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Societal effects – Planning

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1 Executive summary

The railway can contribute to deliver societal effects, but one needs to know what the relevant effects are and how they interact in order to decide on the best investments and changes in the railway (and in the overall transport) system. The plan for assessing the societal effects of Shift2Rail targets and activities is described in this deliverable. Specifically, the plan considers two tasks that will investigate the impacts on the societal objectives that the Shift2Rail programme has defined, and assess which are the realistic expectations of what future railway systems will deliver and how trends affect these expectations.

One task is to perform a socio-economic impact assessment of the key targets stated in the strategic Masterplan: i) a 50% reduction of the life-cycle cost, (ii) a 100% capacity increase, (iii) a 50% increase in the reliability and punctuality and (iv) an increase in the attractiveness of railway services. This socio-economic impact assessment will investigate how the fulfilment of the key targets contributes to the achievement of the societal objectives stated in the Multi-Annual Action Plan (MAAP, Shift2Rail, 2015, p. 724): Greening of society; Competitiveness and sustainability; Smart inclusive growth; Liveable smart cities; Regional integration and enlargement to reach critical mass (labour markets, health care, and education); and Attractive, connected, and accessible regions. This socio-economic impact assessment will use output from the transport model used in Work Package 3; analysing how a modal shift translates into reduced noise and CO_2 emissions, increased accessibility, increased economic growth etc., which in turn will contribute to the societal objectives stated in the Multi-Annual Action Plan.

The other task will analyse the societal effects that are not included in the mode choice analysis for the different System Platform Demonstrators in Work Package 3 that corresponds to four different rail market segments: high-speed passenger rail, regional passenger rail, urban/suburban passenger rail and rail freight. Specifically, this task will analyse how the key targets will impact the accessibility and transport behaviour, which in turn will impact on the societal objectives and needs for the railway that are stated in the Multi-Annual Action Plan. Now, the System Platform Demonstrators in Work Package 3 can predict for instance how ticket prices will impact competitiveness of rail services and thereby the mode choice and trip frequency. However, Work Package 3 will not be able to analyse how a 50% reduction of the life-cycle cost will impact ticket prices, as this is something that is dependent on the institutional setting and degree of competition within and between the different modes of transport. Likewise, it will not be possible to directly translate a 100% capacity increase to a corresponding increase in the supply of rail services, because this might impact the generalized cost of rail transport in many different ways (it might impact the number of rail travellers, the reliability of the travel time of the rail services). In general, to be able to implement the effect of the key targets in the transport model in Work Package 3, one needs to better understand how the key targets impact the generalized transport cost.

To undertake our second task, we will develop a model of a transport corridor in which the equilibrium depends on the regulation and organization of the railway market and the completeness of the different modes. Specifically, this model will include the demand and the supply side of rail transport, such that equilibria for different market conditions can be found. This will differ by country and the System Platform Demonstrators.

The key targets in the strategic Masterplan also interact with each other, as do societal objectives, and the intuition is not clear on what the results of these interactions will be. The planned method of assessment will allow for an analysis of the interactions between these effects and thus contribute to a better understanding of the societal effects.

Specifically, the main methods for operationalising the assessment of the societal effects are: 1) desktop research through reading and synthesising previous research and other relevant work, 2) expert interviews, and 3) the creation of a model that can analyse effects not directly considered or analysed in the mode choice analysis in Work Package 3.

2 Abbreviations and acronyms

Abbreviation / Acronyms	Description
CO_2	Carbon dioxide
CS	Consumer Surplus
EU	European Union
LCC	Life-Cycle Costs
MAAP	Multi-Annual Action Plan
MaaS	Mobility as a Service
PS	Producer Surplus
R&I	Research and Innovation
S2R	Shift2Rail
SEIA	Socio-Economic Impact Assessment
SPD	System Platform Demonstrator
TAG	Transport Analysis Guidance
UK	United Kingdom
VAT	Value Added Tax
WP	Work Package

3 Background

This deliverable is the product of Task 2.5 in the IMPACT-1 project within the Shift2Rail (S2R) programme. Specifically, the role of this deliverable is to outline a plan for how to assess the socio-economic impacts of S2R outputs and what type of methodology is suitable for this assessment.

Following the strategic Master Plan of S2R, the general objectives of the S2R programme are to "*achieve the single European railway area*", to "*radically enhance the attractiveness and competitiveness*" of European rail, and to make the European railway industry "*retain and consolidate its leadership on the global market*" (Shift2Rail, 2015a). To achieve this, the programme has defined the specific objectives to improve services and customer quality, reduce system costs, enhance interoperability, and simplify business processes (Shift2Rail, 2015a) [7]. These specific objectives can be further decomposed into four key targets of the S2R programme, as defined in the Master Plan (Shift2Rail, 2015a, ss. 13-14):

1. 100% capacity increase
2. 50% reduction in life-cycle costs (LCC)
3. 50% increase in reliability and punctuality
4. Improve the attractiveness of railway services

The objectives and targets are all intended to contribute to the societal objectives and needs of the S2R programme (Shift2Rail, 2015b, s. 724; Shift2Rail, 2015c) [8, 9]:

- Greening of the society
- Smart inclusive growth
- Regional integration and enlargement for critical mass
- Competitiveness and sustainability
- Sustainable Seamless door to door mobility solutions
- Liveable smart cities
- Attractive, connected and accessible regions
- Land use and spatial planning

4 Objective/Aim

The aim of this deliverable is to start up and deign activities for the assessment of societal effects of the S2R key targets as stated in the strategic Masterplan: i) a 50% reduction of the life-cycle cost, (ii) a 100% capacity increase, (iii) a 50% increase in the reliability and punctuality and (iv) an increase in the attractiveness of railway services. The main analysis will be undertaken in IMPACT2, but we start to develop the methodology and formation of the problem in this deliverable. Hence, the main purpose of this deliverable is to lay out a point of departure for the analysis to be undertaken in the upcoming Tasks 2.2 and 2.3 in IMPACT-2, and to describe the methodology that we have started to develop for that analysis.

The socio-economic impact assessment (SEIA) and the assessment of how the achievement of the key target can help contribute to the societal objectives and needs stated in the S2R programme (Shift2Rail, 2015b, s. 724; Shift2Rail, 2015c) are dependent on the mode-choice analysis to be carried out within Work Package 3 (WP3) for each of the four System Platform Demonstrators (SPDs) that corresponds to four different rail market segments: high-speed passenger rail, regional passenger rail, urban/suburban passenger rail and rail freight. The mode-choice analysis in WP3 can predict how changes in the generalized travel cost will impact behaviour and the choices of travellers and carriers, in terms of trip frequency and mode choice within the SPDs. Here it can be noted that the generalized travel cost is often defined in terms of $c = p + \alpha t + \beta * S/n$, where p is the monetary cost of the journey, S/n is the average waiting time, and α and β are monetary values of travel time and waiting time (t). The generalized travel cost can also include other variables that have an impact on travel choice.

However, WP3's models will primarily give results on modal shift, while the resulting societal effects are left out. The main aim of Task 2.3 in IMPACT 2 is therefore to use the output from WP3 in terms of impact on trip frequency and modal choice and quantitatively assess the impact of the societal effects as described in Task 2.3 of IMPACT 1. Task 2.3 also includes an identification of the potential effects that cannot be assessed from the output of WP3. Still, a main issue is that all of the S2R key targets described above will not directly impact the generalized transport cost. For instance, reduced life-cycle cost does not directly impact ticket prices, which is an important part of the generalized travel cost. The main aim of Task 2.2 in IMPACT2 is therefore to develop a methodology that translates the key targets to impacts on the generalized transport cost. Specifically, it is necessary to show how the key target impact this cost to be able to implement the S2R's key target in the model developed in WP3, which in turn is needed to assess the societal objectives and needs of the S2R programme.

Societal effect is indeed a very wide term and is not defined more narrowly in either of the Multi-Annual Action Plan (MAAP), the strategic Master Plan or the Grant Agreements of IMPACT-1 or IMPACT-2. It can range from individual to group perspective, from personal to corporate levels, and to incorporate effects relating to economic, social, political, and environmental perspectives. Hence, neither this deliverable, nor the deliverables of Tasks 2.2 and 2.3 in IMPACT-2, can or will cover all impacts on the societal effects. However, this deliverable lays out the plan of how to assess and operationalize the key socio-economic impacts of the SPDs.

5 Operationalization of the assessment

The SEIA framework has been used to lay out a plan for assessing the potential societal effects of the S2R activities and for operationalizing the measurement of the key targets and objectives (greening of society, smart inclusive growth, etc.). The SEIA according to the main components of the innovations developed in S2R will be done by using the state of practice methods of the transport investment appraisal tools used in many European countries. These methods include assessments and operationalize the quantitative measurement of targets such as greening of society and labour market effects (including wages and unemployment) due to changes in transportation. Hence, the impact assessment depends on the results of the transport model forecasts of travel behaviour. Moreover, the socio-economic impact of the S2R activities (decomposed into four key targets of the S2R programme, as defined in the strategic Master Plan) will depend on how the track capacity is used (i.e. the time tables) and the passenger volumes (depending on the time tables and fares). For this reason, the socio-economic impact of the S2R activities will inevitably depend on the organization of the rail market (i.e. the regulation or deregulation of the rail market).

The SEIA plan is described in the following sections: Section 6 provides an overview of the plan, Section 7 presents the plan for the base SEIA for task 2.3 in IMPACT-2 (describing the operationalisation of the measurement of the key targets), and Section 8 presents the plan for the work to be carried out in task 2.2. in IMPACT-2.

6 Plan for the SEIA of Shift2Rail activities

The overall aim of the SEIA is to analyse the desired versus probable effects the rail sector has on society, what effects the fulfilled S2R key targets have on the societal objectives, as well as what effects are not accounted for when analysing the SPDs. Deliverable 2.3 (Societal building by rail services) summarised and defined these societal objectives and much of the discussion in this section relates to that deliverable.

The plan for SEIA that is outlined and described in this section covers the work that will be carried out in Task 2.2 and in Task 2.3 in IMPACT-2. The first part of the SEIA (Task 2.2) will focus on the link between the key targets and the improvement in the rail services facing the passengers (for instance frequencies and fares) and the freight carriers. This, in turn, will depend on the market organisation discussed above and trends in society.

The second part of the SEIA (Task 2.3) will use national guidelines on transport appraisal and the output from WP3 to compute the effect on the society of reaching the four key targets: (i) 50% reduction of the life-cycle cost, (ii) 100% capacity increase, (iii) 50% increase in the reliability and punctuality, and (iv) increase in the attractiveness of railway services. This will be done for each of the four SPDs: high-speed passenger rail, regional passenger rail, urban/suburban passenger rail and rail freight. Specifically, WP3 will model the effect of these key targets in terms of modal shift and number of trips by mode and how this contributes to the achievement of the societal objectives stated in the MAAP. We do not exactly know how the first three key targets (i)-(iii) will impact the demand and supply, but that will be analysed in the first part of the SEIA (Task 2.2).

The plan for Task 2.2. and 2.3 and their relation to other tasks within WP2 in IMPACT-2 is summarized in the GANTT-diagram in section 9.

7 Computing societal effects from the output in WP3

Despite the contrasts of the intended and probable effects of the future's railway system and megatrends, the intended key targets in the S2R programme are still to achieve ambitious improvements in capacity, LCC, and reliability and punctuality. If achieved, contributions will be made to the societal objectives listed in section 3, but the types of contributions made and their impact on the objectives are less clear cut. For example, not only do the objectives by themselves affect society, but in some cases, they also relate to each other: *Land use and spatial planning* is for example likely to affect the *greening of the society* and *liveable smart cities*. Analysing the contribution of fulfilled key targets to the societal objectives and missed out effects in WP3 is the work of Task 2.3 in IMPACT-2, and in this section we describe how the benefits can be assessed quantitatively.

So why do we need to measure the benefits quantitively? While already being the backbone of many cities' public transport system, the fulfilment of the key targets of S2R may indeed imply that railways have an even more important role in future passenger and freight transportation; both as a single mode and in combination with other transport modes. Still, the magnitude of the benefits for the society must be weighed against the costs when evaluating the future expansion and improvements of traffic and infrastructure. Relevant questions are: Where can new investments contribute the most to social objectives? What is the potential in different operational environments and rail types? What are the magnitudes of these effects? To be able to answer such questions, the benefits must be assessed quantitively.

The model simulations of WP3 will result in several outputs that can be used to quantify the impacts on the societal objectives using the methodology of social valuation and cost-benefit appraisal. For example, considering the *Greening of society* (one of the societal objectives in the MAAP), the synthesis in Deliverable 2.3 identified reduced noise and CO_2-emissions as factors contributing to this objective. Using some of the results from WP3, the quantified shift from more to less emitting modes gives us the opportunity to monetarise these effects and infer what impact and magnitude a shift towards a less emitting mode has on achieving a *Greening of society*. However, many of the objectives are hard to analyse with respect to the output from WP3 and this is why complementary research is needed by looking into previous studies on the subject.

Over the decades, the methodology in assessing the effects transport investments have on society has been developed and improved in many countries, often with basis in transport modelling and economics. This includes measuring effects in order to gain better knowledge in what to invest in. Examples on transport modelling and appraisal guidance reports are WebTAG (2014) in Great Britain [10] and ASEK (2016) in Sweden [1]. The tools used have also improved both in the accuracy in measuring effects and in separating the same. For passenger transport, such effects are, for example, travel time savings for regional and interregional

private, commuting and work trips, ticket revenues, vehicle costs, value-added tax (VAT), track access charges, traffic safety changes, CO_2 and particle emissions, fuel taxes, and budget effects. Similar values are retrieved from freight models. In most cost-benefit analyses for transport measures benefits can be divided into four types.

1. The value of changed accessibility, such as changes in travel time savings, travel cost, trip comfort, waiting time etc. Such effects are captured by the consumer surplus. Usually, the consumer surplus is calculated separately for person trips and freight transport. This is often colloquially referred to as “travel time savings”, since this is a major component of the benefits of many transport investments, but the change in accessibility may include many other parts of the generalized travel cost, for instance reliability, comfort and ticket prices.
2. Changes in the producer surplus for transport operators, usually transit and railway operators. Usually, it is (tacitly) assumed that all other firms, except transport service providers, operate on perfectly competitive markets, which means that there are no producer surpluses in these markets (if there were, new firms would enter the market until profits were driven down to zero).
3. Changes in external effects, primarily from car and air traffic. External effects are effects not taken into account by drivers and airplane passengers, such as noise, emissions and accidents.
4. Changes in transport related tax revenues – most importantly fuel tax revenues, but also VAT on transport services and road user charges.

To be able to compute these effects, we need to know how the generalized travel cost changes. The generalized travel cost includes all aspects of travel that affects how onerous it is, such as travel time, travel cost, waiting time, the risk for delays, the comfort of the trip etc. Sometimes, access to trip information is also included in the generalized travel cost. To be able to predict the societal effects we need a prediction on how the changes in the generalized travel cost impact the choices of the travelers and carriers, a prediction that will be delivered by the transport model developed for the SPDs in WP3. Hence, the results in WP3 will be an important source of information for WP2, considering that it can be further analysed and interpreted to understand magnitudes and effects on the societal objectives that can be generated by, for example, the so-called wider economic impacts.

Now, even if the benefits are computed for travelers and carriers (based on the changes of the generalized travel time), the benefits of a transport improvement do not accrue to travelers alone, but also have an impact on the labour and housing markets (and hence on economic growth etc.). However, this is just the other side of the coin since the benefit for the travelers and carriers trickles down and disperse in the economy. Some of these so called “wider economic benefits” are not captured by the standard approach generating the output from the transport model in WP3. In particular, to assess such ”wider economic benefits”, we

will not be able to use the output from WP3 in terms of changes in the travel choices of the travelers and carriers. Instead, to do this, a useful point of departure is to consult the Department for Transport's Transport Analysis Guidance (TAG). WebTAG (2014) [10] (unit A2.1) notes that most impact from transport investments can be captured through the consumer and producer surplus if we have conditions similar to perfect competition, which is most likely not the case in reality. Rather, markets are imperfect and wider economic impacts occur. In particular, WebTAG (2014) [10] notes three groups of wider economic impacts that transport appraisal needs to consider and suggests how these can be calculated. These groups are:

1. Agglomeration
2. Output change in imperfectly competitive markets
3. Tax revenues arising from labour market impacts

8 Plan and methodology for the work in Task 2.2

8.1 The market organisation will impact the effect on the key targets

Investments in improvements of rail infrastructure do not produce societal benefits by themselves. This is because it is not more infrastructure that impacts the generalized travel cost. It is the trains operating on the infrastructure that produce the benefits for society. Investments in rail infrastructure are different from most other transport investments in the sense that its use is often planned and determined by society to a large extent through capacity allocation, regulations, track access charges, subsidies, public transport provision, and by commercial operators who strive to maximise profits, often with some monopolistic power. This stands in contrast to most other transport investments, such as roads or bicycle paths, where the use of the physical infrastructure is mainly decided by individual decisions made by a large number of travellers.

The institutional setting determines the use of a given rail track, the stakeholders' incentives and constraints and how potential conflicts between stakeholders are resolved. This has an impact on time tables and ticket fares. Hence, the institutional setting will to a large extent determine how investments in, or improvements of, the rail infrastructure will be used and therefore how these investments contribute to the demand and the societal objectives. Considering that the institutional setting differs between European countries (and may differ in the future depending on the Mega-trends in society as discussed in deliverable 2.2 in IMPACT-1), rail infrastructure investments' impact on societal objectives will also differ. Task 2.2 in IMPACT-2 will therefore analyse how the impacts on the societal objectives of the achievement of the key targets depend on the market organization.

Irrespective of which target, objective, or effect that is discussed, the organisation of the market is of major importance and sets the rules for how the market can function and thereby to what extent the societal objectives are reached. Moreover, they differ in general between the SPDs. In particular, the amount of regulations and degree of liberalisation differs between the freight and passenger markets, but also across countries and across regional/local, intercity and international rail traffic services. The European freight market was gradually deregulated and is now in principle open for intra- and international traffic, although competition is not yet established everywhere (Crozet, 2017) [4]. For passenger traffic, the situation is more fragmented. While open access competition is established for international services through the EU's second railway package, most domestic markets see monopoly rights for state-owned operators (Nash, 2017) [5]. The situation is, however, likely to change as open access competition and competitive tendering is to be imposed with the EU's fourth railway package. All in all, there are strong trends towards a deregulation of the rail services in Europe.

Competition is widely believed to have the potential to stimulate passenger demand, which in turn creates more railway trips. This happens because, compared to a regulated monopolist, entrants have (stronger) incentives to be innovative, for example introducing new train services and new business models (e.g. aiming at better yield management). In open access

regimes, entrants could also challenge incumbents on existing routes by lowering fares and increase supply, something that happened, for example, in Sweden (Vigren, 2017) [11].

8.2 Plan for the work in Task 2.2

Following MAAP, the aim of Task 2.2 in IMPACT-2 is to explore how the railway system can be used as a design tool for societal development: to create the wanted society. In this task we will explore the potential for the rail sector to fulfil societal objectives and the needs of society, today and in the future. The point of departure for the work is the defined societal objectives in Deliverable 2.3 (IMPACT-1) and the mobility scenarios for passenger traffic (Deliverable 2.2 in IMPACT-1) and freight traffic (Deliverable 2.1 in IMPACT-2).

To make improvements in society, proper measures are needed at the right time. In other words, the probable outcome must be aligned with the desired outcome. The probable outcome is not only shaped by which mode is operated where, but also on long and short-term trends in user demand, technology and regulation, to name a few. Just as these trends might steer away from the desired society, they might as well enforce the achievement of it. As noted in the S2R strategic Master Plan, the railway sector must not only consider its own mode in isolation, but also the integration with other modes in order to be successful and competitive. One example of this could be the concept of the “last-mile” in the Mobility as a Service (MaaS) discussion, where rail is an integral part in many trips in the transport system.

Moreover, as described in the previous section, the market organisation is crucial for understanding how investments / improvements in the rail system will contribute to the societal objectives. Which major trends in the organisation of the rail-market will contribute to or lead away from the realisation of societal objectives, and which trends are important for different countries? For instance, what will happen to the demand and supply of train services in countries where the railway is vertically integrated - that is, where infrastructure investments and frequency and fares are integrated decisions and there is only one operator? How will this differ from countries where capacity is allocated through auctions or similar forms of market-based allocations (in the UK for instance)? To answer these questions, one needs to consider first the underlying goal function with respect to the market organisation and institutional setting. For example, in the vertically integrated railway system, one can assume social welfare maximisation as the goal function. A principle close to that may also prevail in other organisational settings in which the railway system is regulated and subsidised by society in different ways, including public provision or subsidisation of public transport, subsidised track access charges, public control over capacity allocation etc. The underlying idea would then be that the train services should strive to achieve the maximal social benefit, which the infrastructure can generate, and that society is trying to achieve maximal social welfare through its combination of regulation, subsidies and traffic provision. If, however, traffic supply is decided mainly by profit-maximising train operators with at least some monopoly power, it would be natural to let the frequency and fare be decided by maximal producer surplus.

In countries where the allocation process is a legal-administrative procedure, with a public agency that determines how the wishes of different operators should be negotiated (in Sweden, for example, the Transport Administration determines which operators should get priority), it could be reasonable to assume that capacity is allocated to operators (with the intention) to maximise social welfare. Different operations have, however, different objectives; long-distance trains and freight operators maximise profits, while regional train operations, which are often subsidised using public funds, can be viewed as maximising consumer surplus subject to a budget constraint. Moreover, the Swedish track allocation process is not so transparent, even if it is supposed to strive for maximal social welfare. This maximisation principle may also be difficult to operationalise, and the operators differ in terms of bargaining power. Thus, the goal function is only a point of departure for the analysis on how different market organisations and trends will affect the societal objectives when the S2R key targets are met. How this work will be carried out is described more in detail in the next section.

8.3 Methodology for the work in Task 2.2

One source of information for identifying major trends and the predictions of what future rail systems can bring (including contrasts to these predictions), will be previous research and other relevant literature. Interviews with experts in the field will also be an important activity that brings more knowledge. The intended project participants have a wide network of contacts in the rail industry, as well as the transport industry in general. It is, however, important to emphasise that the theme of task 2.2 in IMPACT-2 is “living matter” and that the impact on the railway system of all major trends are, in their nature, hard to identify. The future megatrends of electrifying the road network, MaaS, and autonomous vehicles are still in very early phases of development. However, this makes it even more important to reflect on the benefits and challenges they can bring to the rail sector.

One key target of S2R is to reduce LCC by 50 percent, something that would reduce the operating cost of running trains. In perfectly contested markets, economic theory suggests that the cost reduction will be channelled out to the customers in terms of increased supply and/or lower fares. However, the railway market is not a market with perfect competition. As noted above, both the degree of competition between operators and the organisation of the market influences this greatly as well as if an operator has instructions to operate with a societal objective, or if it acts as a traditional profit-maximiser. When faced with lower operating costs in an environment with limited competition, inefficiencies from the society’s point of view will arise and the resulting question is: which are the implications on supply, fare, and operator profits as well as on different societal objectives? A stylised model would be able to investigate this issue and give better predictions on what reduced LCC will mean for society. If reduced LCC does not translate into better service for customers, irrespective of it

being in the passenger or freight market, the societal objectives will see worse outcomes than was the intention of the key target.

The effect of fares and frequencies in a deregulated market is demonstrated in the Swedish high-speed rail appraisal. To predict the passenger volumes, real (unchanged) fares have been assumed 60 years ahead and the fares on the high-speed rail is assumed to be the same as on the other trains. However, this is unrealistic. One reason is that those operators who first receive traffic rights will be protected from competition with other operators for some time, which creates space for ticket price increases. In addition, the new track would mean a significantly more attractive service in terms of shorter travel times, which allows for price increases.

More specifically, the work of Task 2.2 in IMPACT-2 will be based on the fulfilled key targets of S2R ((i) 50% reduction of the life-cycle cost, (ii) 100% capacity increase, (iii) 50% increase in the reliability and punctuality) and their impact on the societal objectives with respect to the trends discussed earlier. The aim is to infer how these trends will affect the social objectives. For instance, we will derive the effect on the fares, frequency, delays and capacity arising from the key targets, and contrast them against different organisational structures (degrees of liberalisation) in the railway sector. If the key targets are achieved, for instance 50% reduction in production cost (a part of the LCC), this will have different impacts on the supply (and frequency) and thereby on the demand if the supply is decided mainly by profit-maximising train operators (often with some monopolistic power) or not. Of course, this analysis also takes into account the consequences on the other modes of transport, since these are the main competitors. This example would contribute with more knowledge on the development paths regarding the organisation of the rail operations, which in turn will increase the possibilities of reaching the societal objectives the most in different contexts. The methodology will be desktop research, interviews with experts, and modelling work.

In particular, to further understand the effects, a demand and supply model will be set up and calibrated for a relevant rail corridor, inspired by the model used in WP3 (however, the interaction between the demand and the supply will be modelled in more detail). The effects on the fares and frequency arising from the key targets under different market organisations and from the attractiveness of competing modes, will be derived.

In the model, the producer surplus (PS) is defined as fare revenues minus operations costs for the operator. In the numerical examples we will assume a demand function $D(c)$. The consumer surplus (CS) for group of travellers (*i*) of a change in generalised costs from $\{c_i^0\}$ to $\{c_i^1\}$ is by definition $CS = \sum_i \int_{c_i^0}^{c_i^1} D(c)dc$. There is obviously a number of possible settings and at least two simplistic examples will be provided to illustrate the effect under the assumption of an operator that is *a)* profit maximising (maximising PS) and *b)* maximising social welfare (maximising CS+PS). Optimal fares and frequencies will depend on the elasticity of demand for rail trips (which in turn depend on the generalised cost with alternative modes). Hence, one needs to consider all modes, not only rail.

Examples of similar models include Parry & Small (2009) for bus and rail transit systems in megacities [6], Cats et al. (2015) for an upcoming metro corridor in Stockholm [3], and Börjesson et al. (2017) for a Swedish bus corridor [2]. By using this methodology, the effects relating to optimal fares, demand and supply, and operating costs can be analysed in detail. Further, such models allow for incorporating the S2R key targets and to better infer and separate the magnitude and effects these would cause. They will also allow a better inference of the predicted and realistic future of railway investments and will thus serve as a tool that could be used.

The model analysis proposed here can also help in separating the effects stemming from the three different key targets. Although the three targets aim at different aspects of the railway system, they do also work together and can re-enforce each other. Doubling the capacity will affect the competitiveness and sustainability of society, which increasing punctuality by 50 percent also does. An interesting question is, what effects do these key targets have on their own and how do they enforce each other – that is, in what way(s) are the key targets interdependent? Having this question in mind can give valuable information to the S2R programme concerning which of the key targets that are most important in reaching the societal objectives.

Finally, when analysing the trends' impact, one needs to consider that the SPDs have different purposes, which means that the trends will affect the societal objectives differently. For example, a high-speed rail line serves a city in a different way than a metro line does. It is therefore important to consider the modes' respective purpose (transporting passengers or freight), where the modes could have the most and least impact respectively and which the effects are.

9 GANTT-diagram for the SEIA of potential Shift2Rail outputs

The following Figure shows the planning explained in the previous subsections as a GANTT-diagram. Note that task 2.1. in the diagram is similar to the work carried out for passenger transport in IMPACT-1 on influences to 2025, 2035 and 2050. In IMPACT-2, the corresponding work will be carried out for freight transport and an update will be made for passenger transport.

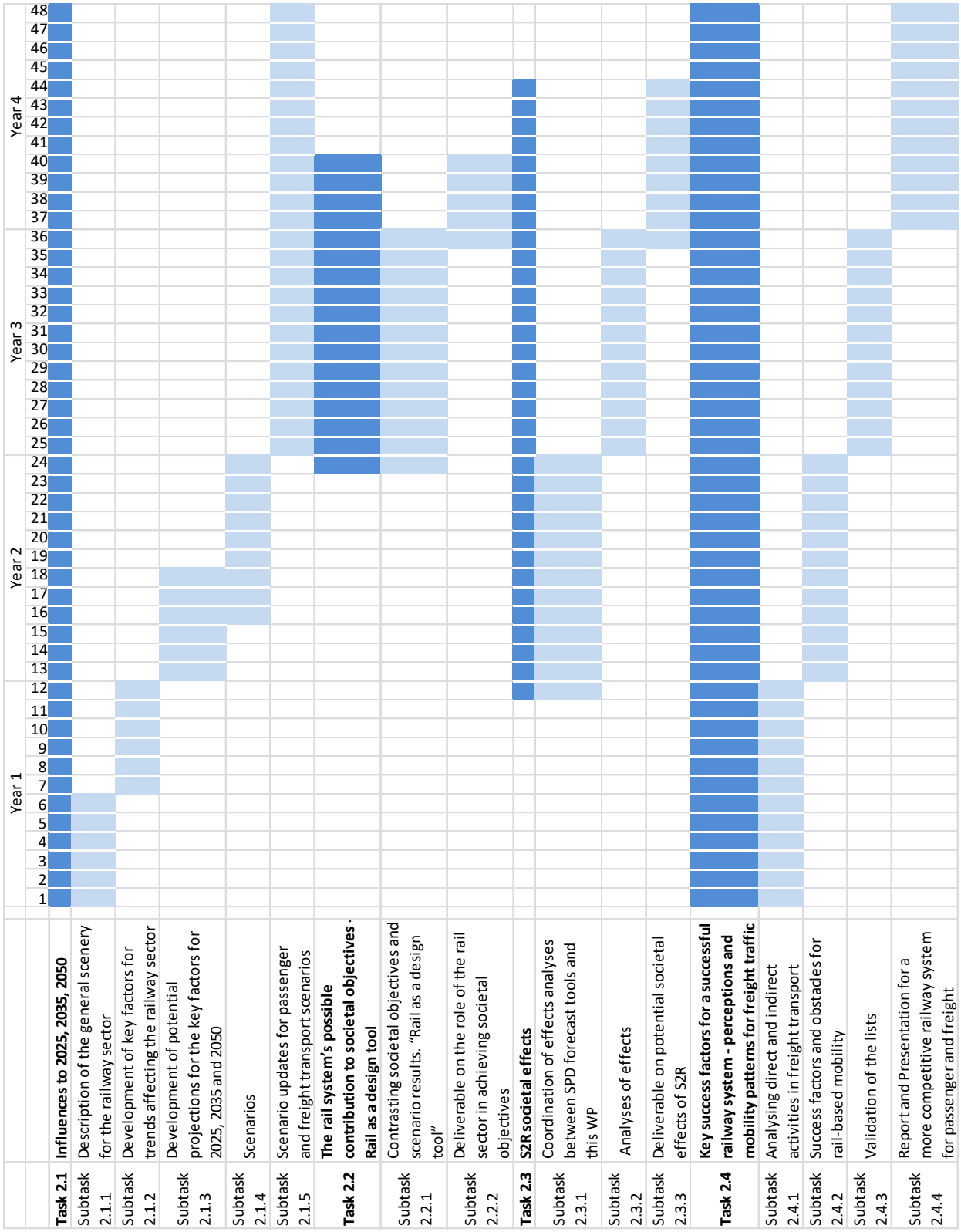

Figure 1. GANTT-Diagram for the SEIA in IMPACT-2 of potential Shift2Rail outputs.

10 Conclusions

The conclusions reached at this stage of the R&I and highlighted in this report are that there are three main methods that can be used to analyse the societal impacts from improvement in the SPDs: 1) desktop research though reading and synthesising previous research and other relevant work, including guidelines for cost benefit analyses (WebTAG (2014) in Great Britain [10] and ASEK (2016) in Sweden), 2) expert interviews, and 3) the creation of a model that can analyse effects not directly considered or analysed in WP3. This model will include the demand and the supply side, so that equilibria for different market conditions can be found.

It was concluded that the impacts of the key targets and how they interact will depend on the market organisations. The reason is that the institutional setting and the degree of competition among train operators and other transport modes will result in different societal effects when the key targets are met. Changes in the market organisation of the railway sector is also a major long-term trend in the European railway sector.

To sum up, it will be possible to use output from WP3 to increase the understanding of a number of societal effects arising from the four key targets of the S2R programme as defined in the strategic Master Plan (Shift2Rail, 2015a, ss. 13-14) [7]. Railway can indeed contribute to deliver such effects, but one needs to know what the relevant societal effects are and how they interact in order to decide on the best investments and changes in the railway (and in the overall transport) system.

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12 Annexes

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