERS TO THE EVALUATION QUESTIONS

A number of aspects of the evaluation questions (see Section 4) have been answered in the previous sections of this report, especially in terms of transparency and openness. The Expert Group has made its conclusions and recommendations based on these evaluation aspects in the final part of this report. In addition a number of further questions including:

7.1. S2R mission and governance

The JU has been established in full compliance with its regulation and there is sufficient evidence that the JU is totally committed to the realisation of the objectives set up by Article 2.

We have strong indications that during the recent independent operations of the JU (less than a year), the management have been able to catch up with most of the initial delays in fulfilling all the fundamental tasks as set up in Article 2 of Annex 1. The membership of the JU has been constituted in accordance with the rules set up in Article 3 and 4 of this same Annex and, as far as we can tell, all the functioning principles as set up in the other chapters have been respected. The management structure and procedures are clear and well documented and perfectly aligned with the regulation as far as we have been able to appreciate. The roles and responsibilities of the Executive Director and staff are well documented and clear and the working programme (annual and multiannual) in place. Although the structure of some of the other bodies is clear there is some improvements in the processes as set out later in this section. The application of the H2020 framework is treated in the chapter on coherence.

The S2R JU states that its task is to prioritise the research and innovation activities set out in the Master Plan throughout and beyond the lifetime of the Joint Undertaking, taking into account the following:

- Improved services for users and customer quality, reduced life-cycle system costs, simplified business processes and enhanced interoperability,
- Business benefits in terms of market uptake in Europe and globally,
- Available resources,
- Proportionality, feasibility and acceptability,
- Potential for accelerated deployment,
- Value-added of action at EU level,
- Link to on-going research and innovation activities, in particular to projects funded under previous EU Research Programmes and at MS level, and
- Potential synergies with other sectors.

7.1.1 Evaluation of the current structure and management

Among the responders to the Web enquiry launched by the evaluation team, about 75% were able to answer the question whether the present JU organisation and management was fit-for-purpose in terms of organisation, operational efficiency and effective implementation. Two thirds of them declared that they were satisfied, a third of them said that some improvements

might have to be brought and nobody felt that the current organisation and management was not fit for purpose.

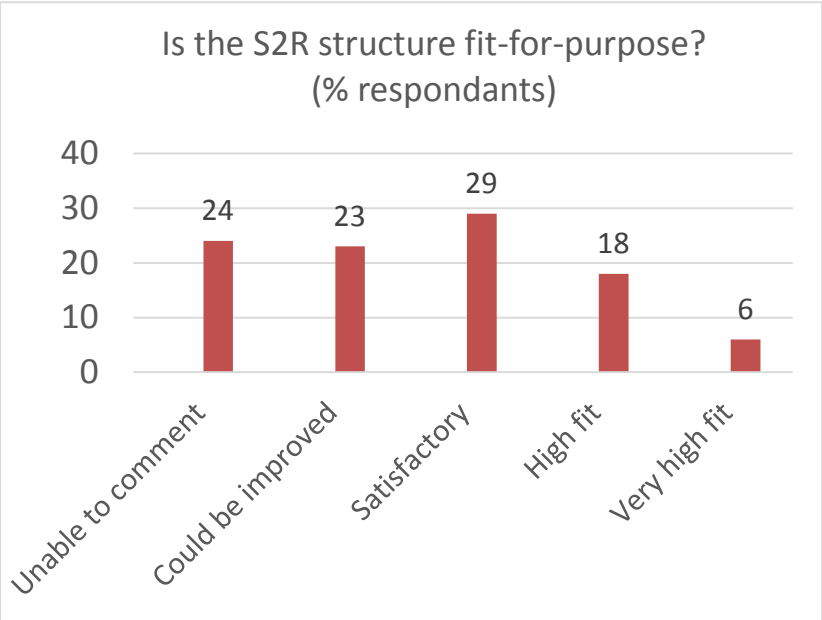


Figure 20. Opinion of the stakeholders on the S2Rstructure from the Internet survey

Based on interviews with stakeholders and the JU management it is clear that there are some weaknesses, but most are due to S2R being in its early stages of management maturity. The extremely lengthy procedure for the nomination of the Executive Director (who took office almost two years after the creation of the JU), and of the head of the program office to a lesser extent, left the JU without solid strategic and technical management for a long period. Any impact on the future programme's results or resulting difficulties encountered in the technical coordination of the various IP during this transition period cannot be measured at this stage[22].

Steps are being taken by the management to addressed the above in terms of management processes, within the limits of the budget, and progress has been recognised by direct S2R members and those outside of the JU (validated by interviews). The occasion of the present revision of the MAAP is the opportunity to address this. Further details on the administrative burden are given later in the report.

It is the experts' opinion from their observations and discussions with stakeholders and the management that reflections should be launched for more fundamental changes to be introduced in the scope, organisation and processes for an eventual S2R-2 to be able to function more efficiently.

The following section sets the key areas for this reflection.

1 Complexity of processes

The main criticism is with the complexity of the technical management, linked with the organisation of the work in a myriad of projects, each strictly following the management rules defined in the H2020 regulation. This complexity is well represented by the figure below, explaining the relations between the JU management, the IP steering committees and the coordinators of each and every project or action and one can see that the process cannot be considered to be lean.

[22] Remarks made in particular by the SRG chairman.

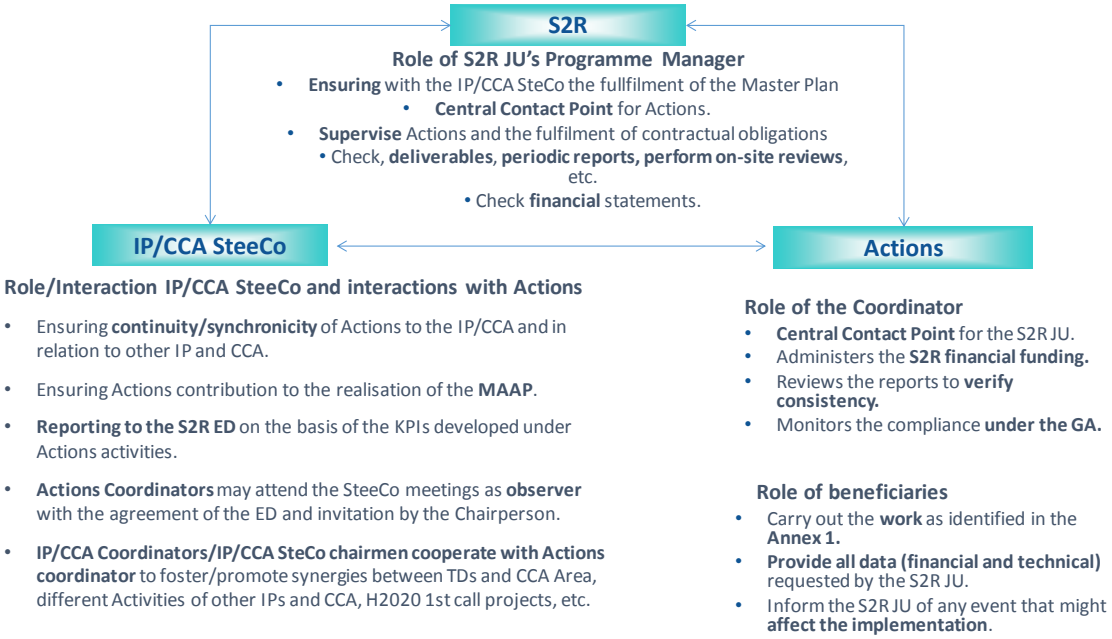


Figure 19. Illustration of complexity of management roles (S2R governance and process handbook)

Suggestions for addressing this are made in the conclusions and recommendations and a project management optimisation process needs to be launched as soon as possible to ensure effective project management and resource allocation.

7.1.2 Involvement of all actors in the value chain

The JU membership by itself is overall considered to relatively well represent the whole value chain of main railway transport actors with the significant exception of urban rail operators (and see below section on AMs). It should also be noted that it is somewhat weak in operational aspects. This is best reflected in certain IPs (IP4 in particular) and in view of the demonstration and implementation phases, but this relative weakness is deemed to be compensated by open calls to proposals.

The participation of private industry members from outside of the traditional rail sector is welcomed and needs to be increased. An example can be noted in the participation diagrams, with the providers of aviation technologies (composite structures in IP1, ticketing in IP4 etc.). This is seen as positive although it does not compensate for not having some key rail players within the JU.

In addition to the main economic actors, some academic institutions, research bodies and SME are themselves members of AM consortia. Therefore, the experts believe that the creation of the JU has achieved the expected levels of SME and research participation and the results of the first open calls by the S2R JU are encouraging. That said this aspect should be followed with attention by the JU management and all members of IP steering committees (and the States Representative Group), who should directly encourage and help the creation of consortia involving as many SME as possible to answer the open calls that they launched.

It is still to early to fully assess the way in which grants attributed as a result of open calls will result in a fully satisfactory balance of the participation and even further improve the level of participation of players outside the traditional rail sector. However, the second open calls have resulted in a better level of responses, which is seen as promising. This rather positive assessment is done with respect to the presently very technology oriented innovation program. A possible second phase of the JU, which should be more customer focussed, would mean a necessary enlargement of the operating companies' representation.

However, an unforeseen side effect on the participation of SME has occurred due the adoption of H2020 rules. The initial intention was to grant SMEs direct and easier access to the programme and a facility to propose their innovative solutions out of any consortium put together by larger players. It has now come to light that this also means that they have to invest time and resources in the preparation of responses to calls. Previously support for this could be provided by larger organisations, which are now members of S2R and who are not authorised to participate in answers to open calls. This creates a barrier for some high potential SMEs to participate in the open calls and may also reduce the quality of the results of the calls, compromising innovation.

It seems that in the case of the manufacturing sector such support can in some cases still be provided by UNIFE, but this is not seen as being efficient for fostering SME participation (as the support that would be provided by national organisations). In some cases (e.g. Railenium in France) the national organisation that has been created to support SME participation in national rail research became itself an associate member of S2R, possibly therefore jeopardising its own effectiveness in supporting national SME in their tentative to become partners of S2R.

In terms of the selection of AMs the experts feel that there could be some improvements in the long-term. Several S2R members noted to us that the outcome of the process has not filled all gaps in technical knowledge and expertise[23]. For example, there were applications from some major railway undertakings and infra managers, which would have enlarged the national basis of railway operators' representation in the JU and would have brought significant added value in terms of implementation of the results in demonstration activities. These gaps have been mentioned previously in relation to the IPs and the transfer of knowledge from the lighthouse projects into the IPs and technical demonstrators.

Responses are further documented in the interviews and from the two questionnaires. There were quite strong opinions on this noted by the EU stakeholder respondents.Specifically 29% strongly disagreed, 20% partly agreed but would like to see changes and 26% agreed or fully agreed (25% did not feel they could comment) that the process for selecting AMs was sufficiently open and non-discriminatory, while 49% felt that it was. This was considered a rather high level of dissatisfaction compared to the majority of responses by this group (who were predominantly those already associated in some way with S2R – nearly 60% of the total).

Some choices of AM have excluded organisations that were instrumental in the elaboration of some of the initial proposals. It is for example the case for a company that was involved in the creation of IP3, and was only retained for a participation of secondary importance in IP2. This is considered as being due to the imperfect evaluation process, as mentioned earlier. These companies will obviously be able to participate in open calls (e.g. for demonstration activities in the part of the rejected major operators), but unfortunately not in cases where they may have been retained as associate members and accepted into IPs where their role may be useful but marginal compared to the value of their expertise to other IPs via their open calls.

Other examples of this partial failure of the selection process to correctly complement the JU membership are given further down in paragraph 6.4, they concern the participation in IP4 and IP5.

Several consortia were also accepted as associate members, but with an extremely limited amount of time and budget allocation. This presents the risk that they will not be able to make significant contributions to or add little value in terms of innovation. For example several members of the railway operating community in the EUROC consortium could have brought more value if their operating expertise was used to support bodies of the JU without becoming members. Another similar example is the Railenium Swi'TRACK'EN consortium, gathering several universities and laboratories, which may have been better suited to contribute to their

[23] Board minutes

services for innovation in railways by answering open calls. However all these "small" consortia members are now no longer be able to answer open calls.

In the case of the two selected major railway undertakings (DB AG and SNCF), their programmes of work mix their participation as innovation leaders (which should be the essential activity of a JU member), with support activities (that might have been simply exerted through participation in some JU support bodies) and offers for demonstration that might have been made in answer to open calls.

It should be noted that the associated membership process or selection did not strengthen the Eastern Europe representation, nor compensate for the absence of any urban operator, but this was due to weaknesses in their applications, rather than any other reason.

This selection of associate members was also identified as an area where there were some levels of dissatisfaction from stakeholders as shown by the answers to this question in the expert's Internet questionnaire (see Figure 21 below).

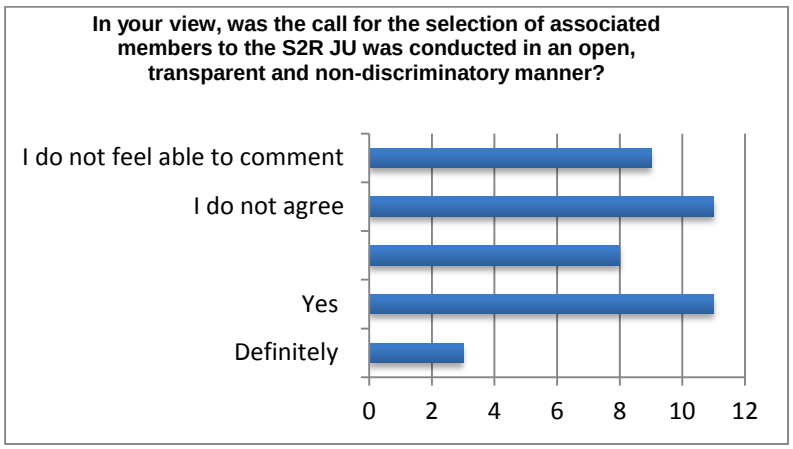


Figure 21 Number stakeholders answering openness question

It is therefore suggested that a process for selection of members, more directly aiming at the completion of the expertise of the JU membership and at a better geographical balance, should be followed for a possible second projected call for associate membership. However, bearing in mind the limited remaining 7 M€ budget. This budget should not be dispersed between too many new members and the idea of the creation of a single consortium might be considered, gathering a small number of participants preselected by the JU Board and invited for discussion and negotiation. Ways should also be found to allow by exception some small associate members to answer open calls for proposals in their best field of expertise (possibly limiting this right to IPs in which they are not involved as AM).

For a possible second phase of the JU, it is suggested that there is a deeper reflection on the distinctions between founding and associate members and that the composition of the JU membership should be better and more strictly aimed at achieving leadership in innovation, possibly on an IP by IP basis and/or for a duration limited to the duration of the IP in which they are involved. The experience of other transport JUs such as SESAR and Clean Sky 2 where they have created some partnership arrangements could be transferred. A corresponding increase in the proportion of the budget allocated to open calls (e.g. 50% for members and 50% for "beneficiaries" rather than 70/30) would offer more flexibility in the choice of partners for either the development of advance solutions or demonstration activities.

7.1.3 Involvement of other stakeholders

Several bodies of the JU allow for the representation of other stakeholders, standardisation organisations or safety authorities, academia and research organisations, users associations etc.

Two supporting bodies have been set up to help advise the Executive Director. These are namely:

- The Scientific Committee (SC) (12 co-opted members from academia and research bodies) advises on the scientific and technological priorities to be addressed in the Annual Work Plans (AWPs)

- The States Representatives Group (SRG), representing all EU Member States and countries associated with the Horizon 2020 Framework Programme. This group offers opinions on the strategic orientations of the JU and on the links between Shift2Rail activities and relevant national or regional research and innovation programmes and can help suggest potential organisations from their respective countries that have relevant expertise for responding to open calls. However it was noticed that much depended on the dynamism of the chair of this group to motivate the state representatives to fully engage with S2R. The members are coming from all kind of organisations: national administrations, consultants, universities, incumbent railway operators, infrastructure managers etc.

These two committees are asked to give opinions "ex post" and both chairmen have raised concerns during the evaluation that they are always consulted at the end of the decision-making process, rather than being given the opportunity to provide inputs earlier on in the project development. The value of this input earlier rather than later is considered to be high, and there is potential for this to occur without major intervention. It demonstrates a shortcoming described earlier in this section and the efforts required to put robust processes in place (which the JU management is currently doing).

Two other bodies provide support to the technical management:

- The User Requirements Working Group(s) is composed of S2R JU members and non-members to assist the JU in ensuring that technical solutions developed within S2R meet the specific needs of all relevant end users.

- The Implementation and Deployment Working Group(s) is composed of S2R JU members and non-members to test the operational reliability of the results of Shift2Rail and thereby contribute to a more rapid uptake and large-scale deployment of the solutions developed through the Shift2Rail activities.

These working groups are, for the time being, are clustered into a single one (URID-WG). There is a list of 22 organisations that may nominate members of this URID-WG, among which 5 have not yet delegated any representative. This membership includes representative organisations of all categories of stakeholders. The effective role of this group does not appear as fully clear. There might be doubts about it being anything else for the time being that a vector for dissemination of information. It is typical in this respect that no mention of it has ever been made in the interviews of the IP and CCA leaders.

An ad-hoc group for the revision of the MAAP has also been created and it is called TIGER Team MAAP. It should also be noted that the Commission has the Transport Advisory Group (TAG) that is set up to give overall transport research guidance but that currently has not been asked to give input into the strategic rail research agenda.

7.1.4 Whole System approach

As explained in the general introduction to the present report, no progress in the efficiency of the railway transportation system can be made without a strong system approach to deal with all interfaces between the subsystems and between the railway system and the "outside world".

As far as the group of experts has been able to evaluate, there is a good system management at IP level (e.g. in IP4, of which the scope is transversal to all sub-systems and is not even only railway specific as it encompasses other modes of transportation). However the responses to the Internet questionnaire asking if the technical management of the 5 innovation programs works effectively as a coordinated system indicated that people would like to see some changes and improvements (16 responded that they either felt it did not or could be improved while 13 were satisfied although only one answered that it was definitely effective).

Participation by the experts as observers in a meeting of the System Integration Working Group (SIWG), gathering the JU program management, the IP and CCA steering committees and members of the SC, has showed a good (but very large!) team of railway engineers and projects managers discussing many and various medium term management issues.

In the expert's opinion there is a lack of railway system-wide competence at the JU management level (this is not a reflection on the management competence but technical expertise), which is not compensated by the existence of the SIWG. It is also noted that the SWIG is a large group to manage. It is composed of different types of specialists from the various IP steering committees, but just because it is made up of a lot of experts, does not automatically result in high railway system wide engineering expertise.

There is certainly a need to streamline and reinforce the overall technical management of the JU. The creation of the TIGER team for the revision of the MAAP can be seen as a first step in this direction but an audit of its membership (also very large for such an ad hoc group) by the Governing Board might be useful to determine its ability to ensure a real railway system management leadership.

The scientific committee also has concerns about its insufficient involvement generally and in particular in the MAAP revision. As already mentioned, a number of stakeholders answered to the Internet questionnaire that the JU is still functioning as a 'closed shop'[24]. Having the outcome of the work of the team reviewing the MAAP validated only at JU level will raise doubts about the legitimacy of the decisions. A wider stakeholder consultation would show that S2R has the intention to be inclusive[25] and be more representational of the whole railway sector, in line with S2R managing all rail research. The historic legacy of S2R as an exclusive 'club' is still prevalent despite efforts to the contrary so every opportunity should be taken to address this. As noted that in other informal interviews (such as with members of the Transport Advisory Group) scientific expertise despite being available is not always used.

It is worth mentioning here a possible future role for ERRAC. In other sectors, it has been shown that the ETPs can continue to play a useful role in providing JU with strategic guidance (e.g. in the aviation sector). The Advisory Council for Aeronautics Research in Europe (ACARE) is an advisory body to Clean Sky and in the past has assisted it to develop and maintain a Strategic Research Agenda (SRA. It has also played a role in helping to bring in SMEs[26] from EU Member States to take part in the JU led projects[27]. Experience from ACARE in its role could have been transferred to S2R. Its success was achieved after an initial period where it needed adapt its working processes and early on experienced similar challenges as those being experienced currently by S2R, in adapting its processes to find the most productive ways of working. Indeed the expert team noticed that there is a gap in the transfer of knowledge and experience in the management aspects (not content) of transport related JUs that could help new JUs to avoid pitfalls.

[24] It is difficult to estimate if this is a historical reaction or the present day reality as the experts are aware of significant efforts made by the JU management to address this.

[25] Positive steps have been taken by the JU management, who is engaged in a process of discussion of this revision of the MAAP with the representative organisations of the sector.

[26] Based on interview with ACARE previous Chair at CS1 final event.

[27] This observation is based on an interview with the ex ACARE chair.

It is therefore suggested that although the roles of the different bodies and the management structure may be clear, there are improvements to the actual implementation and processes themselves. This is more fully developed in the section with recommendations.

7.1.5 Coordination of stakeholders along the value chain and development of a vision on the medium and long term.

All in all, and despite a certain number of weaknesses (which the new management is seriously tackling) with the full deployment of the JU work program and the strengthening of its management team, the creation of the S2R JU will certainly contribute to a broader and better-coordinated participation of stakeholders along the full rail value chain. There are no doubts that compared to the previous situation, there is better continuity in project planning and, as a consequence, in the coordinated participation of all stakeholders.

The technical management of the JU is not able, nor is it its role to develop by itself a vision of the future of the European railways in a changing economical and societal environment. However there is a need to have a robust structure and processes in place to ensure that there is a broad and diverse approach to mid and long term visioning, or there is a risk that the IPs' results will be satisfactory but not future looking. The scientific committee inputs are currently limited to a purely reactive role and a suggestion is made to enlarge its membership to include non-railway specialists, to broaden its perspective and bring in new ideas.

Initial confusion coming from positions taken by some market actors has been resolved after discussion with the JU management: that S2R is in charge of managing railway focused collaborative European research, not of developing the strategic agenda for future railway research, neither to propose the scope of work for a possible S2R second phase.

ERRAC remains the European technology platform for rail, in charge of looking at the future of all rail research. Its membership has the potential to gather a larger spectrum of interested parties than that which S2R can do from its own membership or its present supporting committees. Furthermore, the Board of the JU, of which the members other than the Union are only the main industry participants in the present research program, has no legitimacy to supervise the development of any strategic research agenda for the future. Therefore there is a clear role for ERRAC in this context, but one that it is not well positioned to deliver currently. The absence of any organised connection with ERRAC remains one of the most surprising findings of this evaluation.

The JU itself will however of course contribute through its reports and remarks.

There would be therefore a need to re-organise and re-activate ERRAC and to establish strong links between it and the following S2R bodies:

- a strengthened and streamlined JU technical management group (i.e. more or less the so-called "TIGER Team" presently in charge of the MAAP revision;

- a scientific committee enlarged to other scientists than railway engineering specialists (economists, sociologists, geographers etc.);

- the States Representatives Group (SRG).

It is also suggested that the groups mentioned here above (TIGER, SC, SRG) might intervene so as to facilitate coherency and avoid redundant works. The Tiger group might be considered as the railway-engineering working party of ERRAC and the membership of the SC and SRG be aligned respectively with the one of the corresponding two permanent advisory groups (PAGs) of ERRAC.

The present chairman of ERRAC is a member of the S2R Governing Board and this membership, at least as an observer, might be institutionalised. However for the elaboration of the future European strategic agenda, which would *inter alia* serve as a basis for a possible S2R2 work plan, he should report to the ERRAC steering committee and plenary assembly.

This type of functioning has already de facto started in an embryonic form, with the revision of the MAAP of S2R going already beyond a simple revision of the technical program of the present JU (and incidentally the ERRAC chairman being a member of the TIGER group). The draft of the revised MAAP in its present state indeed starts with an in-depth analysis of the need for innovation in railways for the future and it will deliver the S2R vision of what might be European railways of the future. But this analysis, only conducted by the JU members, will quickly find its limits.

What the revision of the MAAP can deliver are obviously conclusions on the gaps to be filled in the present S2R program, noticeably concerning demonstration activities, which for the moment appear as not yet being clearly planned. For the steps to follow, including implementation of the results of the present program and their funding mechanisms, as well as possible extension of scope to innovation in other railway subsystems than the present ones (operations, communication, maintenance…), the findings of the analysis should be transferred to ERRAC.

7.1 6 Contractual arrangements between partners

The contractual arrangements between partners appear to be effective as far as it has been possible to appreciate by the group of evaluation experts. There has been no difficulty reported in terms of allocation of responsibilities between the JU members involved in the different IP and there is obviously a strong commitment of all members on the long term.

7.1.7 Transparency and communication to all interested parties

To assist in the transparency of the JU a communication strategy has been The S2R JU communication is designed to take a new approach to taking a "users first in mobility as a service" via a number of channels such as the Internet, newsletters, events and social media. Two main communication objectives are identified:

1. Raising S2R JU profile

2 Highlighting the Innovation Programmes technology potential and Project Results – Project Dissemination

The main target audience is been identified as:

- Scientific Community, i.e. Universities, Research Centres, etc.
- Other agencies (ERA, GSA, ESA, FCH, other JUs, etc.)
- European Rail Research Advisory Council (ERRAC)
- Other policy makers:
- International, EU level, Member States, regional and municipal authorities, councillors and scientific attachés of Permanent Representations to the EU
- International, European and National environmental & energy and mobility associations, NGOs, etc.
- General public, potential applicants and the media

S2R and its associated projects have websites as the main portal for communications. In addition, S2R has an active Twitter feed (mainly with tweets from the Executive Director) with 1.280 followers and at least one tweet on average a day.

It also has an international communications strategy, which includes attending a number of international events as speaker (at least 6 over the period of 2017) or as participant. Events include more research-focused events such as the Transport Research Arena (TRA) and major rail exhibitions (INNOTRANS).

Other outreach activities include collaboration with the S2R state Representative Groups and their national ministries. In 2017 several "regional info-days" were organised and hosted by different local ministries and this will be continued for the upcoming calls in 2018 as this experience has produced positive results in terms of increased knowledge about the JU and responses to the open calls. It can therefore be concluded that S2R is making good use of modern and tradition communication tools to outward facing and communicate clearly and frequently with interested parties.

All TJUs have set up a variety of dissemination tools and activities, ranging from demonstrators, scientific publications, event organizations, newsletters and the use of social media. S2R is no different – although it is not easy to obtain evidence it is the experts opinion that the communication and dissemination activities (such as they are currently) reaches out to its own community and to some extent the wider transport community. 50% of the EU stakeholder questionnaire respondents said the web site provided easy and effective access to the 'public'. It could be worth considering extending this to the general public especially rail users once the demonstration levels are reached. It is also noted that reporting on the amount of dissemination and the reach / impact of dissemination activities is not consistent across the TJUs.

7.2. Operational effectiveness

The emphasis put by the Commission White Paper on a Roadmap to a Single European Transport Area (2011) on the need to create a Single European Railway Area has been exposed in paragraph 3.1.1.

The S2R JU Master Plan sets therefore as one of the fundamental objective for the JU "To achieve the Single European Railway Area through the removal of remaining technical obstacles holding back the rail sector in terms of interoperability and through the transition to a more integrated, efficient and safe EU railway market, guaranteeing the proper interoperability of technical solutions".

The regulation on the European Union Agency for railways[28] (ERA) states in its article 2 that the objective of the Agency shall be: 'to contribute to the further development and effective functioning of a single European railway area without frontiers'. This is why the regulation establishing the S2R JU gives in its article 12 the remit to the ERA to propose possible amendments to the S2R Master Plan and to the annual work plans, in particular to ensure that research needs relating to the realisation of the Single European Railway Area are covered.

The close relationship between ERA and the S2R JU as exposed in paragraph 3.3.2 appears as being in continuity with its participation in the management of former FP7 projects (e.g. Trio-train projects) that were aiming at similar objectives. These objectives for contribution to the development of a Single European Railway Area are detailed IP per IP in the table of the paragraph 3.2.3 of the present report. They include improve standardisation, improved safety

[28] Regulation 2016/796 of the European Parliament and of the Council of 11 May 2016

and interoperability, closure of open points in TSI or developing methods for certification by simulation etc.

There is a widespread opinion among the stakeholders and the participants to the programme that the on going works will deliver these expected results in terms of construction of the SERA.

The stability of the organisation provided by the creation of the JU and the consecutive possibility of medium and long term planning is seen as a significant improvement as compared to the previous situation. It will, inter alia, allow for the continuous identification of the needs for standardisation of solutions for the closure of newly identified open points (the so-called "hidden open points"), all along the process of recurrent revision of TSI and elimination of redundant national technical rules.

A danger to avoid would be to forget the urban rail issues and in particular the need for seamless interfaces between main lines and urban systems from the point of view of infrastructures and control-command systems, as the SERA and therefore the scope of competence of the ERA does not encompass these urban transport systems. This has already been mentioned in paragraph 3.3.7.

7.2.1 Expected results and contribution of the lighthouse projects to the innovation programs of S2R

Four so-called "lighthouse" projects were launched before the formal creation of the JU, to anticipate the expected work topics of the S2R innovation programs. Although their contents were inspired by the JU preliminary strategic work-plan, these projects were subjects to calls launched by the EC under H2020 and they have all been granted to consortia independent from the JU. All four projects started operating in May 2015 and they are briefly described hereunder. Discussions took place after the JU received its financial autonomy in May 2016 to find ways in which these projects might be put under the JU management as foreseen by the JU. At the present time a solution to this has not been found as there are significant legal issues preventing the management to be transferred from the EC to the JU. Therefore it was decided that only a technical coordination by the JU could be considered. The focus of the evaluation on this aspect has thus been on the integration of the Lighthouse Projects in the S2R work programme.

In terms of budget, the Article 3 of the S2R JU regulation states that the maximum Union contribution to the S2R initiative would be 450 M€, of which a 398 M€ maximum contribution to the S2R JU and 52 M€ was earmarked under the Horizon 2020 Transport Work Programme 2014-2015. The so-called lighthouse projects to which this budget of 52 M€ has been granted are therefore explicitly part of the initiative, although they are managed independently from the S2R JU by DG MOVE and RTD. The projects therefore cannot be used to check the S2R JU's processes on the management of these projects but they are still considered very relevant for the evaluation of effectiveness and efficiency of the JU in terms of topic definition and cross project integration. Moreover, there is still some input from the JU on the technical coordination that can be examined in terms of collaboration between the projects technical leaders and the steering committees of the S2R IP. The main issue at stake is the extent to which the deliverables of these projects will contribute to the achievement of the S2R objectives.

In fact, given that the four projects have all passed their mid-term period (two of them will finish their work in 2017, the two others in April 2018), only collaboration between the projects technical leaders and the steering committees of the S2R IP can be reasonably considered. The main issue at stake is whether the deliveries of these projects will be able to contribute to the achievement of the S2R objectives. How this will occur will be very different from a project to another as can be found in the following section.

Roll2Rail (coordinated by UNIFE)- IP1

Duration 30 months (ends in October 2017), 31 partners, budget 16 M€

Roll2Rail is setting the foundation for many of the technologies that will be continued within Shift2Rail's IP1 (Cost-efficient and reliable trains, including high capacity trains and high-speed trains). Roll2Rail aims to develop key technologies that will overcome hurdles to innovation in rolling stock development and forms part of a longer-term strategy to revolutionise the rolling stock of the future.

In the case of Roll2Rail, all the members are members of IP1 and the technical leader is also the same (CAF). The scopes are also perfectly coherent. Due to this is therefore logical to consider that the R2R project and the technical operations of the IP1 started on one and the same date. A particular mention is to be made of the preparatory research topic on harmonisation of brake system requirements, which is seen as of significant importance for the creation of the SERA.

In2Rail (coordinated by Network Rail)-IP2/IP3

Duration: 36 months (ends in April 2018), 54 partners, budget 18 M€

In2rail sets the foundation for a resilient, consistent, cost-efficient, high capacity European rail network. In2Rail will feed into the Shift2Rail IP2 (Advanced Traffic Management & Control Systems) and IP3 (Cost Efficient and Reliable High Capacity Infrastructure) to deliver smart infrastructure, intelligent mobility management, and improved rail power supply and energy management.

The project is considered to be progressing well. The coordinator of the project is the same as the technical leader of IP3. It is therefore expected that this will ensure that there should be an effective transfer of results and the most significant contributions to the continued work in IP3. An added benefit within In2Rail is that a number of the Work Package leaders are also the elected Technology Demonstrator Leaders within S2R so this helps with continuity and transfer of knowledge.

There are however a number of non-S2R members in In2Rail consortium and there is a risk that some of the expertise could be lost at the end of project as these members will not be able to continue under the present structure. Network Rail (IP Leader) is looking to manage this risk through enlisting a number of these partners as Linked Third Parties within S2R projects. Another other option being considered is that a couple of partners would contribute to an Open Call consortia. A clear strategy will have to be elaborated by the JU management in this respect

IT2Rail (coordinated by UNIFE)-IP4

Duration: 30 months (ends in November 2017), 27 partners, budget 12 M€

IT2Rail is considered to be the first step towards the long term Shift2Rail IP4 (IT Solutions for Attractive Railway Services). IT2Rail will look to transform the European citizens' global travel interactions through the introduction of new technologies and solutions and a fully integrated and new seamless travel experience, giving them access to a complete multi-modal travel offer, which connects the first and last mile to long distance journeys.

IT2Rail has the same scope than IP4 and the same technical leader and therefore should constitute a good start for it. As with In2Rail there are the same potential difficulties with the transfer of results due to the fact that certain members are not the same, although the technical leader is the same (Thales). In the case of IT2Rail and due to the subject matter, the difficulties are amplified by the integrated character of the project, of which the results cannot be easily separated into packages.

Furthermore, a number of operators are members of IT2Rail, including Trenitalia and UITP, but they are not members of S2R and moreover there are no operator members in IP4 as the operator members of S2R (such as SNCB and DB) are not involved in IP4. This creates not only a possible problem of lack of continuity in the project, but also highlights the lack of operator input directly into IP4. The members of IP4 are essentially manufacturers or suppliers of IT solutions. This is probably the most typical example of a gap that should/could have been filled by the selection of AMs.

IT2Rail started in May 2015 whereas IP4 started in September 2016. For the moment IT2Rail continues on 100% of the common scope, and IP4 works to introduce constructive "bricks" in the system. It is still unclear how the JU will be able to compensate for this discontinuity in membership that could jeopardise the chances for IP4 outputs to get a good market uptake. It is perfectly clear that a project on ticketing and passenger information that does not involve any operator will encounter some problems of market uptake of the results. Here also an explicit strategy will have to be developed by the JU management in terms of issuing of open calls.

SMART-RAIL (coordinated by TNO)- IP5

Duration 36 months (ends in April 2018), 19 partners, budget 6 M€

SMART-Rail aims at improving rail freight services offered to shippers, focusing on five main aspects that are important to shippers, namely reliability, lead time, costs, flexibility and visibility. The project focuses on innovative solutions and their implementation in the rail freight sector by testing them in three Continuous Improvement Tracks, along certain specified rail corridors. The outcome of this project was expected to contribute to Shift2Rail IP5 (Technologies for Sustainable & Attractive European Rail Freight). (http://www.smartrail-project.eu/).

In this particular case, the processes of selection of the winning project and the process of selection of Associated Members of the JU lead to totally different results, with a Smart-Rail project and a S2R IP5 that have different scopes, programs and members!

The contacts are good but there will be little to be transferred and there is no way to compensate this disconnection through open calls. There is however a support provided by SMART-RAIL to IP5 in terms of business analytics and KPI.

7.2.2 Effectiveness of the calls

The effectiveness of the call for associate membership in attracting the best possible players in their field of competence has been discussed at length in preceding paragraphs of the present report and, despite some deficiencies that have been noted, the general composition of the JU membership is considered as satisfactory in terms of involvement of the best possible players in the railway sector. A few companies from other sectors with a high reputation in innovation are also members of the JU and participate in particular in IP1 or IP4. There was also widespread general agreement in the responses to the Internet questionnaire that the principle of annual calls was appropriate for a sound management of the programme on the medium term.

As already mentioned several times above, there is a widespread opinion in the railway sector that the JU will lead to better services to the stakeholders and addressees as compared to the alternative options. The Internet questionnaire also showed a good perception by the stakeholders of the services that will be provided by the JU. However there is also a general agreement that more needs to be done to attract the best talent in research to S2R, with only just over 20% feeing that the current system definitely attracted the best.

There is therefore an obvious need for the partnership to be widened on the occasion of the open calls and in particular try to attract expertise from other sectors than the railway industry.

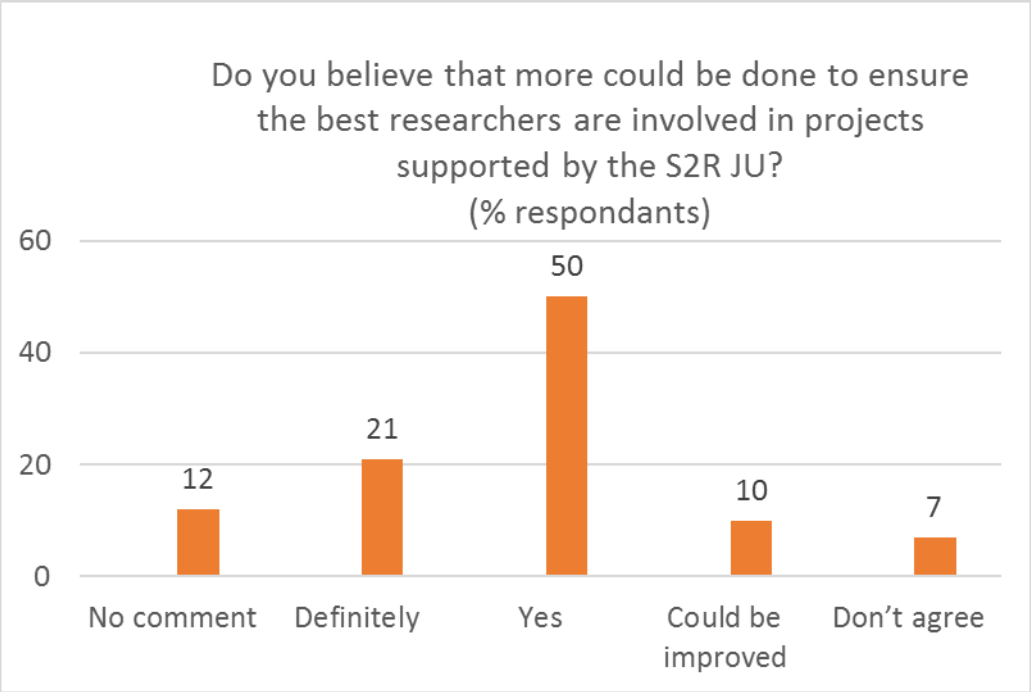


Figure 21: Responses from the stakeholder Internet questionnaire on attracting the best research talent to S2R

There is however a certain danger for the JU to be considered as a « closed shop », partly due to historical reasons that remain in peoples' minds. This is necessary to address and for progress and trust to be built up, especially via the processes for the selection of future innovation topics and new partners in view of a possible S2R-2. The Executive Director is also aware of the need to ensure transparency and openness.

It is too early to speak about the satisfaction of new beneficiaries participating in projects resulting from open calls and having only been launched in late 2016, the survey conducted by the Commission however shows a generally positive judgement.

7.2.3. Direct achievements

It is too early to evaluate any direct achievements of S2R, however the experts are able to confirm that S2R has helped to create continuity and shared common vision for rail research within the railway community. It is clear that this alone will help to deliver a more coordinated and seamless rail system. In addition it has helped to build trust between players that would otherwise not have the opportunity to share ideas and common interests outside a commercial situation.

Nonetheless, the rail supply industry is still highly fragmented as local suppliers have served many national rail operators for many years. S2R plays an important role in bringing these players together at European level, and thus aligning developments for achieving the Single European Rail Area. Its outputs should also reduce their costs and (by eliminating standards conflicts) speed up deployment (increasing interoperability). Although it is too early to evaluate any output from S2R itself, the evaluation of the progress of the lighthouse projects indicate that there is high levels of potential and overall the combined effect of lighthouse plus S2R outputs are in line with expectations.

There is universal agreement that there is a high level of interest in rail research and that this should be done collectively in order to deliver the European policy objectives. The expert group

found no dissenting voices on this aspect. Therefore it is correct to conclude that S2R is still highly relevant.

It is too early today to establish if the technologies will deliver but from the initial interviews (with project and IP coordinators) and responses to the questionnaire indications are that there is a strong belief that the expected achievements, as they had been defined by the JU promoters, will also constitute a strong basis for the reinforcement of the positions of the European industry against its worldwide competition.

However some gaps that have been identified might deserve corrective actions even within this current period. These gaps are seen as at least partly resulting from the technical structure of the programme based on the system components of the interoperability directive (see 3.2.1), without a complete telecommunication sub-system and not considering urban rail within the European rail system.

They include the absence, except for control-command purpose, of an innovation program on telecommunications, across all railway subsystems and applicable to the different transport mode[29]. At the moment several IPs are looking in particular for innovative solutions in radio communication (such as IP1, IP2, IP3), with a risk that different proprietary solutions may be developed in parallel (and those that are late to market run the risk of becoming obsolete before getting a chance of any market uptake[30]). A unified communication system based on novel IT solutions might be able to provide for the exchange of all necessary information at system level (notwithstanding differences between urban and main line information contents). In the interviews some examples were given where useful progress had been made between a large number of different rail players but that this work risked to be duplicated within S2R as different actors were involved. One very significant evolution of the external environment that is not being taken into account by S2R is the incredibly quick evolution of the Information Technologies and of the "Web Society" that might make obsolete any development of proprietary solutions by the railway sector actors even before they are implemented. It is difficult for those in rail to also be aware of the cutting edge developments in this fast moving sector without specialist players in the field. The current structures and processes are seen to be well adapted to the agility required in accepting new players.

In the same domain, there is serious concern over bandwidth issues, also been mentioned in particular by the urban rail operators[31] and by Member States representatives. There is a current fight in Europe for bandwidth and the fact that, in public transport, safety is largely dependant on voice transmission is not well taken into account from the point of view of urban operators. The experts would like to highlight the fact that two different EU DGs are also in charge (the ITS JU depends obviously from DG Connect), which further complicates matters. The Chinese example was mentioned by the urban operators as a path to follow, a specific band having been allocated to railways by the authorities.

The risk of seeing ATO solutions being developed on a strict ERTMS technology basis, with no sufficient attention being paid to the specific needs of urban operations. This fear has been expressed by UITP but does not seem to be shared by the manufacturing industry, nor by the ERA. This has been already quite a long story of misunderstanding between the main line and the urban "sub-sectors" and the absence of experts from urban rail operators in the IP2 working parties does not help. This point should absolutely be clarified by the JU with the support of UITP.

Some of the above are considered to be barriers to S2R being able to deliver on the European policy agenda and achieving interoperability in the widest understanding of the term, even

[29] A point that has been in particular highlighted by UNIFE/UNISIG.

[30] As it has already been the case with GSM-R for ERTMS

[31] UITP

beyond strictly regulatory interoperability. Urban rail is not in the scope of the Interoperability Directive, which in part is why urban rail players were not interested in the early days of developing S2R but their interest is now beginning to emerge as the scope of S2R widens.

However, stakeholders who are not members of the JU, who may have previously been reactive, are now starting to be pro-actively engaged. It is recognized that no major changes in membership or structure can be considered for this period of S2R but the internal architecture of a possible S2R-2 should be adapted to be able to include a more flexible approach to market changes and emerging research needs. The programme of S2R is largely frozen as members are chosen for the duration of the programme on the basis of their participation in IP's of which the content is described in full details by the Master Plan.

The approach of CleanSky2 in terms of membership could be considered as an example to follow, with members nominated for the duration of a particular project.

Despite these few identified weaknesses in the program, our interviews indicate that the Work Programme is still considered to be fully relevant within the present time-scale and budget. It is expected to strengthen in the future. The S2R JU, as a unique tool able to gather all the actors of the sector together in the same effort towards innovation, will certainly be a strong contributor to the Union's policy priorities. In particular, the contribution by the JU to the reduction of life cycle costs, increase of capacity, increase of reliability and punctuality, removal of technical obstacles to interoperability, reduction of negative externalities, should greatly contribute to the objectives set up in the White Paper for Transport.

7.2.3 Key Performance Indicators (KPIs)

Despite the attention of S2R to KPIs this is an area of some debate. Performance measurement of organisations has evolved substantially since the 1990s. Essentially developed for private companies, KPIs and the related dashboards, integrated views on performance and strategy maps have become of widespread use within projects, private and state-owned companies, as well as on the level of governments and their sub-departments. Even on the higher transnational EU level, for the transport domain as a whole, a so-called transport scorecard has been developed[32], including indicators, across transport modes, from both sources within and external to the EU institutions.

Analysing more specifically the S2R JUs approach to KPIs, based on its recent annual activity report (AAR 2016), and its mission and vision, we need to distinguish three levels of performance measurement.

The **micro-level**, which essentially entails various KPIs related to project management, budget execution, program-specific KPIs such as gender participation, SME participation, country breakdown, etc., specific to each JU. In this sphere, quite some standardization is already achieved given the need to comply with H2020 rules and definitions.

Based on the above AAR of the S2R JU, these tables with KPIs are formally mentioned as annexes, but are relatively sparsely populated with data (a lot of indicators remain N/A). There is little accompanying information in the AAR on why the majority of KPIs is not available (lack of data, lack of resources, lack of reliability) or simply not applicable. Clearly, some additional progress is to be achieved here to have a more evolutionary and easy-to-find view of the JUs performance relative to their core activities of formulating, evaluating and implementing Research and Innovation activities. Reporting of KPIs without an evolution has limited value, but this refinement will presumably become available as the JU develops its activities.

[32] https://ec.europa.eu/transport/facts-fundings/scoreboard/

The **meso-level** essentially refers to the sector or industry specific competitiveness of rail transport. All JUs formulate strategic objectives in their legal mission and vision on the enhancement of the competitiveness, for example, here of the EU rail transport (manufacturing/supply chain) industry. Given that an overarching objective of the JU is to improve competitiveness with the Far East competition, KPIs, including international / global benchmarks on the competitiveness of the respective industries, are relatively under-represented or absent all together.

As these industries (and the EU in general) are increasingly under pressure from a global competition point of view, and given the EU's strategy towards an industrial renaissance[33], it is advisable to start the development and implementation of KPIs which are able to monitor the global competitiveness of the EU versus the world (and/or major competitors such as e.g. China and the US) for the rail industry. Suggestions of KPIs are to be found in the context of e.g. number of patents, industry export intensities, size and growth of manufacturing industries, global market shares in exports, etc. Other KPIs might be deducted on a EU level (i.e. patents filed resulting from JU funded research versus the overall amount of patents filed relating to the air and rail transport supply chain / industry).

Therefore, we recommend to start a reflection across the TJUs on a limited number of KPIs relating to the global competitiveness of the concerned industries, and the contribution of the TJUs towards this important strategic objective (the other alternative is to remove this objective from the TJUs missions, as it is currently not measured or assessed in a meaningful way, and not linked to the overall EU industrial policy).

The **macro-level**, which consists of social, environmental and economic impacts of the programs conducted. Here, the JUs currently mainly rely on both ex-ante assessments through ad-hoc research, results from demonstrators. For these indicators, which are linked to the core objectives of the JUs themselves (reduction of environmental impacts of transport, improvement of resource efficiencies, economic impacts, etc.), the AAR shows different scope and detail. Another issue with macro-level indicators resides in the causality and scope of impacts, in particular when socio-economic impacts such as employment and gross added value contributions are concerned.

In the discussion of the 'multi-level' nature of KPIs, and the related causality issues towards the actual policy intervention, some other observations and considerations on the use of KPIs and the assessment of the TJUs performance can be put forward. The TJUs tend to keep a large distance when it comes to integrating, linking or contextualizing their performance vis-à-vis existing public reporting and data from their industry stakeholders. For example, an increasing amount of top-100 airlines produces annual sustainability reports, reporting historically on KPIs such as fuel efficiency, emissions and other resource consumption, both in absolute and relative terms (e.g. per passenger km or revenue passenger km). But for the railway sector, there are currently no 'institutionalised' approaches such as the Global Reporting Initiative(GRI)[34] (e.g. in terms of sectorial guidance) but based on desk research a number of railway undertakings have embraced GRI certified sustainability reporting, e.g. NS (Dutch Railways) and CrossRail (UK). Based on Internet research, many other examples publicly available are found around the world (Australia, US, Canada, Japan). Also, rail industry related trade associations might play an important role as partners to achieve those global benchmarks.

It appears that the reporting and discussion of KPIs, in particular based on dynamic evolutions, is not yet rooted within the AARs consulted. Furthermore, most KPIs are stated in absolute terms (reduction or increases in output parameters), but do not relate the outcome to the resources used to achieve the output (including the evolution). As enhancing resource efficiency

[33] Communication from the Commission to the European Parliament, the Council, the European economic and social committee and the Committee of the regions: For a European industrial renaissance (COM/2014/014 final)

[34] Global Reporting Initiative, 2011. Sustainability Reporting Guidelines & Airport Operators Sector Supplemment.

of transport systems is a major objective within all TJUs, we would recommend to re-assess the use of KPIs towards an increase in meaningfulness.

Given the existence of a transport scorecard on the EU level, linkages to and contributions to the indicator(s) development represented on this scorecard is advisable to provide even stronger links to the EU policy impact measurement, and highlight the JU contribution within it.

7.3 Operational efficiency of the S2R Joint Undertaking

Overall there have been many improvements in the S2R management processes but nonetheless frustration has been expressed by the JU members concerning the administrative burden. This is based on the discussions with the JU management as well as from interviews with representative bodies of the sector (UNIFE in particular) and with S2R participants (e.g. the S2R chairman). All identified this as a negative aspect of being part of the JU, and also saw that there were possible solutions.

The extent of administration was not foreseen by the JU original promoters, and although it is recognised that this comes from the application of H2020 rules there is a risk that too much time is allocated to this task, detracting from building continuity in the research programme and motivating the partners to actively participate. As the JU partners are still getting used to the requirements of being a partner for some this may part of a learning curve, however many partners have been involved with FP projects for many years and therefore we think that this is a valid point to bring to the attention of the Commission.

In the short term, some levels of simplification should be able to be achieved whilst conforming to the basic requirements of H2020 and not detract from the research objectives in hand.

'*Radically enhancing the attractiveness and competitiveness of the European railway system*' and ensure modal shift will require non-traditional rail players to join the S2R programmes.

From our discussions, the perception of the administration required to be either directly involved or as part of a consortia is seen to hamper attracting those from outside rail (but indirectly involved, such as GSM providers). It is the experts opinion that it will be vital to attract these players to broaden the experience and knowledge of the JU and deliver the multi-modal and seamless solutions that are in line with the European policy agenda.

It includes also the obligation to build consortia and submit detailed proposals for the evaluation by external independent experts, for projects submitted in response to calls to members. These projects have been identified as strategic to the objectives of the JU from the origin and their participating members, being FM or AM, have been from the origin selected for this purpose. This is the reason why, indeed, only one proposal per call has been received.

It is, of course, recognised that there is a need to build carefully the projects constituting the JU work plan and to have them evaluated, at least through an internal process, before being confirmed. The JU members generally believe however that a simpler procedure should be found so as to:

- shorten the present lead time, which is of about 18 month
- avoid the creation of unnecessary additional administrative layers, new management and support committees etc. that have presently to be created at the level of each new project.
- reduce generally the administrative burden of reporting by simplifying processes

Similar criticisms also apply to projects resulting from open calls. Even though the need for a careful independent evaluation is better recognised, the creation of specific independent

management organisations for each and every new project is seen as constitutive of a risk of dispersion of efforts and of these projects forgetting the essential objectives of the JU. The IT or ICT related projects in particular cannot wait for the result of projects in one call to be used in the next call. The time for innovation in IT is significantly shorter.

Specifically the following points were made in terms of the administrative burden:

i) Evaluation process

JU members complain about the numerous evaluations. From their perspective they have been selected either under the S2R regulation (founding members) or as a result of a competitive call (associate members). Their technical proposals have been evaluated by independent experts and they have had to commit to contribute up to the end of S2R, as part of their Membership Agreement. These commitments are therefore guaranteed.

However another administrative layer is added to this selection process, as the distribution of S2R grants is once again dependant on evaluation of technical proposals. The members must submit their proposals of how they will actively contribute to the JU to become a member, a full submission under H2020 rules for participating in joint projects at the occasion of each annual call, and then further submissions following a slightly different format and rules for their input into the projects which are reflected in the MAAP and approved by the Governing Board and the various Membership Agreements. Much of the information is duplicated but there is effort required to put it each time into the different submissions and this means that resources are used for this and not for the purposes of research.

Everyone is in agreement that the allocation of funds by S2R requires independent evaluation, but the process described above results in all work under the programme being evaluated three times: evaluation of technical proposals at the occasion of the selection of the members, evaluation of the proposals submitted in answer to calls to members, and then on the deliverables at the annual review.

ii) Unnecessary administrative expenses for the JU

The process of annual calls also creates an administrative cost for the JU, in terms of setting up, managing and closing more projects that it is necessary. For example, the JU has had to unnecessarily break down IP2 projects into a series (X2Rail-1, X2Rail-2, etc.). What is lacking in particular in the JU Regulation is the notion of "multi-annuality", i.e. the possibility of allocating the budget (but not necessarily to spend it) on a multi-annual basis. In more general terms, the obligation made to the JU to strictly follow the H2020 processes, coupled with the number of projects to follow (as of today already 36 + 4 lighthouses) creates a heavy administrative burden that is not entirely necessary and does not add any value or transparency. The JU management has to both organise project per project reporting and at the same time to ensure consistency of the S2R programme.

It also results in a stock piling of management layers at IP level (Steering committee, user requirement groups etc.) and at project level (technical management team, advisory groups of all sort etc.) each of which is resource intensive.

The JU management has made efforts to minimize the number of projects to partly alleviate this burden and encourages technical coordination and common communication efforts between them. But a streamlined management would be more efficient. For example instead of having a WP communication per project, as standard in H2020, having only one per IP (or even only one at the level of S2R) would free additional budget for more productive tasks.

iii) Double financial reporting

The JU has to generate two levels of financial reports. According to the H2020 regulation, projects are funded at 100% (or 70%) of the eligible costs, but according to the S2R Regulation, members must contribute to at least 55.56% of the total costs (of costs eligible under H2020 as well as those that are non-eligible under H2020). On the members side, it results into two different annual financial reporting being requested for the same activity; one at project level and another one (audited) as part of their JU membership. A simple way of simplification would be to give grants to the members at a modified and single rate (44,44%) based on their total costs.

iv) Proposals

The burden linked with the obligation to build fully-fledged proposals affects many SMEs, who may not have either previous experience in H2020 to draw or have little addition resources within their organisations to allocate to the administrative side of taking part in projects. In the past (or even today for a regular H2020 call) they would have most often simply brought their expertise to a consortium organised by a big player, or by a professional organisation such as UNIFE or UIC who would have done this task. As most of the major players are now founding members of the JU they are unable to assist in this fashion.

There is no discussion on the need for independent evaluation of the scientific value of the proposals or of the financial and technical ability of the companies to achieve what they propose, but in terms of pure consortia organisation simplified procedures could help considerably. A model might be proposed by the JU (management structure, IPR, dissemination etc.) that would both alleviate the burden for the applicants and allow for a simplification of the management by the JU itself.

More generally there are a number of ways of alleviating the burden put on both the members and the JU, by at least taking as a given the pre-existing agreements on technical and scientific contents of the members participation and through the use of standard consortium agreements allowing for an automatic alignment of individual project management structures, IPR issues, dissemination of results etc. with the pre-existing JU organisation.

7.4. EU Added Value

EU Added Value relates to changes that can be attributed to the EU intervention and the additional value resulting from establishing the JU. As previously mentioned S2R is still in its early stages of implementation so it is not possible to make any robust comparison on the financial leverage of the partners. The creation of the JU appears as an excellent way of promoting the EU policies for rail and also to promote the sector's leadership position.

A key aspect of Shift2Rail is that it should bring together the different actors of the railway sector value chain to work together with the objective of validating solutions that will contribute to a modal shift from road to rail through a system demonstrator approach. A number of other areas have already been mentioned as having directly benefited from the creation of the JU, that would otherwise not have happened such as reduced fragmentation of the market, shared common vision for rail, and building trust between sub-sectors, major players and SMEs. 73%[35] of the respondents from the EU stakeholder survey felt that the industry (along with other possible actors) would be able to overcome the barriers that hinder innovation in the sector without the involvement of the EU.

In addition due to the integral complexity of rail an added difficulty is that there is a high level of inter-dependence within the system so if one aspect may be improved the effect is not seen

[35] 27% strongly and 46.5% disagreed that this could be done without EU involvement.

across the system until **all** the relevant areas are upgraded. The extent and speed of uptake of research outputs therefore affects the value and impact of the system in non-lineal ways. This will also impact the leverage effect.

As the first S2R projects only became operational in September 2016. The expected leverage effect of the JU grants cannot therefore be calculated on the basis of project accounting[36]. We can only calculate some expected leverage effects based on commitments taken in the membership agreements and the already signed grant agreements.

The following figures have been taken into account for this calculation:

- IKOP: total presently minimum committed value of the in kind contribution of the JU members to the S2R JU programme, for the total duration of it, as per the presently signed[37] membership agreements. IKOP=334 M€

- IKAA: total presently committed value of the additional activities of the JU members, as per the signed membership agreements. IKAA=163 M€

- Total expected maximum S2R contribution to the same activities: 267 M€

The committed leverage effect for the members only activity for the whole duration of the programme, as per the already signed membership agreements is therefore of: (334+163)/267= 1,86.

It was impossible for the experts to make any relevant estimate of what is the leverage effect of the signed grant agreements under S2R. The first grant agreements were signed in September 2016, for a total value of 167.3 M€, co-funded at a level of 88 M€ (i.e. IKOP= 79,3 M€).

The JU members have declared to have spent 55 M€ in additional activities by the end of the first reporting year (2016). This value corresponds to activities that started before the allocation of the S2R grants and therefore cannot be used for the calculation of a leverage effect, as the scopes do not correspond.

From the discussions by the experts one aspect that appeared problematic was that even between partners and founding members there were a number of different ways that leverage is calculated and that this depended largely on the data that was collected internally as much as trying to follow a preferred EU process on how to calculate.

An indirect consequence of putting all European led research under the JU is the possible impact on national rail research. This was explored to some extent in the Internet questionnaire and the results can be seen in the table below:

	I fully agree	I agree	I partly agree	I do not agree	I am not able to comment
In your view has S2R increased national rail research investment	0	3	4	14	18

[36] At the end of April 2017, only 7,8 M€ worth of R&I activity had been declared by the JU members (additional activities excluded).

[37] There is a remaining budget for an additional activity worth 5.6 M€ by future new members.

In your view has S2R decreased national rail research investment	4	3	2	9	18
It has had little impact on national rail research investment	1	9	5	3	19

Table 3 Possible impact on national rail research

It should be noted that the majority of the respondents were not from the research sector so it is not clear if these results are really representative, but nonetheless it appears from interviews that the impact of S2R might have had a negative rather than positive impact on the level of rail research at national level in terms of funding levels. No details of any note were offered on this point. The situation is however probably extremely different from a country to another, depending on national funding mechanisms, national priority given to rail transport development or the existence or not of national structures dedicated to innovation in rail. The issue would therefore certainly need further investigation, including direct interview of the concerned national research organisations.

The experts suggest that this could be streamlined in line with the Annex note on KPIs and EU Added Value could also be recognised as a value of investment rather than a return on investment. This opinion is based on the positive and strong support that was received by us from both those taking part in the JU and those that are not and usually have more critical remarks about it. They all thought that there was great value in creating such a PPP and that the EU was the best institution to do this.

7.4 Coherence

Two aspects of coherence have been investigated in this evaluation. Firstly we assessed the internal coherence of the JU governance structure and management processes and evaluated if they comply with the requirements set out by the EU in an effective and efficient way. We also reviewed if the JU and its programmes are being managed in an open and transparent fashion and if they are consistent and coherent with a long-term strategic investment programme and the extent that this helps to overcome the fragmentation of R&I efforts. Secondly, we looked at external coherence considering how S2R interacts with other interventions under Horizon 2020, if it is coherent with the main H2020 programme and its contribution to the Union's transport policy goals. We briefly considered its relation with other Union funding programmes (e.g. structural funds, CEF, EFSI). In addition a reflection on how S2R positions EU research globally, especially in respect to the retaining the competitiveness of the European rail industry has been considered and this is further developed in the annexes.

7.4.1 Internal coherence

In accordance with Article 17 of the S2R Statutes, the JU is required to carry out its work plan through two mechanisms:

- Up to 70 % of the EU's financial contribution to the S2R Joint Undertaking will be implemented though financial support to S2R members, through appropriate measures such as the awarding of grants following calls for proposals, of which

- up to 40 % of the EU's financial contribution will be allocated to the founding members other than the EU and their affiliated entities;

- up to 30 % of the EU's financial contribution will be allocated to the associated members and their affiliated entities.

At least 30% of the EU's contribution to the S2R JU budget will be implemented by outsourcing tasks through competitive calls for proposals and calls for tenders for non-JU members. This is coherent with the other PPPs. In line with H2020 rules neither founding nor associate members are able to respond to open calls.

The activities of the S2R JU are identified in its strategic master plan (and multi-annual action plan MAAP). The five key "Innovation Programmes": cost-efficient and reliable trains, including High-Speed and high-capacity trains; advanced traffic management & control systems; cost-efficient and reliable high capacity infrastructure; IT Solutions for Attractive Railway Services; Technologies for Sustainable & Attractive European Freight are aligned with the policy objectives of S2R is expected to deliver. 50% of the respondents from the EU stakeholders survey stated that they considered other research and innovation areas not mentioned in the current Master plan and MAAP as being important to be addressed. It should be noted that since the time of the questionnaire the MAAP has been reviewed/updated and it is now under consultation. There was no detail of what areas were considered important, however in the interviews concerns were expressed that there was not enough attention given to some areas that can be considered rail focussed or inter-modal – the example of stations over interchanges was given – and that these tended to slip through both the S2R research agenda and the H2020 one.

As mentioned in earlier sections there has been an unforeseen side effect on the participation of SME due the adoption of H2020 rules. The initial intention was to grant SMEs direct and easier access to the programme and a facility to propose their innovative solutions but this also means that they need to invest time and resources in the preparation of responses to calls. Previously they could rely on the experience and support provided by larger organisations, but who are now members of S2R and therefore who are not able to provide this. It is felt that this is a barrier for some high potential SMEs to participate in the open calls and may also reduce the quality of the results of the calls, compromising innovation.

The S2R JU only became autonomous very recently and therefore it is not possible to properly evaluate the extent of the success of any outputs. The expectations are in line with the policy ambitions. 70% of the respondents from the EU stakeholder questionnaire stated that they felt it had been set up in a transparent manner. However, despite the setting up process being transparent, it is apparent that the current membership of the S2R JU does not cover all rail actors in a balanced fashion. Due to the origins of the JU, rail manufacturers are very well represented, but the presence of rail operators is not strong, with weak links with urban and intercity sectors. This is not considered to be a problem now but it should improve over time so the JU can better represent the whole system.

7.4.2 External coherence

EU interventions in respect of Europe's railways are based on two main policy instruments. On the one hand, legislative measures aimed at opening the European rail market and promoting interoperability (including rail safety and passenger rights), and on the other co-financing of new and upgrading rail infrastructure. Overall progress in the sector depends on making the most of the synergies between these instruments; for example, new cross border infrastructure should be built in such as way as to allow seamless travel between the two countries.

Regulatory European packages (SERA and interoperability) are not sufficient for the development of a strong and competitive European rail transport industry. The current rail infrastructure is not well adapted to cater for trans-European services. Due to historical reasons the European network is made up of a patchwork of national rail systems, most having been developed to meet national rather than international needs. There are also missing links between national rail networks (especially at cross-border locations), some bottlenecks on important axes and the general age of much of the infrastructure, rolling stock and systems

(with some exceptions of course) being a number of decades old, sometimes more than 60 years, and in need of replacement or upgrade.

The EU's Transport White Paper sets out 10 goals (across all transport sectors) to achieve a *"competitive and resource efficient transport system"*, with a central benchmark to achieve a 60% GHG emission reduction target. Those that concern rail are set out below.

1 Developing and deploying new and sustainable fuels and propulsion systems

- Reduce conventionally fuelled car transport, achieve CO2 free city logistics (indirectly associated with increasing rail modal share).

2 Optimising the performance of multi-modal logistic chains

- Modal shift of 30% of road freight on distances higher than 330 km to rail and water-borne by 2030 (50% by 2050)

3 Complete the HSR network by 2050, tripling the length

- Connect air core network to rail, preferably high speed

4 Increasing the efficiency of transport and infrastructure use through information systems and market based incentives

- Multi-modal information, management and payment systems

5 Making Europe a world leader in safety in all modes of transport and implement the user pays and polluter pays principles

Out of the 40 initiatives identified in the Transport White Paper, S2R is directly associated with:

- A true internal market for rail services (n° 1)
- Rail Safety (n°19)
- Multi-modal freight corridors (n° 35)

Research is seen as being a key enabler of achieving these goals via H2020. S2R was set up to help the rail sector achieve the European transport policy ambitions, as set out in the 2011 Transport White Paper (TWP) and other documents through world class research and these outputs should be delivered in line with the main H2020 programme. The JU objectives are perfectly coherent with these overarching EU Policy objectives, and it has been set up in line with the regulation and basic act. Processes (management of JU, open calls, reporting etc.) also follow the rules of H2020. The JU has been set up in a transparent fashion and there is no evidence to imagine that this will not continue to be the case.

S2R is not mentioned in the EU's 2011 White Paper as it was not yet in existence; rail is seen as a key enabler and the sector is also identified as a priority area within the Connecting European Facility (CEF)[38]. Therefore no direct links with the other funding facilities can yet be made although CEF mentions ERTMS, command and control management system, as part of the traffic managements systems required in all modes, and TEN-T rail projects devoted to the implementation of common technical standards to help make transport safer, cheaper, more reliable and "greener" and enable the integration of both high-speed and conventional rail lines and their related infrastructures and facilities. S2R outputs are likely to assist in making these

[38] https://ec.europa.eu/inea/en/connecting-europe-facility/cef-transport/projects-by-transport-mode/

realities but it is too early to be able to provide any evidence and at this point in time there is little evidence of the use of other financial instruments directly as an outcome of S2R.

Nonetheless, the set of Shift2Rail has been designed to contribute to addressing the challenges faced by the rail sector through a comprehensive and coordinated approach focusing on the needs of the rail system and of its users. Its priorities are:

- Achieving the Single European Railway Area (SERA) with the removal of remaining technical obstacles (interoperability) and through a transition to a more integrated, efficient and safe EU railway market, guaranteeing the proper interconnection of technical solutions.

- Radically enhancing the attractiveness and competitiveness of the European railway system to ensure a modal shift towards rail through a faster and cheaper transition to a more attractive, user-friendly (including for persons with reduced mobility), efficient, reliable, and sustainable European rail system.

- Help the European rail industry to retain and consolidate its leadership on the global market for rail products and services by ensuring that R&I activities and results can provide a competitive advantage to EU industries and stimulate and accelerate the market uptake of innovative technologies.

Shift2Rail publicly states (via its web site) that it will contribute to:

- Cutting the life-cycle cost of railway transport (i.e. costs of building, operating, maintaining, renewing and dismantling infrastructure and rolling stock) by as much as 50%;

- Doubling railway capacity;

- Increasing reliability and punctuality by as much as 50%.

Achieving the Single European Railway Area (SERA) relies heavily on the technical pillar of the 4th Railway Package (adopted in May 2016) and this will impact the sector with new processes for vehicle authorisation, safety certification and ERTMS trackside approval with ERA playing a defining role. The content of the S2R Master-plan, structured into 5 innovation programmes, has been highly influenced by the technical scope of the European legislation for railways and the technical pillar of the Fourth Railway Package. Therefore, S2R is well positioned with ERA, and the Master Plan is aligned to the technical objectives, so there is every reason to expect the research outputs being fully coherent with the requirements to deliver SERA in terms of standardisation.

S2R can contribute to achieving the main EU policy ambitions but alone it is not sufficient to deliver them, this is especially true in the short and medium-term, but it is an important instrument. 92% of the EU stakeholder survey agreed that the PPP (S2R), and by cooperating with 'industry', would bring better results to overcome the challenges of the rail sector in Europe than without this. 84% felt that S2R would contribute directly to achieving SERA, and again a large majority 84% felt that it would enhance the attractiveness and competitiveness of the European railway system (helping to ensure modal shift). As rail transport is expected to be the most efficient mass transport mode in the medium distance, modal shift should primarily take place as a result of support and development of rail transport, but this can only be measured in the future and it is encouraging to see that there are high expectations from those involved in S2R and others who firmly believe in the role of S2R in this.

In addition, the strong connection with the European regulations and standards for railways, which did not apply to urban operators, was in particular seen by them as a disincentive for urban rail operators to join the JU in the early stages. Despite the lack of urban players in S2R,

it is indisputable that the JU has helped to address the historical fragmentation of the market and has been instrumental in building greater trust and understanding between the manufacturing industry, operators and the research community. This is an on-going process and the experts are convinced that this will only improve.

Paradoxically, in some aspects of S2R strong adherence to H2020 rules have caused some constraints, for example the requirement to use H2020 IT solutions, which are not adapted to the needs of JUs. The issue of management of the S2R lighthouse projects is another example. The management of these 'precursor' projects was intended to be transferred to the JU but this has not proved to be possible due the H2020 rules. It can also be concluded that despite adhering to those rules in a coherent manner, the fact that these projects cannot be fully integrated into the JU has created unforeseen challenges in the continuity of the knowledge and research base. This may lead to a lack of continuity from the research outputs of the lighthouse projects under H2020, at this point it can only be considered as a risk, for these projects only. How S2R will deal with other aspects of multi-modal rail research from H2020 is not yet clear but the responses from the EU stakeholder survey showed positive expectations – 76% felt that the activities of S2R were coherent (somewhat or very) with other activities of the H2020 programme.

A point can also be made about a level of incoherence in some horizontal areas of work such as the use of GSM. Efficient rail communications will in the future rely more and more on digital exchanges – yet there is as yet little cooperation between DG MOVE, RTD and CONNECT so transport could benefit from the developments in this sector. The life and research cycles of information technologies is significantly shorter than most rail research so rail should probably benefit from expertise and research coming from outside its sector in order to avoid obsolescence in this area (which is not a core competence of rail).

In addition, in other parts of this report there is reference to freight and its lack of visibility within this version, and although this is perfectly acceptable now in the future freight should be better positioned within S2R. It is unlikely that this would be the choice of the current major players in S2R as freight is not seen as being a very dynamic sector, but it is precisely because of this that it needs to find a place in S2R or it will continue to be considered to be marginal. This notion is supported by the European Court of Auditors report on rail freight (2016)[39] which investigated the performance of rail freight transport in the EU since 2000, based on visits to five Member States – the Czech Republic, Germany, Spain, France and Poland – between mid-2014 and mid-2015. In the report, they state that the EU budget contributed approximately €28 billion to funding rail projects between 2007 and 2013, but despite this and the priority given by the Commission to shifting freight from road to rail, EU rail freight transport has not responded effectively to the competition presented by road and its performance overall remains unsatisfactory and rail freight's average share at EU level has actually declined slightly since 2011. Although this decline was not Europe wide and some Member States (such as Austria, Germany and Sweden) managed to achieve better results, it shows that without clear impetus it is unlikely that freight will deliver on its own. Within S2R the current thinking is that freight will benefit from a number of the IPs outputs from S2R, but in the future the JU should put more effort directly into freight (maybe in S2R-2). A second finding from the report notes that better maintenance would go a long way to improving the performance of rail.

It is also unknown what impact the "Brexit" negotiations may have on this JU (or any other with strong UK players). It is likely that others will step in to fill any gaps but this may not be as simple as it appears. Network Rail is both a founding member and an IP leader (and currently is also the Chair of ERRAC) therefore either the other founding members will need to both fill any financial shortcomings and provide the resources for filling the expert gap, or there may be a

[39] http://www.eca.europa.eu/en/Pages/NewsItem.aspx?nid=6970

need to bring one or other new/different player on board. As this is a complete unknown at this point, it is only pointed out as a risk.

8. CONCLUSIONS

The evaluation has analysed, assessed and draws the conclusions on the following aspects:

- the continued relevance of the S2R Joint Undertaking.
- if the (original) policy rationale underlying the S2R JU is still in line with today's challenges faced in its specific industrial area.
- the overall progress towards the objectives set in the Council Regulation establishing S2R JU.
- whether the public-private partnership is implemented in an open, transparent, effective and efficient way.
- whether the public-private partnership demonstrates EU added value and is generating the necessary leverage.
- that there is coherence between the S2R JU and the main H2020 programme;
- that there is an overall contribution of the transport JUs (combined) to the Union's transport policy goals.

In the following section the experts put forward our conclusions followed by some recommendations for improving the future implementation of S2R JU, taking into account the specific governance structure of this public-private partnership and the specific needs of rail.

During our investigations, the expert team has appreciated the open and frank interactions with the S2R management team, JU members and stakeholders. We have been uniformly impressed by their support and enthusiasm for the JU. In this respect we are unanimous in extending our own support and enthusiasm for the JU and our confidence that valuable contributions will be made to European Railway Research from its creation that would otherwise not have occurred. We are assured that the JU will help to promote increased mutual understanding and cooperation amongst the members and other stakeholders, and that it will generate outputs which will assist the development of EU Transport policy. We do however reiterate that because of the early stage of the life of the JU, there are currently no concrete research achievements on which we could form an opinion.

8.1 Relevance of the initiative and objectives

The JU and its objectives continue to be of relevance despite the fact that they were set down between 5 and 7 years ago. These are in line with the EU's general transport objectives and the challenges set out earlier in this report. This was validated in the interviews as well as the Internet survey. It has been created according to the legal framework and the agreed regulations and is currently being managed following this structure and requirements. However that said there is still room for improvement and adjustments in the period of implementation of this JUs term as well as areas that need more fundamental changes in a S2R–2.

There are some key areas that we would like to highlight in terms of a lack of flexibility in the current management structure(s). The management structure and processes are seen to be too rigid to allow new ideas to be introduced that may arise and a suggestion is made in the recommendations on this. The constraints for AM to take part in other areas such as open calls should also be rethought as presently this is seen to reduce rather than increase both innovation and the potential for leaders to contribute outside of their allocated position within an

IP. As the process for the appointment of AM was seen as somewhat flawed this goes hand in hand and is logical outcome.

However, it is important to recognise that current trends in transport are not yet aligned to the European policy goals set out earlier in the report, despite significant investments in infrastructure and services. The modal share of passenger rail has remained sensibly constant since 1995[40] and the modal share of rail freight in Europe has decreased in the past decade. Rail needs to become more attractive to the end user and these trends need to be reversed if the rail sector is going to remain competitive and fulfil the policy ambitions of Europe.

8.2 Implementation state of play of the S2R JU

Overall, we are pleased to conclude that public funds have been made assessable through transparent processes and competitive calls. Participation however is not even throughout the EU Member States, but this is through no fault of the management of the JU and there is still some way to go to fully be representative of the whole rail system. In addition, due in part to the nature of the market and the dominance of leaders in each sub-sector, there is a tendency for the larger players to guide the work leaving the smaller players somewhat dissatisfied. Care will need to be taken in order to address this in a sensitive fashion but it is entirely possible for the JU management to ensure that small and medium player find their correct place and feel that their voices are heard. It is after all often the case that SMEs bring in innovation rather than the more dominant players. In either case space for everyone should be ensured.

~~I~~It is apparent that there is a huge degree of difference in the situations of the railways in different countries, and therefore the medium and long-term objectives of different countries may vary and may indeed be at variance with overarching European single railway strategies. We also propose in our recommendations that there is an argument for the open-calls for non-members to form a larger proportion of the budget.

8.3 Effectiveness of implementation and main achievements

We are content that, in general, the JU has been formulated in accordance with its regulatory framework. The roles and responsibilities of the each of the bodies of the JU are clear and well defined, but it is too early to judge how well they will operate in the longer term. We have some reservations about the role played so far by the Scientific Committee.

We have identified no major issues with the channels of communication between the various bodies, which comprise the JU, although there are areas of improvement. While noting that the JU has been additionally tasked with managing all EU funded railway research, which initially it was not intended we feel that in order to discharge this task effectively, its membership should be more representative of the railway system as a whole and its role and remit with other European railway bodies, particularly in relation to ERRAC should be clarified.

The strategic vision and working programmes are coherent with the objectives of the JU and are considered to be relevant. They are expected to deliver the level of innovation and change in the rail sector that will contribute to achieving the SERA and enhance the competitiveness of the European rail sector. There is a focus on technical rather than societal or operational aspects in this period and it is thought that this is a correct approach but that these other aspects should be considered for any subsequent S2R-2.

The design and topics chosen for the first open calls attracted a good response, and the trends indicate that this will improve with time. It is desirable to attract a broad geographical representation of players and expertise. It is too early to fully evaluate if the balance between members-only and open calls is optimal.

[40] EU Transport in figures, 2016, Table 2.3.2

The number of major players from the private sector in S2R indicates that the outputs of the IPs and the experience from the demonstrator projects should result in a high level of market uptake. The experts noted that due to unforeseen complications the lighthouse projects have not been able to be seamlessly integrated in the JU and this may create some gaps (as different players may take these issues at a later date).

The creation of the JU has lead to an increased visibility of rail research and improved the coordination of many technical aspects. However there are some concerns on the multi-modal aspects. From a number of interviews concerns were expressed that having all rail research being 'organised' by the rail sector increased the exclusivity of rail and reduced opportunities for inter/multi-modal solutions and innovation. The rail sector seen from the outside is often perceived as being individualistic.

8.4. Operational efficiency of the S2R JU

S2R is still setting into its management processes. Whilst things have worked so far, and we have been impressed by the efficiency of the management personnel and their open and raid response to our queries, there are some areas we have identified which may improve matters in the future. The current management is seen as being effective and there is widespread support for the new Executive Director. The experts would also like to recognise that S2R will certainly benefit from his previous experience with SESAR and the running of the JU. This has already borne fruit with accelerating the management processes since his coming on board. He is also putting his full team in place and this should help to ensure that S2R fulfils its potential.

The experts also identified that some improvements are needed in the advisory roles and supporting bodies of the JU. This has been discussed in the section on ERRAC and ERA, and the fact that the scientific committee which is a useful resource appears to be underutilised currently. The Governing Board should shift towards playing a more strategic rather than administrative role and it is felt that advantages could be had if there were more (or at least some) non-rail voices in the bodies that are developing the future thinking of S2R.

Additionally there are some issues with communication between the IPs that also need to attention. The main risks identified by the expert team are some lack of continuity between the lighthouse projects and certain IPs work and also a lack of communication between the IPs currently. Although it is not felt that this poses any immediate problem but in the future and especially in terms of the demonstrators it will be important to maximise the full potential of the combined effects of the outputs from the IPs.

The management functions of the JU appear to be timely and well executed. There is no benchmark for time to grant, as there are few calls to base this on.

8.5. EU added value

Our discussions with the major players have indicated that the joint programme of cooperative research would not have happened without the creation of the JU. This is in itself a major added value and is seen to have significantly helped to improve fragmentation in the market.

The founding members are committed to 50/50 funding within the JU, but it is too early to say what addition leverage will flow from the work programme and therefore too early to carry out quantitative assessments. It is envisaged that much of the added value of the JU will be spread over the wide societal benefits that railway influence and, again, it is too early to estimate the magnitude of these benefits.

In addition the experts feel that there is potential for greater collaboration between transport JUs. It is felt for example that a number of pitfalls could have been either avoided or mitigated had there been more learning transferred from other more mature transport JUs. Most JUs face the similar issues, such as lower participation of SMEs, patchy coverage of member states with

a few more dominant countries, and having to engage with a wide variety of players with different interests etc. It is felt that there could have been more exchanges in these areas as well as the experience of managing large multi partner projects as part of a JU. The experts feel that there is missed potential and collaboration should be fostered between similar JUs. This would also boost exchanges of thinking as well as identify areas of common interest. In the past there were some calls issued by one of other JU that should have had some input from, for example S2R.

8.6. Coherence

While the objectives of the JU are perfectly coherent with the overarching EU Policy objectives, it is apparent that the current membership of the S2R JU does not cover all rail actors in a balanced fashion. Due to the origins of the JU, rail manufacturers are very well represented, and indeed dominate, but for example, the presence of rail operators is not strong, and the interactions between urban and intercity sectors could need to be better to fully represent the whole system. The outputs may therefore be limited to this rather skewed membership and this may limit the achievement of delivery of system wide research and the delivery across the range of EU policy objectives.

These relative weaknesses in the membership are linked with the fact that S2R is largely focussed on providing technical solutions, while many of the EU policy objectives require behaviour change. This is currently lacking in this JU – although it was never intended to include these aspects when it was designed, a second version should consider how to incorporate this more formally.

Another aspect that should be highlighted is that there is a lack of continuity due to the rigid nature of the structure. This was pointed out in a number of interviews, notably by UITP who gave the example of important technical outputs from a previous EU project that had been built by consensus but that were not being incorporated into work being done by S2R. There was no one from that project in the S2R IP, and more worryingly in the opinion of this major urban stakeholder, and partly shared by the experts a lack of the broad experience required for this topic available within S2R. This creates a risk for technical standards to be proposed that are not aligned with urban or possible regional requirements.

9. RECOMMENDATIONS

From this evaluation, it is clear that the creation of this JU on rail is widely supported and considered to be crucial for the delivering better quality, integrated and value for money research than would otherwise be the case. The expectations of the level of excellence and outputs of the JU are considered to be in line with estimations. The concept of S2R is fully supported by all stakeholders, and those that are currently involved are starting to build a sense of community. From the experts' observations from the two other transport JUs, which were part of this evaluation group, this is one of the main outcomes of the JUs. The more mature JUs, especially CS, have created a strong bond between players that would not have been able to be built up without the long-term investment of the JU. These JUs cannot be considered to be merely research or demonstrator programmes, but act as a catalyst not only for new ideas but also for new partnerships to be created. This has already been the case for S2R. Trust and partnership-spirit are difficult to monetise but can be considered as a value of investment rather than a return of investment.

Despite the strong support for the setting up of the S2R JU and its management, we have put together a number of suggestions in this report, which we think could would bring improvements both in this edition of S2R and provide guidance for a second edition, S2R-2. This section recapitulates the most significant ones followed by a more discursive and analytic section on strategy going forward in the context of the worldwide railway situation and a paper on the learning from the evaluation of all three transport JUs (Clean Sky 1 & 2, SESAR & SESAR 2020 and S2R).

9.1 Transfer of knowledge between transport JUs

In this respect, it is noted that there is little transfer of knowledge between transport JUs and this is considered to be an area where improvements could be made. There are many complementary aspects that could be usefully shared between JUs. The usual complaints of how to be more inclusive, getting SMEs on board, achieving good geographical balance, complicated management processes and reporting processes etc. are common to all transport JUs, however this learning was not really transferred despite S2R being largely based on Clean Sky. Indeed part of the success of the new Executive Director is because he has been able to use his previous experience from SESAR in this way. The experience of how others are able to comply with the regulations yet broaden the players and eco-system is another example. Compared to Clean Sky and in some respects SESAR, the number of players in S2R is still very small but this does not mean that they should remain so, and the learning of how others have managed this is considered to be useful. Another example is the Technology Evaluator, part of the Clean Sky JU that uses modelling to estimate the combined impact of the research from the JU with variable uptake values. S2R also has a technology evaluator, not exactly the same but with similar objectives. The same organisation (DLR) is responsible for both the Clean Sky and S2R ones, but currently it has not shared any experience or been asked to do so. Although one technology evaluator cannot be copied directly to another JU, the experience from Clean Sky could also be valid for S2R, where the effectiveness of an innovation strongly depends on its interaction with other parts of the subsystem.

There is a common problem with the IT tools across all JUs imposed by H2020 and this could be an area that a joint, rather than individually per JU, solution could be found. In short, there is a tendency for each JU to reinvent the wheel when there is already useful learning that can be used, not necessary to copy but to accelerate solutions and therefore increase efficient use of resources. The trick will be to make this process of exchange meaningful without being cumbersome.

The current joint JU meeting is not the right forum for this type of exchange and an annual or biannual meeting between like-minded JUs could be very productive and also create a better community where sharing may occur naturally. Currently this is not formalised and relies on personal contacts. We therefore recommend that the management of S2R investigates with others how knowledge can be transferred and incorporated into the future.

9.2 Improving the balance of the eco-system

The system wide balance of the actors in SR2 is currently rather poor. Ultimately it is important that both the research outputs and the demonstrators are relevant to a wide range of players and currently there are weak links with the operational side of both passenger and freight as well as gaps in urban rail players. Increasing the participation of a greater number of railway undertakings, increasing the presence of the urban sector and encouraging more Member States especially SMEs to be involved is recommended. Currently this can only be achieved through the open calls. This is considered to be a constraint to achieving excellence, as S2R members are not able to contribute substantively to research in any other IP or the open calls. This exclusion is a seen as a problem due to H2020 rules and the way the JU has been set up. A review of the framework for Associate Members to be able to participate in open calls is also recommended.

There is a lack of incentive, especially for non-traditional actors to take part in the open calls due to the administrative burden involved (perceived or real). Consortia members need to provide a lot of information that could be streamlined. We also recommend that the issues of administrative burden be examined by the Commission (it has been mentioned by a majority of those involved in this evaluation and employs time which could be more productively spent). Ideally simplification of processes, while retaining the integrity of the H2020 requirement could be developed that would be more attractive for rail and non-rail players to respond to the open calls. Currently there is no additional advantage of responding to a JU or H2020 call. This is seen as being attractive to SME participation and could result in increased innovation potential.

9.3 Addressing the societal aspects

S2R has been set up to address the technical aspects of part of the railway system. The current structure and the input of the lighthouse projects overall addresses these aspects well. Yet a number of the EU policy objectives are not uniquely based on technical aspects of the system but also include societal and inter-modal aspects in line with a holistic and integrated approach to seamless mobility. This is partly addressed in one IP but not yet included in S2R in any substantive fashion and we strongly recommend that a whole system approach be developed with more attention paid to societal aspects. There are a number of ways that this can be integrated into S2R, as well as included in a more formal way in S2R-2. For example, it is recommended that non-rail players with relevant experience and knowledge are able to help guide the future development of S2R and its bodies that advise it on visioning. Secondly, a greater use of the scientific committee and a broadening of its membership is also recommended. Thirdly better use generally of the advisory bodies to provide technical and strategic advice is recommended – although it is recognised that this may also come as the JU matures.

9.4 Visioning and outward looking

The current management is functioning well however it is difficult for the expert group to make any substantive recommendations as it has observed the impressive progress made in a short time since the Executive Director has taken up his position. Therefore, the we recommend in that care is taken in ensuring that there is good communication and outreach to those interested in rail but who are outside of S2R and possibly even outside the rail sector. For historical reasons, it is recognised that there is a legacy of mistrust from those that are not involved, which over time also needs to be dissipated.

The expert team observed that the longer-term strategic view of the railway research agenda is somewhat weak in the current structure. This might be improved by a more proactive scientific committee and by reform of ERRAC with a clear steer on its role as a strategic advisor to the commission and to the JU. Because the S2R JU has been charged with the management of all EU railway research, the question arises on who advises on the strategy? This role should be fulfilled by ERRAC, but it is not able to do this effectively at the current time and we therefore recommend that it be strengthened in budget and membership. We also recommend that it should be recognised as an observer on the S2R Governing Board and that its membership should not be a mere subset of S2R members. In addition, the Transport Advisory Group (TAG), which should advise the Commission on taking transport forward with H2020, is not involved in S2R. This is seen as a missed opportunity as there should be close integration between the H2020 and the S2R calls. Creating more inclusive processes for supporting a future orientated planning for S2R could go some way to addressing the perception of exclusion by some players.

9.5 Improving innovation and efficiency

Railways, like all transport modes, use innovations from everywhere and not only those developed in Europe. From a technical perspective one could argue that the only true independent railway research interest areas are at the interfaces which define the railway system: between the wheel and rail, the current collector of the pantograph and between the wayside and on board elements of the control-command and signalling systems. It is therefore essential that a close watch is made of useful developments elsewhere, a task probably best undertaken by "outsiders", as these potentially useful developments may come from, for example, the digital society, from materials science and from evolving societal demands. It is a recommendation that sufficient capabilities and budget are retained with the JU to conduct this outward looking search. It is noted that when it was decided that S2R would manage all rail research the budget from the initial JTI was not increased – this should be revisited in a second edition.

The recommendation for the creation of a transverse IP on IT and telecommunications could be an element of this strategy as well as creating an instrument that (as yet) unforeseen research or areas of interest could be incorporated into current research. The present structure for introducing research is extremely rigid in this respect and there is no space for new or innovative thinking to be included. As the technology cycles for rail are usually rather long this poses no immediate threat. But as new and different, non-traditional areas, such as telecommunications and IT based innovations take a more central role in railways service delivery, and where the development cycles are much shorter, there are risks of obsolescence and redundancy.

In building the current innovation program of S2R more attention has been put on passenger transportation rather than on freight (even though the 83 M€ budget of IP5 is significantly higher than what has been spent in railway freight focused research in the scope of any previous FP). While the European policy agenda also requires significant shift of freight from road to rail, IP5's programme was created after the constitution of the JU membership and its efficiency is partly jeopardised by a lack of continuity with the lighthouse project concerned. The quality of its outcomes will also depend on collaboration schemes to be built retroactively with other IP and JU members. It is recommended that the issues of concern to freight transportation are more pro actively addressed in a S2R-2 and that ERRAC and S2R jointly undertake a strategic investigation to prepare for this.

9.6 Review of performance metrics

Transport is a highly inter dependant and inter related sector, more so than many other industrial sectors. If one part of a journey does not connect or serve the customer properly the whole system does not deliver. Therefore by only viewing leverage in financial terms for transport does not provide the certainty that the higher levels of EU Added Value have been achieved. In our view we recommend that a number of the KPIs should also be reviewed.

The current set of KPIs are considered to be too many and in some respects inappropriate.

10. FURTHER REMARKS

In respect to developing a concept for S2R-2 the expert group would like to highlight some international trends of interest. Europe is not leading in the development of High Speed rail and this needs to be recognised. The density and length of systems in Asia (Japan, Korea and China) are much more extensive that those in Europe. The competition, from the Far East, to European manufacturers, arises mainly though the huge economies of scale enjoyed by the Far East manufacturers supporting huge domestic markets. If European manufacturers wish to defend their position, they need a clear strategic view on how this might be achieved. By competing on cost, reliability, quality, or innovation?

Therefore Europe should focus on high potential areas where it is currently leading. An example is that one of the key targets (objective) of S2R, that of doubling railway capacity, may merit review. If it were to be cast in doubling utilisation, it may be more appropriate. Indeed, the White Paper on Transport, calls for triple the length of the existing European HS network by 2030. Is this realistic? Again, from the White Paper, we note that coherence and relevance at the EU level is vital, but the railway situation across the EU is extremely variable and it is therefore difficult to bring the situation in all Member States into line. Much railway exists which is grossly under-utilised: some railway is extremely congested in some key parts. Very different actions are needed to produce an effective railway in these different circumstances: reducing inefficient route in some countries: removing bottlenecks in others. A blanket policy of doubling capacity does not address these different needs.

In passing we note that the environmental performance of railways depends critically on three factors, the first being the reduction in the use of fossil fuel by the railways, the second by the elimination of fossil fuels from the generation of electricity used by the railways and the third

being high passenger load factor on trains. It is for this reason that the tables 3&4 below are so important.

Innovation has become a prominent buzzword in recent years, but innovation is a continuous process. It is not the result of a management edict, go out and innovate, but more the result of the availability of well educated, motivated and free thinking people. We are disappointed that no emphasis is given to the increasing the human capacity and knowledge management through railway research: this is in stark contrast to the efforts being made by the Far Eastern railway organisations to place their people in top quality European education establishments. (One of the authors has direct experience of almost weekly applications of Chinese Government funding students applying to conduct research with him on high-speed rail topics).

Furthermore, we need to distinguish between research and innovation, even though they form a continuous spectrum. Universities should be principally concerned with research, industry with development: it is clear that most of the research being conducted by the JU will tend towards the development side of the spectrum, the Universities being mainly confined to open call projects. This reduces the opportunity of the Universities to do what they do best: that is, the development of ideas and people. As S2R is responsible for managing and to some extent guiding all European supported rail research they also have some responsibility for helping to create the new generation of rail researchers. As national research budgets shrink this is an area for future reflection, yet is it often at this level and/or with SMEs that innovative solutions are created.

Currently there is not place in the JU for TRL level 1/blue sky research which is often where universities are able to offer the most value in research, and there is certainly no place to consider 'failure'. Failure in research terms can sometimes bring the greatest value – by proving that a concept will actually not deliver what you thought it might, and in the process other unconsidered pathways may become apparent – and there is certainly no place for this thinking currently. As S2R now manages all rail research this should be considered in future editions. In view of the importance of these issues they are discussed further in Appendix 1.

In conclusion we would like to reiterate the wide support for this JU. Its creation was timely, the commitment of the members is evident and there are high expectations for its outputs. It is the opinion of the experts that a second version of S2R should be considered, partly because continuation is needed for the fruitful outcomes of this edition to become mainstream, but also because this evaluation has identified a number of improvements that would help increase the impact and value for money in terms of achieving the European policy targets.

10.1 Future strategy in the context of a world view of rail

In respect to developing a concept for S2R-2 the expert group would like to highlight some international trends of interest. Europe is not leading in the development of High Speed rail and this needs to be recognised. The density and length of systems in Asia (Japan, Korea and China) are much more extensive that those in Europe. The competition, from the Far East, to European manufacturers, arises mainly though the huge economies of scale enjoyed by the Far East manufacturers supporting huge domestic markets. If European manufacturers wish to defend their position, they need a clear strategic view on how this might be achieved. By competing on cost, reliability, quality, or innovation?

Therefore Europe should focus on high potential areas where it is currently leading. An example is that one of the key targets (objective) of S2R, that of doubling railway capacity, may merit review. If it were to be cast in doubling utilisation, it may be more appropriate. Indeed, the White Paper on Transport, calls for triple the length of the existing European HS network by 2030. Is this realistic? Again, from the White Paper, we note that coherence and relevance at the EU level is vital, but the railway situation across the EU is extremely variable and it is therefore difficult to bring the situation in all Member States into line. Much railway exists which is grossly under-utilised: some railway is extremely congested in some key parts. Very different

actions are needed to produce an effective railway in these different circumstances: reducing inefficient route in some countries: removing bottlenecks in others. A blanket policy of doubling capacity does not address these different needs.

	Route km	Pass km (m)	Route Utilisation*
EU 28	220000	428300	5.3
China	103100	1160500	30.8
Japan	27607	404400	40.1
JR East	7513	125534	45.8
Tokyu	105	10711	279.5
Tokaido HS	553	48873	242.1
UK	15775	53316	9.3
Germany	33707	77221	6.3
France	29841	84860	7.8
Italy	17037	50000	8.0
Bulgaria	4023	1700	1.2
Estonia	1510	300	0.5
Romania	10770	5000	1.3
*1,000 pass km/route km/day			

Table 3 Railway utilisation

(EU data from EU Transport in Figures 2016 excluding tram & metro Source: EU Transport pocket book 2016, and JR Tokai Annual report 2016)

It is worth reflecting on the huge variation of passenger utilisation of railways worldwide. The figure of merit we choose is passenger km/route km/day, a parameter well known internationally. For many years Japan has the country with most intense utilisation. Even now the mode share of the railways is nearly 30%, much higher than the western European figure of around 6-9%. But even in Japan usage is varied: the Tokaido Shinkansen achieves 242, some 6 times the average utilisation, similarly Tokyu Corporation private railway has a multiple of 7 times the national average. The average across the EU 28 is just 13% of Japan. China is rapidly approaching the high utilisation of Japan. Looking at the EU, the "big" players in the west achieve only 20% of the all Japan figure. Some of newer EU members have tiny route utilisation: in the case of Estonia only just over 1% of Japan's utilisation.

		Pass km	Route
	Route km	(m)	Utilisation
Japan	2765	89170	88.4
Korea	880	14885	46.3
Taiwan	350	9240	72.3
China	22000	254880	31.7
France	2142	52900	67.7
Germany	3038	24320	21.9
Spain	3100	11840	10.5
Italy	1350	12800	26.0

Table 4 High-speed route utilization (UIC 2014)

First, there is some ambiguity of definition of route: the Far Eastern HS trains run almost exclusively on dedicated track: France, Germany, Italy have some considerable length of route on conventional track, Spain almost exclusively on dedicated HS line. The figure for Japan is for a nearly completely developed HS system covering the whole county, and gives an average considerable lower than the first built Tokaido line of the previous table. As less frequented areas of the country have been reached the average utilisation has dropped. This is an easily anticipated conclusion. Note that only France, of the Western countries with a reasonably well-developed system, has a figure approaching Japan. Spain, with the largest system in Europe, has 8 times lower than Japan.

In the light of these figures, one of the key Targets (Objective) of S2R, that of doubling railway capacity, may merit review. If it were to be cast in doubling utilisation, it may be more appropriate. Indeed, the White Paper on Transport, calls for triple the length of the existing European HS network by 2030. Is this realistic? Again, from the White Paper, we read that coherence at the EU level is vital, but the railway situation across the EU is extremely variable, as is well illustrated by table 3 above. Much railway exists which is grossly under-utilised: some railway is extremely congested in some key parts. Very different actions are needed to produce an effective railway in these different circumstances: reducing inefficient route in some countries: removing bottlenecks in others. A blanket policy of doubling capacity does not address these different needs.

The competition, from the Far East, to European manufacturers, arises mainly though the huge economies of scale enjoyed by the Far East manufacturers supporting huge domestic markets. If European manufacturers wish to defend their position, they need a clear strategic view on how this might be achieved. By competing on cost, reliability, quality, or innovation?

10.2 Longer-term development of rail and S2R

Transport market development takes place against an increasing background of both short- and longer-term uncertainty with regard to technological, social and demographic factors. The TJUs in general seem to consider the externally developed scenario's (including longer-term forecasts) as a given when conducting their strategic planning, referring to objectives and outputs of higher-level planning groups within the industry. While transport demand has indeed shown longer-term growth in the last half century, we observe that major actors in the

transport industry are increasingly considering stagnation or even decreases of transport demand.

As a result, it is worthwhile to more closely monitor technological, economic, social and demographic evolutions. Examples include Virtual Reality, Ageing populations, Re- and Near shoring of economic activities, etc. as only some of major disruptors on the level of both passenger and cargo transport demand and the resulting needs for infrastructure, engines and vehicles, and traffic management systems. Another material element in this discussion is the potential conflict of both market and policy objectives, such as the objective regarding strong growth of High Speed Rail on mid-distances in Europe (potentially at the detriment of air travel). It appears that a more systems-based approach is required to fully capture these disruptors and challenge the TJUs strategies (under the form of master plans and programs) against more extreme scenarios, to make JU programs and strategies more robust in the mid- to long term.

The opening up of TJU management and boards to external directors/experts bringing in this expertise (even from a more global perspective, so not confined to the EU), including challenging the JU management on the strategy formulation and evaluation, is therefore recommended. This instead of the current, more 'closed' approach applied now where all the TJUs seem to be enclosed within their own ecosystem or 'silo', which increases the risk of groupthink when it comes to risk assessments (one respondent of the TE interview used the phrase *"always the same people"* to point out this risk and suggest it as an element to change in this particular context). Another suggestion would be to develop next to a 'Technology Evaluator', a 'Market Evaluator' particularly looking at these risks, including a more qualitative approach to market relevance, market risk and market acceptance, in particular when high-TRL research is conducted.

In conclusion the creation of the JU has been extremely positive in many respects and has helped to make significant strides in closing many gaps in previously fragmented rail research. It has also provided the private and public sectors with continuity and stability in where rail should prioritise its attentions. Nonetheless the expert group feel that there are some immediate actions that should be taken to improve a small number of key areas that are suboptimal within the term of this JU. It is also the experts recommendation to continue with a S2R–2 with a revised and expanded programme.

11. ANNEXES

Appendix 1 List of Interviews and meetings

date	Interview with	location	experts	h.mn	Minutes In CIRCA
18/01	UNIFE management	UNIFE Brussels	EF	2.30	Meeting with UNIFE 20170118
19/01	S2R management	JU offices	EF	2	Meeting with JU management 20170119
02/02	ERRAC chairman	London, Imperial college	EF/RS	3	Informal meeting
06/02	Lighthouse projects coordinators	UNIFE Brussels	EF/HeA	3	Interview IT2Rail coordinator 20170206 Interview Rol2Rail coordinator 20170206
22/02	D. Cadet (Alstom)	Phone interview	EF	2	Interview with D. Cadet 20170222
28/02	ERRAC chairman	JU offices	EF/HeA	2	Interview A Doherty 2017.02.28 V2.2 AD approved
28/02	UNISIG general manager	UNIFE	EF/HeA	1.30	INterview M. Vanlieffereinge 20170228_clean
15/03	SC member Nash	Phone	RS	1	Minutes interviews with SC members
20/03	SC member Iwanicki	Huddersfield	RS	2.5	Id°
29/03	UNIFE	UNIFE	EF/HeA/RS	2.30	Minutes of meeting with UNIFE V4 EF H
29/03	S2R system integration group	JU offices	EF/HeA/RS	2	Participation in the meeting as observers, no minutes
29/03	Member states committee chairman	JU offices	EF/HeA/RS	2	Position paper : Shift2Rail - comments and remarks_Miroslav Haltuf2
30/03	IP leaders	JU offices	EF/HeA/RS	4	meeting with IP leaders V2 2017.03.30
30/03	IP3 leader	id°	id°		position paper N. Allen, IP3
30/03	DG RTD and DG Move	DG Move	EF/HeA/RS	1.30	

31/03	UIC-CER	UIC Brussels	EF/HeA/RS	3	Minutes meeting UIC CER 31-03-17
31/03	UITP	UITP Brussels	EF/HeA/RS	1.30	meeting with UITP V2 2017.03.30
03/05	Mermec France SA, R&D director	Phone interview	HeA	1	Interview MERMEC
03/05	Strukton, S2R contact	JU offices	HeA	1	Interview Strukton
03/05	Michael Cramer, MEP	Brussels	HeA	1	Informal discussion
04/05	TIGER Team, Palacin	Phone	RAS	0.5	Informal discussion
04/05	Scientific Committee French Bombardier	Phone	RAS	0.5	Informal discussion
04/05	Scientific Committee Brennon RSSB	Phone	RAS	0.5	Informal discussion
05/05	ERA head of the ERTMS unit	Phone interview	EF	1	Interview Pio Guido 2017.05.05
05/05	Caroline Alméras - ECTRI	Phone interview	HeA	1	Informal discussion
05/05	Alan McKinnon - TAG	Phone interview	HeA	1	Informal discussion
21/05	Final interview with the JU management	JU offices	EF/RS	2	Informal discussion
21/05	ERA Executive Director and head of the research and strategy unit	DG MOVE	EF/RS	3	Informal discussion

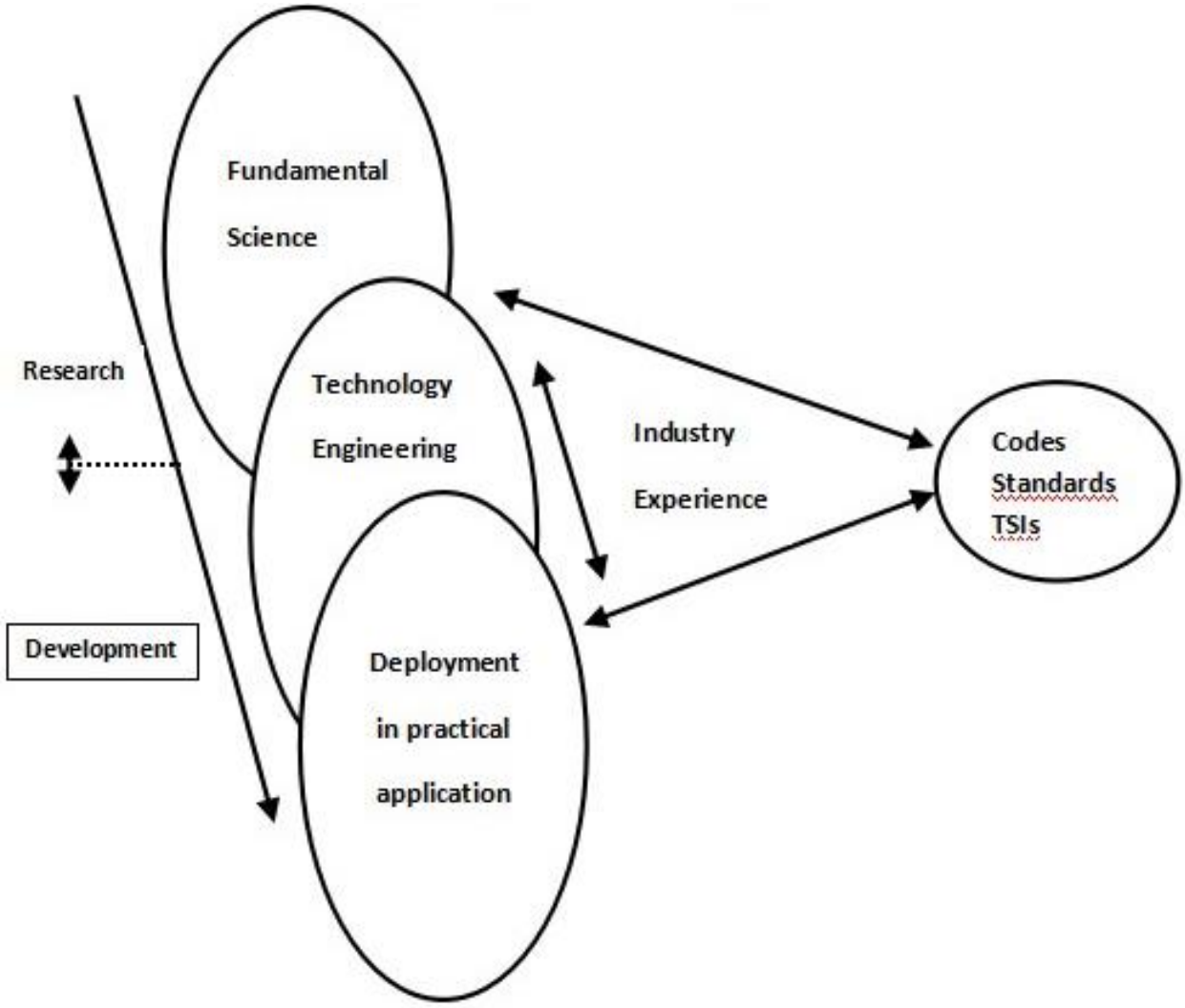
Appendix 2 Distinguishing features of research and development: reliance to railway research

The view of Roderick Smith, but supported by the other experts.

Research is what I'm doing when I don't know what I'm doing."

Wernher von Braun (1912-1977)

This figure below attempts to illustrate the main stages in converting fundamental scientific knowledge into applicable technology.

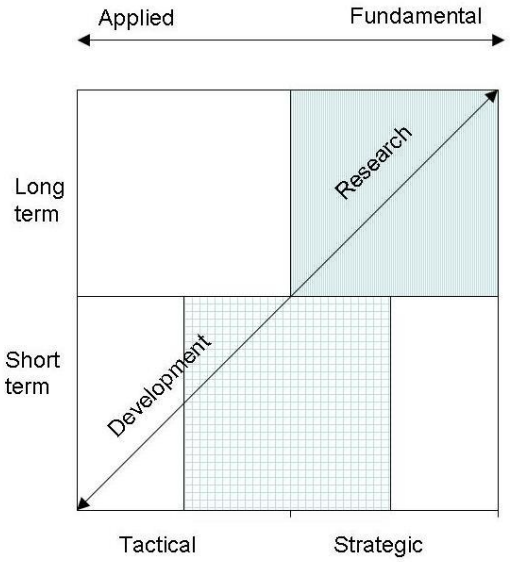


The original development of scientific knowledge is often carried out without any particular application in mind. As examples, early work on the laser could not have anticipated the myriad uses to which lasers are now put, the internet was not invented to sell tickets. Much of this detached scientific work is carried out in universities.

The ideas generated are sometimes, and often long after their original conception, subsequently taken up with a product or industrial application in mind: it is useful to call this stage technological development. Typically this stage will be in an industrial research laboratory, tested in field operations, and after several feedback loops, codified into applications, which will be capable of everyday application.

The above is, of course, a broad generalisation. The stages may overlap: in a rapidly developing high-tech industry[41] the overlap may be considerable. Fundamental work may be undertaken even in the production unit. In general the more established and mature the industry, the less the overlap in these three stages. The railway is a mature industry that operates today after 200 years of incremental improvement with the occasional introduction of step change. Very little fundamental research has been carried out by or for the railway industry. In general it adopts and develops ideas from outside. Only the areas that are unique to the railway, the interfaces between wheel and rail, current collector and power-line, train and control system, can be said to have generated fundamental scientific research for or in the industry. Everything else is a product of the development process over long time periods.

The spectrum of research and development can be considered in the context of short and long term, tactical and strategic. The matrix below is an attempt to illustrate the broad trends:



Long term strategic research (including speculative projects), might be considered to occupy the top right hand box of the spectrum matrix of research and development. Generalising, as the work becomes more tactical and sorter term, in is properly described as development, occupying the bottom left hand box. The terms applied and fundamental might also describe the spectrum from development to research. Long-term tactical research is hard to envisage and is probably an oxymoron, thus the top left hand box is not populated. However, it is possible to conceive of short-term work that is both tactical and strategic. We have placed this in the middle of the spectrum: short-term strategy can hardly occupy the extremes of fundamental research. On the other hand, short-term tactical work may be useful. But it clearly lies within the development end of the spectrum. Research is properly defined by an enquiring, experimental approach with uncertain tangible outcomes, other than the important one of people development. Development can be defined by milestones to anticipated outputs: only rarely does it concern itself with people training. Of course, practically, we frequently need to operate somewhere between these extremes. To a large degree economic pressures have tended to favour shorter-term development projects with the need to identify tangible milestones at the proposal stage, and in the final review stage, by making a quality judgement on "usefulness" as the readiness for immediate take up or deployment by industry. Thus the judgement of the utility of the project has to an extent become more important than the quality of the researcher(s) submitting the proposal or the quality of the scientific relevance.

[41] In the railway domain, the term industry is sometimes used to mean the just the manufacturing segment. In the context above it is used to mean the whole sector.

In an industry such as the railways, the research department acts as the *handshake* between the fundamental science and the application. Its close links with the rail industry are vital to its success, as are the concentrations of minds in one location and the interchange of personnel between the research centre and the industry. It could be argued that this is a primary reason for retaining a research function. In many of the relatively recently privatised (liberalised?) national industries, the research function has been almost entirely dropped, presuming that if research is needed it can be bought out from external consultants. For example, the list of the national laboratories in the UK which have closed includes the Central Electricity Generating Board CEGB, British Gas[42], British Rail, the Atomic Energy Authority, National Engineering Laboratory, Royal Aircraft Establishment, and so on. The situation across most of Europe is very similar, with in the particular case of the rail industry, an overall decrease, if not disappearance of research functions in the national operating companies. This decrease is far from having been fully compensated by research performed within the railway manufacturing industry, given the narrow operating margins.

This short sighted, short term, economically driven policy has led to a weakening of the expertise, lack of opportunities for science and technology graduates, reduction in interest in studying for engineering PhDs and, directly for the industries concerned, a loss of knowledge of what is happening in a fundamental way on the world stage, a loss of informed buyer knowledge and a general decline in European industrial know-how.

Increasingly this has led to a loss of "internal" expertise. The aftermath of the Hatfield accident of 2000 in the UK, an accident caused by a broken rail, is a salutary case study for the railway industry. In the 1960's, British Rail opened a national research centre in Derby. By the 1970's these laboratories had developed a world-class reputation and carried out ground braking research into topics such as vehicle dynamics, wheel/rail interactions and solid-state interlocking signalling systems. Papers were published in international journals, presentations were made at international conferences, the reputation of British railway know-how had a reputation second to none. But all this was closed on privatisation of the industry and after Hatfield no immediate internal technical was available to the infrastructure managers, Railtrack. Expensive external experts were contracted: consultants who had a vested interest in milking the system for as long as possible for huge fees. Much of the rail network was subjected to speed restriction, which caused huge difficulties and complete loss of the timetable for several weeks and left a long difficult aftermath, which took several years to overcome. None of this would have been necessary had the expertise of an internal research team been available to Railtrack and the cost of maintaining this expertise would have been hugely less than that of the advice brought in after the accident.

Discussions with financial people, who in many cases manage industry, bring no comfort to the case for strengthening industry based research teams. The assumption is that the research team exists to produce daily "inventions" which improve the bottom line. But of course, research has a wider role. It provides information on the activities of similar organisations worldwide, it provides a conduit for seeking opportunistic application of developments elsewhere, it provides an informed buying capability for the host company and, importantly, it provides in-house technical opinion when things go wrong.

The purpose of this note is to promote debate about the possible ways of both continuing and funding railway research and development. It has become clear that a fragmented privatised railway has not been given sufficient or indeed appropriate research support by its suppliers, who in many cases are too small, but are also unable to take a system wide view of the problems of the railway[43]. Much of the work they do is short-term development, aimed at

[42] The author's career benefited from the presence of the national research laboratories. He was a Gas Council Research Scholar for a PhD at Cambridge, he spent the first 6 months in the CEGB Berkeley Nuclear Laboratory and over the next decades until their demise had close and fruitful contacts with all the laboratories in this list.

[43] That this is a Europe wide phenomenon is evidenced by the paucity of technical papers related to fundamental railway science published in leading journals and presented at major international conferences. That many such quality publications are emanating from the Far East underlines the challenges to which European railway research is

improving the balance sheet tomorrow: and this is a natural response of private industry with impatient shareholders to satisfy.

It is, of course, a major purpose of publicly funded research programmes to fill this gap. It is therefore important that such programmes are able to provide a system wide view of the industry to which they are aimed. It is also important that the output of technically trained people is recognised as a potentially valuable output. It is important that the IP generated is public property and that the research or development advances paid for by public funds are reported and recorded in open access quality journals and that this valuable part of the output is recognised as a achievement or kpi.

Whilst it is recognised that development work may well be the property of a company sponsoring the work, then for this reason it may be inappropriate for such work to form part of publicly funded research and development.

Finally, the beneficial concentration effect grouping researchers to form the critical mass, which is so important for research interactions, might be considered. Although integration of Europe is to some extent served by assembling teams of researchers to work remotely from each other, might it not be even better and more efficient served to assemble teams under one roof, or at least to create the appropriate organisation for permanent coordination between existing establishments, the role of which would be augmented and widened. The current buzzword innovation might well be better served by a research centre (or centres) having the expertise to scan the literature and search the outside world for emerging technical breakthroughs, which can be adopted and adapted for the railway industries' needs.

There is a excellent example in Japan where the research centre of the Japanese National Railway was retained on the privatisation of the system[44] and funded partly by a levy on all rail tickets sold for research programme and partly by contacts with various players in the railway system to fund what is largely development work. This national centre has flourished in the 25 years since privatisation and development a world reputation for quality. It coexists with research centres developed by the players in the railway who wish to conduct their own R&D, and the IP generated.

exposed. Both SNCF and DB have retained research capability. The the case of DB its website states *DB Group does not conduct its own research and development in the strict sense. However, the division initiates end-user-oriented development based on technical competence and operator experience.*. Neither company would claim to conduct the comprehensive fundamental research such as that conducted by RTRI.

[44] The Railway Technical Research Institute in Tokyo is probably the largest such institute in the world. It certainly has the best reputation, although China is rapidly catching up. http://www.rtri.or.jp/eng/

Annex 3. Profiles of the respondents to the internet survey organised by the Expert Group

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