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Deliverable D 2.1

Socio-economic Values Societal Goals and their Relevance to the Railway Sector

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1 Executive summary

Point of departure for this deliverable is that the railway system should not be considered an end in itself. Rather railway planning and management should be oriented towards overall societal goals. Thus, the overall aim of the deliverable is to contribute building knowledge of the railway sector's and Shift2Rail's potential and actual contribution to a number of societal goals, while the assessment of the contributions to the goal will be carried out in the successor project, IMPACT-2. The societal goals were pre-set in advance of the project, namely: 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.

By use of scientific and 'grey' literature these six societal goals are defined and their relevance for the railway sector is explained. The aim has been to distinguish the individual goals, though the goals are clearly linked and overlap. It is important to stress that focusing solely on the achievement of one societal goal will result in neglect of important societal aspects. In addition, indicators are suggested for possible use when assessing the railway sector's and Shift2Rail's contribution to goal attainment. Two to three indicators are suggested for each goal. The same (or almost the same) indicator in some cases is suggested for different goals. More work on the suggested indicators are needed to be able to apply them for assessment. The definition of goals as well as the suggested indicators for each goal are showed in the table below.

Table 1: Goals, Definitions and Indicators

Goal	Definition	Indicators
Greening of society	Policy sectors other than the environment are transformed in accordance with environmental goals	A composite indicator for development in greening of rail
		An indicator on development in modal shift from air to rail (passenger and freight)
Competitiveness and sustainability	New business and employment opportunities for the railway industry that make the industry competitive over the longer term while ensuring sustainability	An indicator on the development in investments increasing competitiveness (capacity, reliability, costs)
		A composite indicator for development of railway contribution to sustainability (including social-, environmental- and economic dimensions)
Smart inclusive growth	Coordinated fair, participatory planning	An indicator on development in the degree of coordination between railway projects and land use planning

Goal	Definition	Indicators
		An indicator on low income groups' affordability and accessibility of rail passenger services (e.g. price of rail transport and travel time)
		An indicator on development in citizen participation in railway planning processes (e.g. consultation with the affected population when developing plans)
Liveable smart cities	High quality of life and wellbeing for city residents	An indicator on development in travel time proximity (including rail) to designated areas in cities
		An indicator on the development of quality of rail services (e.g. travel speed, punctuality and reliability)
		An indicator on the development of affordability of rail services for city residents
Regional integration and enlargement to	High degree of spatial integration of the cities in a region via intraregional	An indicator on development in regional access to markets: the ease of reaching economically assets (e.g. work places) by trips including railway (door-to-door)
reach critical mass	interaction taking place through trade of goods and services, job commuting, and shopping	An indicator on the development in affordability of intraregional rail services (e.g. as percentage of income)
Attractive, connected, and accessible regions	Improved interregional interaction in Europe, aiming to connect European regions	An indicator on development in the share of exchange of people (for work or leisure) between designated regions by use of rail
		An indicator on development in the share of exchange of goods between designated regions by use of rail
		An indicator on development in the share of exchange of services between designated regions by use of rail

The deliverable in addition includes a chapter on the current status as regards the railway sector's contribution to goal achievement. This, however, is an immense task dependent on geography and planning contexts, and the differences among the European countries are substantial. This chapter further includes a section on implementation factors, which is in this context defined as a factor or condition that need to be met, or a situation, that would

facilitate the achievement of a specific societal goal. Three important factors are highlighted: seamless door-to-door mobility; integrated transport and land-use planning; as well as rail interoperability.

2 Abbreviations and acronyms

Abbreviation / acronym	Description
EU	European Union
GA	Grant Agreement
H2020	Horizon 2020
IMPACT-1	Indicator Monitoring for a new railway PAradigm in seamlessly integrated Cross modal Transport chains – Phase 1
IP	Innovation Program in S2R
JU	Joint Undertaking
KPI	Key Performance Indicator
S2R	Shift2Rail
SPD	System Platform Demonstrator
WA	Work Area
WP	Work Package

3 Introduction

This deliverable is a product of the IMPACT-1 project within the Shift2Rail program. It constitutes the deliverable D2.1 Socio-economic values within the IMPACT-1 project. In this section, we explain the background and purpose of the deliverable and the relevance to the IMPACT projects and the Shift2Rail program.

3.1 Background

Based on a number of challenges facing the European rail sector, the Shift2Rail program has been established as a railway research and innovation program funded partly by Horizon 2020 and partly by industrial partners. The general objectives of Shift2Rail are: (i) to create a single European railway area by removing technical obstacles; (ii) to radically enhance the attractiveness and competitiveness of European railways to ensure a modal shift towards rail; and (iii) to help the European rail industry retain and consolidate its leadership on a global market (Shift2Rail, 2015a).

Four specific objectives have been formulated, around which Shift2Rail is structured:

- Improved services and quality, e.g. a 50 % increase in reliability and punctuality of rail services and a 100 % increase in the capacity of the railway transport system. The aim being to improve the attractiveness of rail services through innovative measures.
- Reduced system costs: the long-term aim being to achieve a 50% reduction in railway lifecycle costs by 2030 while also reducing negative externalities.
- Enhanced interoperability: the aim being to remove remaining technical obstacles, which are holding back the rail sector in terms of market openings for rail product supply, connectivity, and efficiency.
- Simplified business processes: the aim being to reduce the development and production costs of innovative technologies.

To achieve these objectives, Shift2Rail is organised in five innovation programs for technical activities and five cross-cutting themes (work areas 1–5). The first of these cross-cutting areas (WA1) is “Long-term needs and socio-economic research”; the second of these (WA2) is “Key performance indicators”.

IMPACT-1 is the first of two projects established in answer to WA1 and WA2 obligations. The aim of IMPACT-1 is to assess and evaluate the mobility, societal, and environmental effects of new technology and developments resulting from Shift2Rail (IMPACT-1, 2016). Work package 2 (WP2) and work package 3 (WP3) in IMPACT-1 have their starting point in WA1, the aim of which is to “look at the rail system from the outside”, “as a part-function in a much bigger societal and transport context”, and help to “assess the railways from an outside perspective”

(Shift2Rail, 2015b, p. 718). The basic idea is that the railway system should not be seen as an end in itself or merely as a technical transport system. Once seen as a technical solution to a transport need, the railway system should now be considered a tool to help developing cities and regions. Moreover, it can be seen as a mean to raise living standards and improve people's wellbeing. Therefore, railway planning and management must be oriented towards a strategic and long-term vision, which takes the societal function of railways into consideration. IMPACT-1 will be followed by the IMPACT-2 project, and some IMPACT-1 activities are intended to prepare the methodology for later activities in IMPACT-2. This deliverable is a result of work carried out in IMPACT-1/WP2.

3.2 Aim and structure

WP2 of IMPACT-1 is about "Socio-Economics". The overall aim of WP2 is to contribute to building knowledge of the railway sector's and Shift2Rail's potential and actual contributions towards society.

A Shift2Rail background document, the Multi-Annual Action Plan (MAAP), mentions several societal goals that Shift2Rail may help achieve (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)
- Attractive, connected, and accessible regions
- Sustainable and seamless door-to-door mobility solutions
- Land-use and spatial planning

The goals of the MAAP are not further specified. Hence, the meanings of and relationships between the above-mentioned goals are unclear. Therefore, it is difficult to find out whether or not Shift2Rail has helped to fulfil the goals. For that reason, a main task in IMPACT-1/WP2 is to clarify these goals, thereby contributing to evaluate the extent to which Shift2Rail innovations and developments could help attain these societal goals.

We consider the last two goals on the list, *sustainable and seamless door-to-door mobility solutions* as well as *land-use and spatial planning* to be means to achieve the other abovementioned goals, rather than being goals in their own right. This matter will be discussed in chapter 6.

More specifically, the aims of this deliverable 2.1 are: (i) to specify and define the societal goals of the MAAP; (ii) to suggest possible indicators which could be relevant in assessing the rail sector's contribution to goal achievement; and finally (iii) to discuss current status and

important implementation factors for the sector's contribution to achieve the societal goals of the MAAP (Shift2Rail, 2015b).

By this, the deliverable contributes to later activities in IMPACT-2, where the rail sector's potential to contribute to the above-mentioned societal goals will be studied as well as quantitative and qualitative assessment of the Shift2Rail program's contribution to this.

In chapter 3, the methodology carried out for the deliverable will be explained. In chapter 4, the societal goals are specified and defined. This will be done with reference to their relevance to rail. In chapter 5, indicators relevant to measuring the goal attainment will be discussed. Chapter 6 focuses on the current status of how the railway sector contributes to the societal goals. In addition, implementation factors important for the railway sector's contribution to achieving the societal goals will be discussed. Conclusions are presented in chapter 7.

4 Methodology

The Description of Work for IMPACT-1 (IMPACT-1, 2016) mentions the establishment of a "socio-economic impact assessment framework" (SEIA) as an appropriate framework for the evaluation of the Shift2Rail goal achievement.

There is extensive literature on impact assessment frameworks: Environmental Impact Assessment (EIA), Social Impact Assessment (SIA), Strategic Environmental Assessment (SEA), Environmental and Social Impact Assessment (ESIA), Gender Equality Impact Assessment (GEIA), and even Socio-Economic Impact Assessment (SEIA) (IAIA, 2009; Levin et al., 2016; Mackenzie Valley Environmental Impact Review Board, 2007; Vanclay, 2015). The overall label for these assessments is "impact assessment". It is also the term used by the European Commission when providing ex ante evaluations of legislative and non-legislative initiatives (e.g., European Commission, 2015a).

Simply defined, an "impact assessment" is the process of identifying the future consequences of a current or proposed action. The "impact is the difference between what would happen with the action and what would happen without it" (IAIA, 2009).

These impact assessment frameworks differ and are usually applied for other purposes than the purpose of this deliverable. Some variations from the usual applications of impact assessment frameworks are as follows: the problems to be solved are already specified in the background documents of Shift2Rail (EC, 2013; Shift2Rail, 2015a, 2015b); in this context, a specific policy initiative (i.e., project or strategy) should not be assessed[1], but rather the outputs of an innovation and research program; and finally the intention in this context is not to suggest or evaluate various options that decision makers can choose between ex ante, but rather to help evaluate the results ex post and during the process.

In this deliverable, the inspiration from the SEIA-framework is limited to helping provide an assessment of the consequences of Shift2Rail covering economic, social, and environmental impacts.

The Description of Work further suggests that the societal goals should be ranked. Ranking such goals is usually considered a political rather than a scientific task. Ranking various criteria, concerns and consequences is often done in, for example, cost–benefit analyses (CBAs) and multi-criteria decision analyses (MCDAs). In these analyses, ranking is necessary to be able to compare specific projects, which, in the transport sector, are usually infrastructure projects (e.g., Jensen et al., 2011). However, in the present case, the aim is not to compare different projects or efforts, but to assess how and to what extent a very diversified research and innovation program (Shift2Rail) contributes to the attainment of six societal goals. Hence, we do not see a need to rank the goals in order to comply with this aim.

[1] The proposal for the Shift2Rail program was assessed via an impact assessment in 2013 (EC, 2013).

The main methodological tool behind this deliverable is to review literature. Thus, relevant academic literature and grey literature including policy documents have been reviewed. In chapter 4, where the definition of the societal goals is thematised, and in chapter 5, where indicators are suggested, a "snowball approach" was applied. This means that we started reviewing literature we already knew first, then supplemented our search with documents in Google Scholar and finally screened references in publications we had initially found.

For chapter 6, which deals with the current status and implementation factors, a more thorough search was carried out, however also complemented by the "snowball approach". The terms "Europe" or "EU" in the keyword field combined with "rail"* in the title field was searched for within the database TRID. By doing so, only those publications published after August 2012 were taken into consideration. TRID – the TRIS and ITRD database - is the world's largest bibliographic resource on transportation research information, which is produced and maintained by the Transportation Research Board, USA. TRID covers all modes and disciplines of transportation and contains references to books, technical reports, conference proceedings, and journal articles. Overall, the search led to 520 references, from which relevant references were chosen. In general, the TRID database was chosen since here one can find more limited literature regarding the issues of current status and implementation factors vis-à-vis the railway sector's contribution to attain the under 1.2 mentioned societal goals.

In addition, a small number of qualitative interviews with experts were carried out within the scope of the research. These were conducted by phone to economize working hours and save travel costs. Every phone call was recorded and summarized. The interviewees were chosen according to their specific knowledge on issues relevant for the deliverable, and where we found limited support in the literature, and thus mostly in relation to chapter 5 and 6. Overall, the interviews were applied to complement the literature review and designed to find out whether we overlooked important aspects.

5 Definition of societal goals

Subsequently, the societal goals *greening of society*, *smart inclusive growth*, *regional integration and enlargement to reach critical mass*, *competitiveness and sustainability*, *liveable smart cities*, as well as *attractive, connected, and accessible regions* are discussed and defined. These goals are considered as the relevant societal goals to which the rail sector could contribute.

Hence, a section is dedicated to each goal. In each section, the goal as it is written down in the policy documents is discussed; then the corresponding scientific literature is reviewed, before finally proposing a definition relevant in this context.

5.1 Greening of society

If one conducts an Internet search for "greening", one gets hits such as "greening of society", "greening the economy", "greening the regulatory framework for products", "greening government", "greening Europe's agricultural sector", and "greening European Union (EU) competition law and policy". The *greening of society* is a goal of uncertain origin. It is used in a highly general way to describe an environmentally friendly societal shift. What greening actually means and how it might be achieved is unclear. Greening is also a concept related to other goals, such as "sustainable development" and "sustainable growth". The EU's "green shift" will combine environmental values with considerable economic growth, which were expressed here in the EU's white paper on growth (European Commission, 2010, p. 14):

> "Sustainable growth means building a resource efficient, sustainable and competitive economy, exploiting Europe's leadership in the race to develop new processes and technologies, including green technologies, accelerating the roll out of smart grids using ICTs, exploiting EU-scale networks, and reinforcing the competitive advantages of our businesses, particularly in manufacturing and within our SMEs, as well through assisting consumers to value resource efficiency. Such an approach will help the EU to prosper in a low-carbon, resource constrained world while preventing environmental degradation, biodiversity loss and unsustainable use of resources".

The vagueness of what is actually meant by "greening" and how greening is related to other goals makes it difficult to define the concept, even though greening, as indicated above, is often used to describe reforms designed to make society, the economy, products, regulatory frameworks, etc., more environmentally friendly. Greening can therefore be defined as the *integration* of environmental considerations with sectors other than the environment, such as transport, industry, agriculture, and energy. A need to integrate environmental considerations with sectors other than the environment naturally arises when policies and measures for specific sectors fail to sufficiently consider environmental goals.

Therefore, some research looks at how organisations, companies, and bodies such as the EU work towards integrating environmental concerns with sectors other than the environment. Research into how environmental considerations might be integrated with sectors other than the environment – so-called environmental policy integration (EPI) – may be tapped to expand the definition of greening. Considering greening in terms of environmental considerations that are integrated with the policies and measures of sectors other than the environment is relevant. Within the EU it is a requirement under the European Council (EC) treaty calling for environmental protection requirements to be integrated into the definition and implementation of EC policies, in particular, with a prospect to promote sustainable development. The Cardiff Process is the name given to the process launched by the EC requiring different Council bodies to integrate environmental considerations into their respective activities. "Environmental integration means making sure that environmental concerns are fully considered in the decisions and activities of other sectors" (EC, 2017).

The way integration is described by the EU corresponds relatively well with how EPI is defined in the research literature:

> "[EPI] refers to the incorporation of environmental concerns in non-environmental policy sectors. EPI aims to avoid conflicts between environmental and other policy objectives and to enhance environmental policy by directly targeting the driving forces of environmental degradation" (Runhaar et al., 2014, p. 233).

According to that definition of EPI, environmental considerations should be integrated at the sectoral and individual organisational levels. Integration should also entail a shift from "end-ofpipe" solutions to solutions that address the causes of environmental problems (Jordan & Lenschow, 2000). EPI is a matter of avoiding goal conflicts and, according to a farther-reaching and potentially controversial definition: it is also a matter of prioritising environmental considerations in other sectors, to improve the outcome of environmental policies (Candel & Biesbroek, 2016).

Practical experience of the implementation of EPI within the EU framework (Jordan & Lenschow, 2010) shows that the implementation is complex, as it is burdened with conflicts between environmental goals and goals belonging to other sectors. Also, as is so often the case, the relationship between the environment and economic development appears to be particularly problematic; for example:

> "The main challenge during the reform process [of the agricultural sector] was how to design greening so as to reap environmental and climate change benefits and ensure the sustainable use of natural resources, without undermining either territorial balance throughout the EU or the long-term competitiveness of the agricultural sector" (Solazzo et al., 2016, p. 1117).

Another potential problem is that institutional capacity is spread between organisations. Public authorities may lack both mandates and resources. This implies that both public and

private actors must work together, sometimes on a voluntary basis, as there may be no formal levers that can be used to steer organisations' actions in the desired direction.

We can evaluate the outcome of integration using quantitative measures such as CO_2 emissions or air quality. Research into EPI (e.g., Runhaar et al., 2014) proposes combining quantitative and qualitative measures of: a) decision-making, through the degree of coordination (Is the environment mentioned in policies and strategies? Are there contradictions between policies?); b) harmonisation (Are synergies between policy goals developed or utilised?); and c) estimated outcomes, although such estimation may be difficult (e.g., in environmental impact assessments).

Definition of greening of society, and rail relevance

To conclude, the *greening of society* is generally taken to mean that policy sectors other than the environment are transformed in accordance with environmental goals. Though railway is usually considered less polluting than road and air transport (European Environmental Agency, 2016a, Trafikanalys, 2017), we do in this context choose to define greening as the railway sector's incorporation of environmental concerns by its constituent private and public organisations, based on the premise that all four market segments (i.e., high-speed rail, regional passenger rail, urban/suburban passenger rail, and freight rail) can be made more environmentally friendly than they are at the moment[2]. This can be done by regulations, but also by more voluntary means than in traditional environmental governance, which is often prescriptive and based on restrictive policy instruments, such as emission norms (Runhaar et al., 2014). In this context, greening further incorporates a modal shift from more polluting transport modes, such as air and car transport, to rail. It should however be emphasised that more railway is not always supporting greening of society. This is not the case along corridors where limited volumes of passengers or goods are transported.

5.2 Competitiveness and sustainability

The concepts of *competitiveness* and *sustainability* are linked to different layers such as at the EU, country, and firm levels, which will be presented in the following. The EU's ten-year growth strategy, Europe 2020, defines sustainable growth as development promoting a more resource-efficient, greener, and more competitive economy that brings economic, social, and territorial cohesion forward. "Investing in cleaner, low carbon technologies will help our environment, contribute to fighting climate change and create new business and employment opportunities" (EC, 2010, p. 11). The countries' abilities to achieve sustainability and competitiveness is strongly emphasized in some literature regarding sustainable competitiveness. For example, the World Economic Forum defines a nation's sustainable competitiveness as "the set of institutions, policies, and factors that make a nation productive over the longer term while ensuring social and environmental sustainability" (World Economic

[2] Also, the more polluting modes aim to increase their environmental performance, e.g. European Commission 2011c; Eurocontrol, 2015.

Forum, 2017). That implies that the concept of sustainable competitiveness "places more emphasis than the concept of sustainable development does on the importance of productivity as a driver of prosperity and long-term growth" (World Economic Forum, 2017). In a similar way, though with a stronger focus on sustainability, the "Global Sustainable Competitiveness Index" defines sustainable competitiveness as "the ability to generate and sustain inclusive wealth without diminishing future capability of sustaining or increasing current wealth levels" (SolAbility, 2016, p. 7). At the firm level, the link between corporate competitiveness and sustainability is highly debated on, and often framed into simplified "yes or no" terms, i.e., "Does it pay to be green?" (Reinhardt, 1999). Many studies support the hypothesis that good corporate environmental performance is bad for corporate economic success, as well as the contrary hypothesis that good corporate environmental performance is good for corporate economic success (Schaltegger & Synnestvedt, 2002; Wagner & Schaltegger, 2004). However, a recent meta-analysis of 149 studies found a positive relationship between corporate environmental and corporate financial performance (Endrikat, Guenther, & Hoppe, 2014). Even so, the contradictory research results suggest that the question of whether or not it pays to be green is insufficient by itself. Rather, as Schaltegger and Synnestvedt (2002, p. 340) put it, the question that should be investigated on is *when* it pays off for firms to be green. This means that managers should look at environmental problems as business issues, and should make environmental decisions for the same reasons as they apply to other investments, i.e., because they expect them to deliver positive returns (Reinhardt, 1999). This could occur when companies save costs via environmental measures, technical improvements, or product differentiation. That is, through environmental improvements that permit a higher price for a service or that grow the market share.

Definition of competitiveness and sustainability, and rail relevance

The other MAAP goals described and defined here largely concern how the railway industry might further the development of regions and cities (see below). *Competitiveness and sustainability* is a twofold goal that can be linked, more clearly than the other goals, to corporate development and contributions to a desired societal developmental path. A competitive railway industry could also help to achieve other goals of the Shift2Rail program. For this reason, we chose to define the *competitiveness and sustainability* goal in terms of new business and employment opportunities for the European railway industry that make all four market segments competitive over the longer term while ensuring sustainability. Goal fulfilment can be assessed based on investments that increase the competitiveness of the railway industry through improved accessibility, capacity, reliability and reduced costs for customers, competitiveness vis-à-vis roadway traffic, and increasing market share as a result of the Shift2Rail program. Further, there should be assessment in terms of sustainability.

5.3 Smart Inclusive Growth

This goal can be traced back to the 2010 EU white paper on growth, *A strategy for smart, sustainable and inclusive growth*, which defines the following vision for Europe:

- Smart growth: developing an economy based on knowledge and innovation.
- Sustainable growth: promoting a more resource efficient, greener and more competitive economy.
- Inclusive growth: fostering a high-employment economy delivering economic, social and territorial cohesion. (European Commission, 2010, p. 10)

This goal comprises two concepts, each of which in turn combines two concepts that may have multiple meanings. For this reason, smart growth will be discussed first and inclusive growth thereafter.

About smart growth

"Smart" is used in the above-mentioned EU white paper and in Horizon 2020 (EC, 2011a). The authors write about "Smart, green and integrated transport" in such a way that "smart" is used synonymously with "innovative", but also with a meaning similar to that of the "greening" concept (see above):

> "Developing smart equipment, infrastructures and services This will help optimise transport operations and reduce resource consumption. The focus will be on the efficient use and management of airports, ports, logistic platforms and surface transport infrastructures, as well as on autonomous and efficient maintenance and inspection systems. Particular attention will be given to the climate resilience of infrastructures, cost-efficient solutions based on a lifecycle approach, and the wider take-up of new materials allowing for more efficient and lower cost maintenance. Attention will also be paid to accessibility and social inclusiveness" (EC, 2011a, p. 66).

Hence, "smart" is used to describe the resource-efficient use of materials and infrastructure that creates growth and favourable development for EU inhabitants.

In the transport context, it has become popular to talk about "smart infrastructure", "smart mobility", and "smart transport", which we consider relevant when talking about "smart growth". The related concept of "smart cities" (like "smart growth") is widely applied and therefore will be discussed in section *4.4, Liveable smart cities*. In a transport and land-use context, the concept of "smart growth" has historically been used, particularly in North America, as a way to combat urban sprawl by connecting transportation and land use. The guiding assumptions of the concept are, for example, that building highways contributes to urban sprawl and car use, while investing in rail systems fosters and increases density (Handy, 2005). The notion of "smart growth" in this tradition is somewhat similar to the European concepts of the "compact city" and "urban intensification" (Dempsey, 2010). In this interpretation, "smart growth" is clearly linked to the connection and integration of transportation and land-use planning.

Additionally, the concept of "smart" is currently used in connection with a multitude of devices, such as smart phones, smart watches, smart televisions, and smart cards, as well as at a system level in concepts such as smart mobility, smart urbanism, smart city, and smart growth. "'Smart' is the order of the day", as one author stressed, though also emphasising that smart "appears to be a contested notion that rather defies clarity of definition" (Lyons, 2016, pp. 1, 2). When used in connection with devices, "smart" seems to stand as a symbol for digital technological innovations, while at the system level, the term is also used for other purposes.

In academic as well as non-academic literature, the notions of "smart mobility" and "smart transport" are increasingly applied as synonyms of transport or mobility futures that encompass self-driving or autonomous vehicles, the Internet of things (connecting vehicles as well as vehicles and infrastructure), and shared platform-based mobility such as carsharing, bike-sharing, ride-sharing, etc. (Papa & Lauwers, 2015). This development might blur the boundaries between established phenomena in the sector, such as freight and passenger vehicles and public and private responsibility. There is considerable political and industry-related enthusiasm for this development (Fagnant & Kockelman, 2015). However, some authors stress that smart mobility might also be counterproductive considering the achievement of political goals, for example, regarding sustainability (Docherty et al., 2017; Schiller, 2016; UITP, 2017).

As with all new concepts, the content and definition of "smart growth" are disputed, and there is no consensus scientific definition of the concept. However, current applications in the academic as well as non-academic literature suggest that smart growth in a transport context encompasses integrated transport and land-use planning and the use of digital technology where appropriate and effective. The use of technology can hardly be considered a societal goal in itself, but rather a possible means to achieve societal goals. Therefore, the technological aspect will not be included below in our definition of smart growth.

About inclusive growth

The 2010 EU white paper on growth, quoted above, describes how inclusive growth means fostering a high-employment economy delivering economic, social, and territorial cohesion. However, there are other ways to conceptualise "inclusiveness". The term inclusive is also typically used not only to describe the distribution of incomes but also to depict the access to, for example, education and infrastructure. The UN's sustainable development goals use the word "inclusive" when defining the goals, namely, Goal 4 (quality education), Goal 8 (decent work and economic growth), Goal 9 (industry, innovation, and infrastructure), Growth 11 (sustainable cities and communities), and Goal 16 (peace, justice, and strong institutions) (Hildebrandt, 2016; UN, 2017). "Inclusive growth" is also a concept used by the OECD, applying it to the distribution of economic development. In a report written in cooperation with the World Bank, under the heading "What is inclusive growth", de Mello and Dutz (2011) state:

> "Inclusiveness is a multidimensional concept. Societies strive to achieve and maintain strong growth as a means of raising living standards and improving

> people's wellbeing. But strong growth is not necessarily inclusive in that the benefits of increased prosperity are not always shared evenly among the various social groups. Neither is strong growth, even if sustained over a number of years, a guarantee that disenfranchised social groups would have stronger voice in the political process and in society at large". (p. 9)

This definition involves a broadening of the concept of inclusive growth in that it stresses aspects other than sustainable economic growth. This definition contains two aspects of inclusiveness, namely, fair distribution across population groups and citizen participation/ involvement/engagement in the political process.

There is extensive research analysing both of these aspects of inclusiveness. Fair distribution is studied in research into social justice and town planning (which is of particular interest in view of its strong emphasis on urban development, which is prevalent in the concept of smart cities, dealt with in the next section). A portion of this research, which tries to formulate planning principles for "fair" planning, promotes the view that urban development and infrastructure projects should give low-income inhabitants access to more work opportunities and service facilities. Since lowincome-earners use public transport more often, fair planning should for example favour public transport over car traffic. A fairness perspective also presupposes, according to this research, that inhabitants should be involved in the decisions that affect them (e.g., Fainstein, 2010, p. 173ff).

There is also considerable research into citizen participation in decision making and planning. Generally speaking, there is a clear trend for government authorities to be expected to empower the public by ensuring at least a degree of user influence on various planning processes. There are also new calls for dialogue, user participation, and stakeholder involvement in transport planning. User participation can be seen as important because many existing studies illustrate how infrastructures are designed according to existing conceptions of individuals or groups that use them. Hrelja and Antonson (2012), for example, illustrate how planning processes in a Swedish planning context reflect a set of assumptions about certain types of users and their behaviours. Transport planners' conceptions of users, needs, and behaviour are built into infrastructures, making certain forms of behaviour more possible than others. For infrastructure to be shaped in accordance to different user group needs and preferences, these groups must be involved in the planning.

Definition of smart inclusive growth, and rail relevance

We suggest defining *smart inclusive growth* as coordinated, fair, participatory planning. When it comes to the railway sector it means development of high-speed rail, regional passenger rail, and urban/suburban passenger rail services characterised by integrated transport and land-use planning. This will be made fair by enabling economic growth shared evenly among various social groups of inhabitants and involving various groups of citizens in decision-making and planning.

The goal is relevant to the railway sector by stressing the needs: to integrate land-use and transport planning, to provide accessible and affordable rail services for everyone, and to be open to involving various citizen groups in decision making. In contrast to the following goal focusing on cities, *smart inclusive growth* facilitates contemplation of the railway's contribution to fair development across rural and urban areas.

5.4 Liveable smart cities

The goal *liveable smart cities* encompass a pair of concepts, where "smart", have already been partly defined above. Combining "liveable" with "smart" results in somewhat broader implications. Liveability stresses more aspects of transport sector development than economic growth. At the same time, however, the goal *liveable smart cities* is narrower, as cities are its geographic scope.

About liveable cities

In European public policy debates, the question of how to plan "liveable" cities has been discussed in many ways by the industry, public authorities, and researchers. A British research project, Liveable Cities, explains that the goal of "liveability" is to:

> "transform the engineering of cities to deliver global and societal wellbeing within the context of low-carbon living and resource security through developing realistic and radical engineering that demonstrates the concept of an alternative future". (http://liveablecities.org.uk/).

The Danish consultancy company Rambøll, which markets its knowledge in the field, describes "liveability" in a similar way:

> "Liveability describes the frame conditions of a decent life for all inhabitants of cities, regions and communities including their physical and mental wellbeing. Liveability is based on the principle of sustainability and smart and thus is sensitive to nature and the protection of its resource. The special focus to improve Liveability is to take all dimensions that are relevant to Liveability into account: the physical, the social and the cultural". (http://www.ramboll.com/megatrend/liveablecities-lab)

These quotations indicate that liveability is a multivocal concept that can be used to describe many aspects of city life and the wellbeing of city inhabitants. Several definitions of liveability are also found in the research literature, and "liveability discourses are nothing if not diverse" (Lloyd, Fullager, & Reid, 2016, p. 344). A literature review of indicators related to liveability found that the indicators were used to evaluate city liveability in such diverse areas as: the accessibility and quality of public transport modes; crime rates and safety; housing affordability, employment, and income; social cohesion and local democracy; as well as access to public open space, leisure, culture, education, food, and other goods (Lowe et al., 2015).

However, most definitions "align with the concept of healthy urban environments, suggesting that the determinants of urban health and liveability are similar" (Lowe et al., 2015, p. 132).

In several definitions, liveability is also linked to the environmental dimension of sustainability. However, there are other ways to describe liveability, which do not include the environment. For example, Newton (2012) contends that liveability:

> "relates to those attributes of a place, ranging in scale from dwelling and neighbourhood to a city and its region that contribute to residents' quality of life and wellbeing. As such, the concept embraces measures of residential amenity, human capital, social capital, human health, and the more qualitative elements of personal satisfaction and happiness. … As an attempt to move towards a more integrated view of city performance, this paper examines the nexus of liveability and environmental sustainability. A joint "mapping" of these two dimensions suggests that city liveability is being achieved at the expense of environmental sustainability: that the world's most liveable cities are, to date, acquiring and retaining their status as a result of participating in a level of resource consumption – by their built environments and their residents – that is environmentally unsustainable under current "business as usual" scenarios of urban development". (Newton, 2012, p. 82)

The existence of a potential contradiction between liveability and the ecological dimension of the sustainability concept concerns, for example, the consequences that the urban planning of high-density developments has for individuals' quality of life, and individuals' dissatisfaction with related factors such as noise, traffic, and environmental quality (e.g., Howley, Scott, & Redmond, 2009).

About smart cities

The "smart city" notion is being increasingly applied, and "is reshaping the debates about contemporary cities" (Luque-Ayala & Marvin, 2015, p. 2106). This is also the case in the EU, where the European Commission has set up a European Initiative on Smart Cities (https://setis.ec.europa.eu/set-plan-implementation/technology-roadmaps/european-initiativesmart-cities) as well as a European Innovation Partnership on Smart Cities and Communities (https://eu-smartcities.eu/). Both these initiatives focus to different extents on energy and climate objectives, quality of life, transport, innovation, planning, use of ICT, and participatory approaches. The term is obviously also applied at the local level (e.g., http://vpt.dk/innovationafbureaukratisering/hvad-er-en-smart-city).

In a survey of the scientific literature on smart cities, Albino et al. (2015) found that researchers typically use "smart" to describe:

- a city's networked infrastructure that enables political efficiency and social and cultural development

- an emphasis on business-led urban development and creative activities for the promotion of urban growth
- social inclusion of various urban residents and social capital in urban development
- the natural environment as a strategic component for the future (Albino et al., 2015, p. 13)

According to this definition, "smart" refers to building "successful" cities through urban and traffic planning. The term "smart city" is used to describe a future city in which long-term strategic planning has created value, utility, and wellbeing for the inhabitants of a city or region (Albino et al., 2015, p. 5). Strategic planning should be understood here as planning that succeeds in moving towards the realisation of the urban development goals. This is also led by companies and stresses the meaning of both economic development and resident participation throughout the planning process.

Researchers also describe another way to define "smart" in connection with urban development and city planning: "smart" is also commonly used to describe infrastructure digitalisation that can be used to plan cities in a better way. Digitalisation, according to Granath (2016), has become an

> "appealing solution to many of the pressing problems policy-makers are facing. … As a consequence, the concept of a smart city has emerged in recent discussions on urban strategy. This concept has come to encapsulate both the work with urban planning, i.e., initiatives taken to become smart (Albino et al., 2015; Washburn et al., 2010), and urban development as such, i.e., visions of a future urban state (Angelidou, 2015; Gil-Garcia, 2012). When spoken of as digitising urban systems and infrastructures, it basically refers to implementation and use of ICTs to analyse and act on city activities (Kitchin, 2014). In effect, this means that cities are equipped with digital devices and a digital infrastructure to produce large amounts of data (also referred to as big data). This could for example mean that sensors are implemented in buildings, streets, vehicles, and open spaces in order to inform city management on ongoing activities". (p. 3)

Definition of liveable smart cities, and rail relevance

In summary, *liveable smart cities* is a goal that is relatively diffuse in that it may encompass many aspects of a city's development that do not necessarily have to do with railways. It may contain potential goal conflicts and may partly overlap with other goals, such as the goal of *smart inclusive growth*. Liveability permits to a broader perspective of urban development: linking the concept to inhabitants' railway access to services and not including the environment enables us to operationalise and delimit it with respect to the other goals.

Liveability can be defined as the degree to which urban and suburban passenger rail supports the quality of life and wellbeing of the city's residents. Liveable cities are intentionally, from a rail transport point of view, planned to provide convenient access to health and social services,

schools, shops, and leisure and cultural activities with limited negative externalities to their residents. Goal fulfilment can be evaluated by assessing the accessibility of services for the city's residents, measured in travel time, distance, and the quality and affordability of rail transport services (see section 4.6 for a discussion of accessibility).

5.5 Regional integration and enlargement to reach critical mass

This goal is not cited verbatim in EU policy documents. The origin of this goal seems to be within national policy discussions considering the role of transport in regional development and labour market enlargement in some member states (e.g., Sweden; see National Board of Housing, Building and Planning, 2005). In general, economic globalisation and internationalisation via the EU have led to growing interest in the regional level. The idea is that global economic development has reduced the significance of the nation and increased the importance of the region as an economic unit. Due to increased economic competition between regions, the regions' or cities' attractiveness as localisation sites for companies or residents have come to the fore in regional development and transport policy. The goal *regional integration and enlargement to reach critical mass* can be understood in light of the assumption that competitive regions and favourable regional development are dependent on the degree of functionality – that is, a high degree of intraregional interaction among the cities in a particular region in the form of trade in goods and services, work commuting, and shopping (Karlsson, 2006; OECD, 2012).

Besides the functional region, the polycentric region is a concept also used in describing how to create successful, integrated regions (Brezzi & Veneri, 2014; Burger et al., 2013). "Polycentric urban regions" have been defined as "historically and spatially separate metropolitan areas constituting a larger, functionally interrelated urban region" (Burger et al., 2013, p. 817). A shared assumption in descriptions in the research literature of functional and polycentric regions is that the aim is to achieve spatially integrated cities. Improved transport opportunities are expected to lead to opportunities for both employers and employees to choose labour and work, increasing the sense of security of both, in that more alternatives will become available or inhabitants will have more opportunities to learn about the services already available in surrounding cities.

The goal *regional integration and enlargement to reach critical mass* is given a more concrete meaning in relation to the goal of functionality and polycentrism. The goal also seems to be based on the assumption that the building and expansion of already functionally successful regions is a matter of achieving a critical mass of companies and services before a region can develop as desired. This means that a functioning rail transport system should be seen (as mentioned when discussing other objectives) as a tool for promoting a region's development, development influenced by factors such as mobility, individuals' commuting propensities, and the region's role as an integrated labour market. Well-functioning rail transport systems can promote the attainment of regional enlargement and critical mass by facilitating commuting within a specific region and helping to connect nearby urban areas. Rail transport systems should therefore be developed through improvements and investments that serve to increase mobility and reduce travel time (particularly commuting time) between cities. This assumes

that individuals' commuting propensities will decrease when the travel time between, for example, home and workplace is viewed as too long. In addition, such decreased commuting propensities may have negative impacts on the long-term economic development of the region as an integrated labour market. Previous transport research demonstrates that this assumption is widely spread in transport policies. Research also indicates that strong policy emphasis is placed on supply-side improvements in transport systems, especially measures that improve intra- and interregional connectivity, and on creating high-quality urban environments hoped to attract new residents and workplaces (Mullen & Marsden, 2015; Svensson et al., 2014). Competition between cities is prominent in this discourse, though with less emphasis on which cities win and lose in a region (Mullen & Marsden, 2015). Investments in rail that reduce travel time may disadvantage certain areas compared to others (Vickerman, 2015), which means that achieving this goal must be set in relation to the target of *smart inclusive growth* as well as the goal of *attractive, connected, and accessible regions*.

Definition of regional integration and enlargement to reach critical mass, and rail relevance

Regional integration and enlargement to reach critical mass entails increasing the spatial integration of cities through intraregional trade in goods and services and through commuting and shopping via regional passenger, urban/suburban passenger, and freight rail services. Improved transport opportunities create increased opportunities for both employers and employees, improving the security of both in that more alternatives become accessible or inhabitants have more opportunities to use the services available in the surrounding cities. Intra-regional accessibility is increased through reduced travel and transport times; in addition, as transport costs drop, accessibility and travel comfort increase (Fröidh, 2003). Goal fulfilment can be assessed in terms of the accessibility of workplaces, for example, in which the change in the number of workplaces within a particular time radius of a door-to-door journey resulting from a measure is visualised and measured (Fröidh, 2003). Goal fulfilment should also be assessed in relation to other goals, such as *smart inclusive growth*, since regional integration may be uneven and can both favour and disfavour particular cities and their inhabitants.

5.6 Attractive, connected, and accessible regions

Two of the six societal goals focus on regions: *regional integration and enlargement to reach critical mass* (cf. section 4.5) and *attractive, connected, and accessible regions*. While the first goal focuses on *intra*regional interaction, the second goal focuses on *inter*regional interaction. Therefore, the latter is the topic of the following section.

Connecting regions and cities in Europe has been the main focus of EU transport policy from the start, promoting the exchange of goods, services, labour, and capital, and thereby helping build the EU internal or single market. That was, and still is, the focus of all EU white papers

on transport. For example, the current transport white paper from 2011 includes goals regarding the completion of a European high-speed rail network and of a fully functional and EU-wide multimodal TEN-T network; in a new topic for the EU, it also includes a goal concerning cities (EC, 2011). The TENT program consists of hundreds of projects whose ultimate purposes are to ensure the cohesion, interconnection, and interoperability of the European transport network and to ensure access to it. This would help making European regions and cities more connected, accessible, and attractive. In addition, the Connecting Europe Facility has been established for the same purpose.

We regard the concepts "connected" and "accessible" to be of more analytical interest than "attractive" in the context of this goal (attractiveness can already be said to have been discussed in section 4.4, Liveable smart cities). In addition, since the concepts "connected" and "accessible" regions in the context of EU policy making seem to be used synonymously, we choose to focus on accessibility because there is a scientific literature on transport accessibility (e.g., Curtis, 2008, 2017; Curtis & Scheurer, 2010). Transport planning has traditionally focused on the efficiency of transport systems, sometimes described as a "predict-and-provide" approach to transport needs and has to a lesser degree addressed economic and societal goals that can be hampered or served by transport development. To address this shortcoming, it has been argued that a shift from planning for mobility supply to planning for accessibility is needed (e.g., Straatemeier, 2008). Accessibility has been defined as:

> "the amount and the diversity of places of activity that can be reached within a given travel time and/or cost" (Bertolini et al., 2005, p. 209).

The potential to reach jobs and services, etc., via interregional transport is influenced:

> "by the qualities of the transport system (reflecting travel time or the costs of reaching a destination, on the one hand, and by the qualities of the land-use system (reflecting the qualities of potential destinations), on the other hand" (Straatemeier 2008, p. 128).

Developing *attractive, connected, and accessible regions* is thus (as for the goals *smart inclusive growth* and *liveable smart cities*) largely about establishing effective and integrated land-use and transport planning.

There is also considerable scientific literature on the link between transport infrastructure and regional development. There is little doubt that infrastructure investment affects spatial development patterns (Spiekermann & Wegener, 2008; Vickerman, 2015). What is disputed is the effect on peripheral regions (Hall, 2009; Spiekerman & Wegener, 2008) and, in the case of highspeed rail, the effect on intermediate cities (Vickerman, 2015).

As suggested by Spiekerman and Wegener (2008), the link between transport infrastructure and regional development is very complex:

> "However, today the relationship between transport infrastructure and economic development has become more complex than ever. There are successful regions in the European core confirming the theoretical expectation that location matters, but there are also centrally located regions suffering from industrial decline and high unemployment. On the other side of the spectrum, the poorest regions, as theory would predict, are at the periphery, but there are also prosperous peripheral regions such as the Nordic countries. To make things even more difficult, some of the economically fastest-growing regions are among the most peripheral ones" (p. 6).

Some authors state that high-speed rail infrastructure, more than infrastructure for other modes (e.g., motorways), particularly favours the densely populated central regions of Europe, where major cities are located at ideal distances (Spiekerman & Wegener, 1996). However, from an environmental and climate point of view (cf. section 4.1: Greening of society), rail travel has relatively little impact in comparison to air or car transport (European Environmental Agency, 2016a).

With the increasing role of ICT in mobility, it is obvious that ICT can have an impact on accessibility, because it might to some extent, and in some situations, replace physical access. This field of research, however, is considered to be understudied (Wee, 2016; Wee et al., 2013).

Definition of attractive, connected, and accessible regions, and rail relevance

We regard the goal *attractive, connected, and accessible regions* as concerning improved interregional interaction in Europe, aiming to connect European regions. To achieve this goal, a high degree of accessibility (i.e., what can be reached from a given point in space) is required for services, measured in the travel time or the cost of reaching a destination (Bertolini et al., 2005). In the present context, this goal focuses on the contribution of rail to interregional transport, above all in the form of high-speed and freight rail. Regional connection has dominated EU transport policy from the very beginning. Politically, the rail sector stands at the forefront of these efforts, as the current European white paper on transport includes goals of increasing the extent of the existing high-speed rail network as well as a modal shift of road freight to rail and waterborne transport (EC, 2011). However, the effects on regions of infrastructure investments and, not least, of high-speed rail investments are disputed, and investments have apparently increased regional disparities in economic prosperity. The goal should therefore be seen in relation to the goal of *smart inclusive growth*. Goal fulfilment can be evaluated by analysing exchanges of goods, services, and people between regions by means of the railway.

5.7 Societal goals: summing-up

In the table below, the findings presented in chapter 4 are summarized. For each societal goal, the definition, relevance to rail, the associated sustainability dimension(s), and relevant market segments are illustrated.

Table 2: Summary of societal goals

Goal	Definition	Rail relevance	Sustainability dimension	Relevant rail market segments
Greening of society	Policy sectors other than the environ-ment are trans formed in accordance with environmental goals	Rail itself becomes more environ- mentally friendly Modal shift from car and air to rail transport	Environmental	High-speed Regional Urban/suburban Freight
Competitive-ness and sustainability	New business and employment opportunities for the railway industry that make the industry competitive over the longer term while ensuring sustainability	Rail companies and authorities succeed in combining eco efficiency and competitiveness	Economic Environmental	High-speed Regional Urban/suburban Freight
Smart inclusive growth	Coordinated, fair, participatory planning	The rail sector is engaged in integrated land-use and transport planning The sector provides affordable and reliable rail services for everyone Citizens participate in decision making in the sector	Social Economic	High-speed Regional Urban/suburban
Liveable smart cities	High quality of life and wellbeing for the city's residents	The railway increasingly promotes accessibility for the city's residents	Social	Urban/suburban
Regional integration and enlargement to reach critical mass	High degree of spatial integration of the cities in a region via intraregional interaction taking place through trade of goods and services, job commuting, and shopping	The railway increasingly facilitates intra-regional interaction between cities, defined as accessibility of services, measured in travel time or the cost of reaching a destination	Economic	Regional Urban/suburban Freight
Attractive, connected, and accessible regions	Improved inter regional interaction in Europe, aiming to connect European regions	The railway increasingly fosters interregional interaction	Economic	High-speed Freight

It appears from the above table that the societal goals in practice are often applied in redundant ways; for example, the notions “smart”, “liveable”, and “sustainable” are all applied to signify or include “greening”. However, in this context, our aim was to distinguish the individual goals from one another and provide every single goal with its own meaning. Nevertheless, one has to consider that the goals are linked and overlap with each other in many ways.

Hence, focusing solely on the achievement of one societal goal will result in the neglect of important societal aspects. For example, a comprehensive assessment cannot be carried out by analysing only regional integration and enlargement or attractive, connected, and accessible regions without considering the inclusiveness goal, i.e., smart inclusive growth. Cost Benefit Analyses (CBA) and Multicriteria Decision Analyses are methods often applied in planning processes to make comprehensive assessments including different goals (Jensen et al., 2011).

6 Indicators

Taking the above-mentioned definitions of the societal goals as basis, the subsequent chapter focuses on possible indicators that could be applied to assess the contribution of the railway sector considering the goal's attainment. The chapter is divided into three sections: First, a definition will be provided of what an indicator is and the role of indicators in the IMPACT-projects explained (section 5.1); secondly, possible and relevant indicators for measuring achievement of the societal goals will be discussed (section 5.2); and finally, we conclude by suggesting a limited number of indicators attached to each societal goal (section 5.3).

6.1 Indicators and use

Indicators are used in many different settings to support individual choices. Indicators also help planners and decision-makers make choices for larger systems (Gudmundsson et al., 2015), for example, the transport (Trafikanalys, 2017) or railway sector (European Union Agency for Railways, 2016). Indicators are often regarded as bridging policy and knowledge (Turnhout et al., 2007).

The term "indicator" is defined in different ways based on specific contexts and disciplines. In the present context, we suggest that an indicator is a "variable, or a combination of variables, selected to represent a certain wider issue or characteristic of interest" (Gudmundsson et al., 2015, p. 139). This definition emphasises the importance of an indicator capturing a specific issue or characteristic, which in this context is the railway sector's or the Shift2Rail program's contribution to the societal goals. "Wider" means that an individual indicator will never be able to fully capture such a complex phenomenon in a single measure. The definition covers indicators based on a single variable as well as composite indicators or indexes based on more variables (Gudmundsson et al., 2015, Reisi et al., 2014). The definition further implies that indicators can be quantitative and qualitative, which is also the case for the indicators suggested below.

The choice of indicators depends on their use, which can vary considerably. The indicators suggested here should help assess the railway sector's potential contributing to the societal goals as well as the Shift2Rail's actual contribution to achieve the goals. These assessments will be carried out in IMPACT-2. Now, possible relevant indicators for these tasks are discussed.

We aim to assess a development from the actual state to a potential new state of railway contributing to attain the societal goals or from the actual state to a situation after the implementation of Shift2Rail results. Therefore, one criterion for the choice of suitable indicators is that they should represent time-series. A further criterion is that some indicators should represent the planning while others should represent the delivery dimensions of transport policy (Gudmundsson et al., 2015), since both dimensions play a role in the definitions of the societal goals. The indicators are provided here in a general format. For

application in the subsequent assessments they will have to be further developed and detailed, e.g. the methodology for obtaining data for the individual indicators.

It should be emphasized that the indicators focused on in this chapter differ from the key performance indicators (KPIs) dealt with in WP 4 of IMPACT-1. While the indicators in the present chapter aim to be an instrument in assessment of attainment of the societal goals (defined in chapter 4), the KPIs which is the focus of WP4 aim to be an instrument in assessment of the attainment of Shift2Rail objectives (mentioned in chapter 2).

6.2 Possible indicators to assess the societal goals

Linked to the broad societal goals, a large number of indicators are suggested in the literature. The main share of the relevant indicator literature is focused on sustainable transport (e.g. Barfod et al, 2018; European Environmental Agency, 2016a; Gudmundsson et al., 2015; Haghshenas & Vaziri, 2012; Holden et al., 2013; Jeon & Amekudzi, 2005; Reisi et al., 2014), while other parts more broadly focus on transport (e.g. European Commission, 2017b; Trafikanalys, 2017), and a share of these again on the railway sector (e.g. European Commission, 2015b; European Union Agency for Railways, 2016; Poelman & Ackermans, 2016; UIC, 2016). Many relevant indicators could be suggested. However, this often proves inappropriate because it might be difficult to interpret many indicators. Therefore, the ambition was to suggest as few as possible indicators for each societal goal.

Greening of society

For the goal of greening of society, indicators related to the environmental pressure from the railway sector are relevant, such as indicators dealing with air emissions, railway noise, GHG from rail, consumption of non-renewable material, sustainable energy use, recycling of scrapped trains, and land area occupied. As the societal goal is defined above also indicators of the modal split between rail and other (more pollutant) modes are relevant – in freight as well as passenger transport. Further, indicators focusing on the process or organisational aspects of environmental policy integration could prove useful, thus contributing to assess if organisational steps are taken even though it might not yet be visible at other levels, e.g. if tenders and contracts with rail operators as well as internal contracts between the governmental level and rail authorities to an increasing extent include environmental issues. Thus, a variety of indicators are relevant. However, a multitude of indicators is not manageable.

On this background we suggest two indicators regarding the goal on greening of society, which we consider to be the most relevant ones:

- A composite indicator for development in greening of the railway sector
- An indicator on development in modal shift from air and car to rail (passenger and freight)

Similar composite indicators are developed in other contexts, e.g. for sustainability of urban transport.

Reisi et al. (2014) discuss advantages and disadvantages of such composite indicators which sometimes are met by scepticism because the construction is subjective, but on the other hand might improve communication because they limit the number of presented information. Reisi et al. conclude that "indicators aggregation is successful if clear assumptions and methodology are used and if the index can be disaggregated to its components" (Reisi et al., 2014, p. 288)[3]. For the use in this context, the environmental component of transport sustainability composite indicators could provide inspiration (e.g. Haghshenas & Vaziri, 2012; Reisi et al., 2014). If a composite indicator cannot be constructed, single indicators for the development in noise or landscape consequences of new rail infrastructure could be relevant alternative indicators (Gudmundsson et al., 2015).

Modal split is a frequently used indicator in transport, measured in traffic or transport volumes (e.g. European Commission, 2017b; Jeon & Amekudzi, 2005; Trafikanalys, 2017). This is an indicator relevant for many of the other goals, as well. It is however important to stress that more railway transport is not always equivalent with greener transport. It depends on the volume transported (see the discussion in section 4.1).

Competitiveness and sustainability

The goal of competitiveness and sustainability is a twofold goal, which we have defined as new business and employment opportunities for the European railway industry that make all four market segments competitive over the longer term while ensuring sustainability. Railway development should of course not only make the railway industry competitive. The purpose of better rail transports is to make the whole economy more productive and increase the return on investments for businesses and people alike. However, the other goals and indicators defined here concerns how the railway industry may further the development of regions and cities etc.

In the literature many indicators are suggested for measuring competitiveness (e.g. employment, growth potential, investments, see European Commission, 2017b; Jeon & Amekudzi, 2005). This is obviously also the case for sustainability, which in relation to this societal goal covers all the environmental indicators related to railway transport (see *Greening of society* above) as well as indicators connected to the social and economic dimensions of sustainability (e.g. access, affordability, safety, suicides, inter and intra-generational equity, as well as efficiency, see Barfod et al., 2018; Jeon & Amekudzi, 2005). Internal overlaps in suggested indicators exist within the twofold goal between competitiveness and the economic

[3] : In an example of a composite sustainable transport indicator for Melbourne, a number of environmental, social and economic indicators were chosen, they were assigned with values, weighted and combined. The result being figures stating the current status of overall transport sustainability in Melbourne, e.g. visualised in a map (Reisi et al., 2014).

dimension of sustainability. Indicators related to the environmental dimension of sustainability obviously overlap with indicators attached to the above goal of greening of society. In addition, indicators on process and organisational aspects of sustainability could be included, e.g. the number of infrastructure managers and railway operators adopting a sustainability strategy and/or including the UN sustainable development goals (SDG) in their business strategy (Hildebrandt, 2016, UN, 2017).

On this background, two indicators are suggested regarding the goal of competitiveness and sustainability

- An indicator on the development in investments increasing competitiveness (capacity, reliability, costs)
- A composite indicator for development of the railway sector's contribution to sustainability (including social, environmental and economic dimensions)

Indicators on infrastructure investments are often found in the literature (e.g. European Environmental Agency, 2016b; Jeon & Amekudzi, 2005, OECD, 2018). As regards the suggested composite indicator, we refer to the discussion above in connection to the suggested composite indicator on greening of the railway.

Smart, inclusive growth

The goal on "Smart, inclusive growth" is broad and can be interpreted in a multitude of ways. In chapter 4 we defined the goal as rail services characterised by integrated transport and land-use planning, enabling economic growth shared evenly among various groups of inhabitants and involving citizens in decision-making and planning.

It seems straightforward based on this definition to suggest three indicators on (1) transport and land use integration, (2) fair distribution, and (3) citizen participation. While fair distribution in various forms is suggested as an indicator topic in the literature (e.g. accessibility for those without a car, women, children, disabled people, affordability of public transport by lower income residents, Barfod et al., 2018; Jeon & Amekudzi, 2005; Trafikanalys, 2017), indicators for integration of transport and land-use planning as well as citizen participating are not typical indicators (with the exception of Jeon & Amekudzi, 2005 and Morrissey, 2000 on participating, and Walle et al., 2004 on integration of transport and land use). The cause might be that such indicators focus on the planning rather than the delivery dimension of transport policy, and that they are likely to be qualitative rather than quantitative. The strong presence of "inclusiveness" in the UN sustainable development goals (SDG) might contribute to change this tendency.

On this background, we suggest three indicators regarding the goal on smart, inclusive growth:

- An indicator on development in the degree of integration of railway and land use planning (see section 6.3 for a more detailed discussion)

- An indicator on low income groups' affordability and accessibility of rail passenger services (e.g. price of rail transport and travel time)
- An indicator on development in citizen participation in railway planning processes (e.g. consultation with the affected population when developing plans)

As already mentioned, the affordability and accessibility indicators are found in the literature (e.g. Barfod et al., 2018, Jeon & Amekudzi, 2005, Trafikanalys, 2017), while for integration and citizen participation, indicators will have to be further developed. Stakeholder consultations including citizens (and local, regional authorities, businesses etc.) is normally part of railway planning processes. However, there is an extensive literature on public participation in planning in general, and to a lesser extent on public participation in the planning of transport infrastructure that conclude that the role of the public must be strengthened. The problem for railway planning is how to involve people who do not usually engage in such consultations, and how to empower people to take charge of their lives and their surroundings. The indicator on low income groups will overlap with the indicators suggested below on rail affordability and travel time proximity as well as with the social dimension of the above suggested composite indicator on sustainability.

Livable smart cities

The goal on "Livable smart cities" is in the literature used to encompass many aspects of a city's development. In chapter 4 above we defined it as quality of life and wellbeing for city residents but linked it rather narrowly to the railway sector by focusing only on the accessibility, quality and affordability of rail transport services. Thus, in the definition here of livable smart cities the negative (often environmental) externalities of rail are left out, though noise, land take, emissions and barrier effects of rail infrastructure also impact on the liveability of cities.

As already mentioned above, indicators for accessibility and affordability of transport services are common in the literature – and even more common when the explicit focus is not on low income groups. Access to public transport services within a certain distance, travel time proximity to certain services or areas and percentage of household income spent on transport are examples of indicators (e.g. Barfod et al., 2018; Jeon & Amekudzi, 2005; Poelman & Ackerman, 2016; Trafikanalys, 2017). Regarding the quality of public transport services more indicators are also applied (e.g. public transport performance, quality of integration with other modes, customer satisfaction, Jeon & Amekudzi, 2005; Urbanet et al., 2017).

On this background the following three indicators are suggested:

- An indicator on development in travel time proximity (including rail) to designated areas in cities
- An indicator on the development in quality of rail services (e.g. travel speed, punctuality and reliability)
- An indicator on the development of affordability of rail services for city residents

The indicators on travel time and affordability will overlap with indicators suggested above on sustainability and low-income groups as well as the below indicators on accessibility.

Regional integration and enlargement to reach critical mass

The goal is defined in chapter 4 as a high degree of spatial integration of the cities in a region via intraregional interaction taking place through trade of goods and services, job commuting and shopping. The railway can have an important role by facilitating intraregional interaction, but transport is only one of more factors of importance (Trafikanalys, 2013). In most trips, rail only constitutes one step and has to be combined with other modes: car, bus, cycling, walking. The railway's coordination with other modes of transport, for example in first- and last mile transport is of importance and could itself be represented by an indicator.

Regional accessibility is a topic in the literature, e.g. the ease of reaching economically important assets (Jeon & Amekudzi, 2005) or more specific indicators for reliability, comfort and competitivess (Trafikanalys, 2013). As explained above, also affordability is covered in the literature (Barfod et al., 2018; Jeon & Amekudzi, 2005).

On this background, we suggest two indicators for the goal on regional integration and enlargement to reach critical mass:

- An indicator on the development in regional access to markets: the ease of reaching economically important assets (e.g. work places) by trips including railway (door-todoor), e.g. changes in travel time between cities
- An indicator on the development in affordability of intraregional rail services (e.g. as percentage of income)

The accessibility as well as affordability indicators suggested for this goal imply an overlap to other suggested indicators, though the indicators suggested within this goal explicitly focus on the intraregional dimension, while other suggested indicators focus on the city (however, sometimes the same as a region) or the interregional relations (see below).

Attractive, connected, and accessible regions

This societal goal of "attractive, connected, and accessible regions" is defined in chapter 4 as improved interregional interaction in Europe, aiming to connect European regions. The role of the railway is to foster interregional interaction mostly by high speed and freight rail.

Indicators applied for high speed rail often consider travel time between certain large cities (e.g. Trafikanalys, 2013, Vickerman, 2015). However, simply measuring travel time between certain large cities might be too simple leaving out possible consequences for intermediate cities and towns (Vickerman, 2015).

On this background we suggest three indicators connected to the goal:

- An indicator on the development in the share of exchange of people (for work or leisure) between designated regions by use of rail
- An indicator on the development in the share of exchange of goods between designated regions by use of rail
- An indicator on the development in the share of exchange of services between designated regions by use of rail

These indicators overlap with other indicators suggested above focusing on accessibility. However, only the indicators suggested here focus on *interregional* accessibility. Some work will be necessary to develop these specific indicators further.

6.3 Suggested indicators: summing-up.

It appears from table 2 that more indicators overlap and thus are suggested for different goals. That is the case for composite indicator on greening, which is also included as an element in the composite indicator on sustainability. Likewise, affordability is suggested in combination with accessibility as an indicator for the goal on *Smart inclusive growth*, while affordability for city residents and affordability in intraregional rail services are suggested for other goals. Accessibility appears in combination with affordability, but accessibility also appears in the indicators on cities (travel time proximity) and intraregional access to markets, as well as indirectly in all three suggested indicators suggested for the goal on *Attractive, connected, and accessible regions*. More work on the suggested indicators is needed to be able to apply them when assessing the potential role of the railway to contribute to the goals as well as to assess the specific contribution from Shift2Rail.

Table 3:Summary of suggested indicators

Goal	Suggested indicators
Greening of society	A composite indicator for development in greening of rail
	An indicator on development in modal shift from air and car to rail (passenger and freight)
Competitiveness and sustain ability	An indicator on the development in investments increasing competitiveness (capacity, reliability, costs)
	A composite indicator for development of railway contribution to sustainability (including social-, environmental- and economic dimensions)
Smart inclusive growth	An indicator on development in the degree of integration of rail transport and land use planning
	An indicator on low income groups' affordability and accessibility of rail passenger services (e.g. price of rail transport and travel time)
	An indicator on development in citizen participation in railway planning processes (e.g. consultation with the affected population when developing plans)
Liveable smart cities	An indicator on development in travel time proximity (including rail) to designated areas in cities

Goal	Suggested indicators
	An indicator on the development in quality of rail services (e.g. travel speed, punctuality and reliability)
	An indicator on the development of affordability of rail services for city residents
Regional integration and enlargement to reach critical mass	An indicator on development in regional access to markets: the ease of reaching economically important assets (e.g. work places) by trips including railway (door-to-door), e.g. changes in travel time between cities
	An indicator on the development in affordability of intraregional rail services (e.g. as percentage of income)
Attractive, connected, and accessible regions	An indicator on development in the share of exchange of people (for work or leisure) between designated regions by use of rail
	An indicator on development in the share of exchange of goods between designated regions by use of rail
	An indicator on development in the share of exchange of services between designated regions by use of rail

7 The railway sector and the societal goals – current status and implementation factors

In order to assess how Shift2Rail helps to achieve societal goals, we need to discuss the current status of the railway sector, that is, the situation without Shift2Rail. It is further relevant to consider implementation factors that might impede or enable achievement.

It is hard to assess the current status of the railway sector's contribution to specific societal goals in all relevant aspects because of the sheer size of such a task. Additionally, it will in some ways depend on highly geographically and planning context dependent circumstances. There are also large differences between market segments on how well they currently help to achieve societal goals.

This makes it difficult to define both the current status, and to pin down generally valid factors that enable or hinder the railway sector in helping to achieve societal goals. Of the indicators suggested in chapter 5, the most prominently covered indicator is the one on modal shift from air and car to rail. This indicator is suggested to be used when assessing contributions from Shift2Rail of importance for the societal goal on Greening of society, but it is relevant for many of the other goals, as well. In the following we will therefore first discuss the current status of the railway sector by describing the development in modal share and the development of passenger outputs and freight activity (section 6.1). We will after this discuss data and literature relevant to some of the other suggested indicators. However, for a number of these, we have not been able to find suitable data or literature for this review of the current status. We will therefore (in section 6.2) focus on four important indicators: investments, affordability, quality and accessibility. When possible, we will discuss the findings in relation to real world cases reported in research literature. In the following section (section 6.3) we will discuss implementation factors of importance followed by a concluding section (section 6.4). An implementation factor is here defined as a factor or condition that need to be met, or a situation, that would facilitate the achievement of a specific societal goal. An implementation barrier is defined as a shortcoming in an implementation factor (this definition is inspired by Walker et al. 2009).

7.1 Modal split, passenger outputs and freight activity

Rail passenger outputs in the EU have grown since 2000 despite economic problems facing member states. Passenger kilometres increased approximately 1% per year between 2000–2015 (EC 2015b, p. 14), and approximately 1,9 % between 2014–2015 (EC 2017b). The most significant increases in rail passenger kilometres have been observed in Western Europe while most other member states have seen relatively minor changes in train kilometres, or even significant downturn in train kilometres. While rail passenger outputs in the EU have grown, the modal share of passenger rail has since 2005 only grown by a half percentage point.

The share of high-speed rail transport in total passenger kilometres in rail transport is growing (from 15,9 % in 2000 to 25,7 % in 2015. See EC 2017b), but regional and urban/suburban passenger rail account for approximately 90% of the total railway passengers in Europe. This makes this segment particularly critical to ensure societal goals of rail relevance. There are substantial differences between countries regarding regional and urban/suburban rail and ridership development that influence how well rail may contribute to reaching societal goals. Countries such as Belgium, France, Germany and the UK have experienced significant ridership increase over the last decade, while countries such as Spain and Portugal have lost up to 15% of their ridership. The countries with the lowest ridership have small rail networks and populations, e.g. the Baltic States (UITP 2016a).

The development of rail should also be compared to the development of other modes. The percentage of travelers using cars decreased from 73.2% in 1995 to 71.5% in 2015. During the same period the modal share of air passenger transport (domestic and intra-EU-28 transport) increased from 6.5% in 1995 to 9,8% in 2015 (EC 2017b).

Freight rail in the EU declined, in contrasts to passenger transport, by 10% between 2007–2012 (tonne kilometres) but has started to grow again (EC 2017b). Freight rail grew 1,6% (tonne kilometres) 2014–2015 (EC 2017b). However, the modal share of rail freight was in 2015 almost the same as in 2006.

To conclude, in passenger rail, a small increase in modal shift can be seen. For freight rail, the sector has not been able to increase its share of the total freight carriage, despite growing freight markets (Ludvigsen & Osland 2009). However, the deviations across the EU are substantial.

7.2 Investments, affordability, quality and accessibility

The basis for this section is those indicators for which we - at this stage - are able to provide data. We will here touch upon four topics related to the indicators: investments in rail, affordability of rail services, quality of rail services and accessibility.

Investments

A suggested indicator in chapter 5 is the development in investments increasing competitiveness through rising capacity, reliability and reduction of costs. Here we will only be able to discuss the actual investments in rail as well as development of length of track and passenger seats.

In general, Europe has seen a reduction of length of track over the last decade as well as a reduction in passenger seats (Fraszczyk et al. 2016). Some countries, especially Eastern-European countries, are preparing to reduce regional and suburban rail (UITP 2016a). Additionally, road investment potentially counteracts the long-term attractiveness and competitiveness of regional and urban rail:

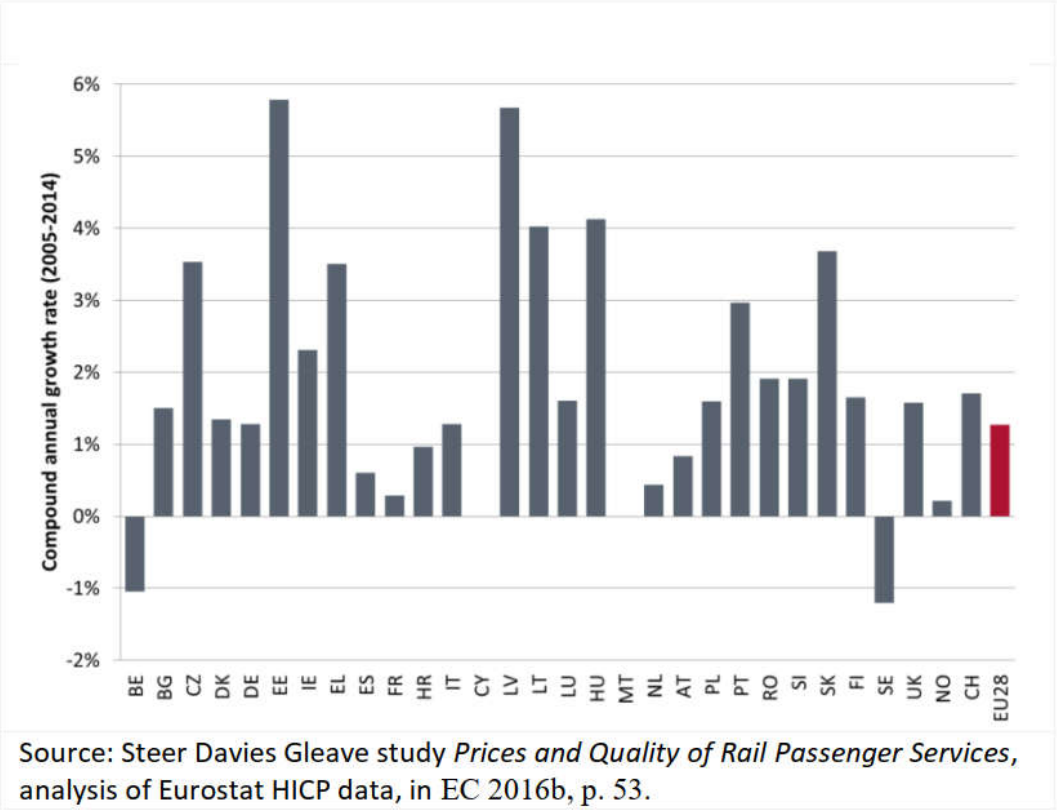
> "This segment suffers from unbalanced competition with the private car and has still a large potential for growth as leverage of sustainable land use and suburban/regional mobility policies" (UITP 2016b).

However, there is also a revival of interest in regional and urban passenger rail (Olesen 2014). One example is the increasing interest of light rail. Light rail projects are seen in many cities, not only as a way to solve cities' present and future transport needs, but as a way to implement innovative urban planning strategies that connect public transport with urban developments with high "urban qualities". A new discourse around light rail emerges for the promotion and realization of light rail projects around Europe. If some time ago, focus when discussing public transportation was on capacity, now it seems much more focused on the contribution of rail transport to the "image" of cities, and development of cities towards "attractiveness" and "liveability" (Ferbrache & Knowles 2017, Olesen 2014, Olesen & Lassen 2016).

Affordability

Several of the suggested indicators focus on affordability. These indicators are relevant for societal goals on *smart inclusive growth*, *liveable smart cities*, *and regional integration and enlargement to reach critical mass*.

We have not yet found an ideal indicator for measuring affordability. Hence, we will use the price of rail travel compared to travel with other modes. However, the reliability of conclusions on prices of rail services based on available data is limited and should be interpreted with care. In all but Belgium and Sweden rail travel appears to have become more expensive relative to other modes since 2005 (figure 3). In figure 1, a value greater than zero suggests that rail travel is becoming more expensive than a basket of transport services (private and public) across all modes and vice versa (EC 2016b).



Source: Steer Davies Gleave study *Prices and Quality of Rail Passenger Services*, analysis of Eurostat HICP data, in EC 2016b, p. 53.

Figure 1: Harmonised Index of Consumer Prices: rail transport/all transport

This indicates that affordability of rail services has decreased. However, the suggested indicators in chapter 5 require more detailed data on the prices of rail services in cities, intraregional services and in particular for low income groups.

Quality

The suggested indicator on quality of rail services is linked to the goal of *Liveable, smart cities*. Many different aspects could be included in an indicator on quality. Here, we will focus on three aspects of quality, namely travel speed, punctuality and reliability. ‘

There are large differences between the EU countries in terms of travel speed. Despite large investments to modernise the rail network system, there are regional passenger networks, especially in Eastern Europe, where the maximum permitted speed is 120 km/h or in some cases even less (EC 2016a).

The punctuality of long-distance services tends to be worse than regional and local services. The number of on-time trains ranges from 99% in Estonia to 63% in Croatia (EC, 2016b). A train is defined as punctual if it is delayed by 5 minutes or less for regional services, and by 15 minutes or less for long-distance services.

Reliability is defined as the proportion of scheduled passenger services that are cancelled. Based on data available, a high level of cancellation is limited to operations in a few Eastern European Member States. Few Western or Central European Member States cancelled more than 3% of regional or 5% of long-distance services (EC, 2016b).

This shows, first, that the rail service in several countries has not been able to increase its competitive capacity against road transport as well as desired, and second, that there are substantial differences between countries in rail transport development that needs to be kept in mind when assessing the status of high-speed rail, regional passenger rail, urban passenger rail, and freight rail in Europe.

Accessibility

Accessibility is an important issue for several of the suggested indicators related to the goals of *smart inclusive growth*, and *liveable smart cities*, as well as the intra- and interregional goals of *regional integration and enlargement to reach critical mass*, and *attractive, connected, and accessible regions*. Among the actual outcomes in real world cases, researchers report how, for example, investments in new urban and regional rail infrastructures have contributed to positive effects on accessibility to jobs and on labour earnings in Copenhagen (Rotger & Nielsen 2015), and employment in the Bordeaux region (Sari 2015). But there are also examples where investments in rail have had no effect on employment or labour earnings, for example in the Swedish region of Uppland (Åslund et al. 2017). These results emphasize the importance of the regional and urban context in which regional and urban passenger rail planning occur. It is therefore difficult to assess the current contribution to accessibility in general. This can be exemplified by high-speed rail research in which accessibility, cohesion and equity are recurring themes (Henriksson & Summerton 2016), making it relevant for the assesment of the current status of the interregional goal on *attractive, connected, and accessible regions*. However, this goal should also, as mentioned before, be seen in relation to the goal of *smart inclusive growth* which facilitates contemplation of the railway's contribution to fair development across urban areas. The literature often asks whether high-speed rail investments by shorter travel times improves accessibility to jobs and services, and consequently results in geographical cohesion, economic development or not. The evidence from this research, often based on case studies, show that the impact high-speed rail improvements in accessibility has on economic development or economic integration differ widely between regions (Cheng et al. 2015). For example, a British-French comparative case study found out that high-speed rail investments did result in economic development, but not for all cities in the studied regions. The connection with the national capital by faster train services did economically strengthen regional capitals, but not the surrounding subregions (Chen & Hall 2012). A French-Spanish comparative case study, focusing on high-speed rail's impact on small cities and on big intermediate cities along high-speed rail corridors, found in a similar way that new high-speed rail lines opened new opportunities for big intermediate cities (Ureña et al. 2009). But Ureña et al. (2009) also found evidence of how high-speed rail contributed to increasing the regional centrality of big intermediate cities in relation to smaller

regional cities (Ureña et al. 2009). These and several other examples show that results from one case cannot easily be transferred to another because of the context dependent character of high-speed rail effects on inter-regional interaction and the railway's contribution to fair development across areas (e.g. Yin et al. 2015). High speed rail may boost local economies, but in cities with poor conditions for economic development high-speed rail can drain away economic activity (Yin et al. 2015). High-speed rail investments may thus in the worst case lead to uneven development between cities on new highspeed rail lines and those left in the shadows of new lines (Vickerman 1997, Vickerman 2015).

7.3 Implementation factors

The current status of the railway sector, and the potential contribution of Shift2rail actions to societal goal achievement depend on several implementation factors. We will therefore in the next section analyse and discuss key factors that enable or hinder the railway sector in helping achieve the societal goals. The focus of the chapter is illustrated in figure 2.

Implementation is a complex process often involving multiple private and public organisations interrelated in both horizontal and vertical configurations. This makes it difficult to pin down generally valid factors that enable or hinder the railway sector in helping to achieve societal goals. However, the aim here is more about discussing potentially hindering or enabling factors that affect Shift2Rail success in reaching the outlined goals. Additionally, the implementation concept appears to indicate that implementation occurs in the late stages of policy processes, often seen as following preceding policy-making stages (Hupe & Hill, 2016). The decline of the monopoly of state organisations over the implementation of public policies, often described as a shift from government to governance, indicates that stakeholder involvement throughout the policy formulation and implementation process may be an important factor affecting policy outcomes.

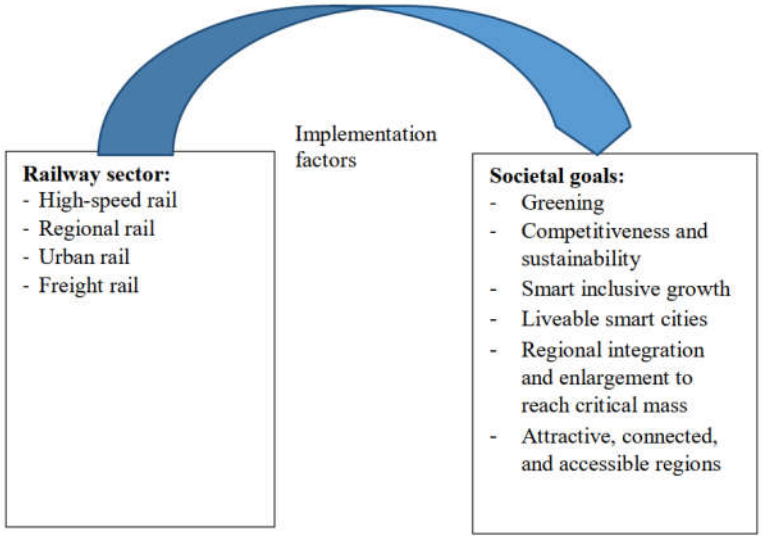


Figure 2: Implementation factors as the link between the railway sector and societal goals

In the following, we define an implementation factor, as already mentioned, as a factor or condition that need to be met, or a situation, that would facilitate the achievement of a specific societal goal while an implementation barrier is defined as a shortcoming in an implementation factor (Walker et al. 2009). We will discuss three implementation factors of general importance, namely, seamless door-to-door mobility solutions, integrated transport and land use planning, and freight rail interoperability. These are important implementation factors, but obviously many other cultural, political, legal, organisational, knowledge-based, fiscal and technological factors could be mentioned (e.g. OPTIC, 2015). A well-functioning railway system is a system that provides seamless door-to-door mobility. The creation of such a system requires a strong integration of transport and land use planning that includes both the design of the transport system and principles for land use development. However, it is potentially difficult to establish such integration due to organizational fragmentation that results in coordination problems, for instance between national, regional and local authorities. While the focus on integrative approaches are motivated by its importance for the effectiveness and attractiveness of the railway systems the focus on freight rail interoperability is motivated by political goals of creating seamless international freight transport and strengthening the competitive capacity of railway freight compared to road freight.

Seamless door-to-door solutions and integrated planning

As stated earlier, we consider *sustainable and seamless door-to-door mobility solutions* as well as *land-use and spatial planning* to be means to achieve the societal goals rather than being goals standing on their own, and several of the societal goals require seamless door-to-door and integrated transport and land use planning approaches. Many of the proposed indicators can be said to measure indirectly or directly how successful rail planning and management have been in establishing seamless door-to-door and integrated transport and land use planning approaches.

Seamless door-to-door mobility requires a network-oriented planning and management of highspeed, regional and urban passenger rail systems with multimodality in transport networks. The principle of network-oriented public transport is that every route should effectively, efficiently, and directly serve a specific flow of passengers, interlinked within the system to provide maximum transfer accessibility (Mcleod, Scheurer, & Curtis, 2017, p. 6).

The development of such networked systems in turn depends on the integration of rail into regional and local land-use planning that takes account of both railway system design and landuse development principles. This has been proposed by research on sustainable mobility, sometimes understood as transit-oriented development (TOD), which has stressed the importance of steering land use so that areas that generate many passenger trips are developed based on the operating conditions of public transport. To create better conditions for travel by passenger rail, politicians and planners should concentrate on: reducing car dependency and urban motoring to prevent urban sprawl, increasing the proportion of the

population living and working in the inner city and central areas, and ensuring sufficiently high density in areas of new development to facilitate the provision of good local services and public transport (Næss et al., 2013).

The change in discussions of public transport to focus on the "image" of cities and development of cities towards "attractiveness" and "liveability" (Ferbrache & Knowles 2017, Olesen 2014, Olesen & Lassen 2016) exemplifies that rail projects need to be rethought as regional or urban development projects instead of just infrastructure projects, which shows how important rail transport and spatial planning integration are as a implementation factor. The cases of high speed rail mentioned in section 6.2 above similarly demonstrate how transport and land use planning integration is crucial implementation factor, and how strongly the spatial, social, political and technical context of such planning influence the outcome (Ureña et al. 2009). Careful planning is thus necessary to ensure positive benefits of new lines.

Integrated transport and land use planning approaches may be equally important for the development of freight rail, but such integrated approaches are less frequent than for passenger rail transport planning. Correct location of terminals and logistic areas can reduce traffic and minimize negative effects as congestion by applying restrictions on local roads regarding speed, time of day and route. Freight rail issues, as part of an intermodal rail-road transport chain, thus need to be integrated in regional and local land use planning in a greater extent than is done today. Local authorities also have key roles to play in facilitating a necessary coordination of shippers, receivers and providers of transport services (Behrends 2017).

Experiences teach us to expect coordination problems, tension among planning sectors, and institutional constraints when implementing integrated transport and land-use planning approaches aiming at creating seamless rail transport. Implementation problems arise partly because multiple discrete organisations are responsible for different parts of the planning process. Responsibilities for public transport systems in several European countries have become divided among various public and private organisations, fragmenting the organisational landscape and resulting in coordination problems, for example, between regional and local authorities. In terms of governance, there is often a lack of decision-making power at the regional level; for example, in legal terms, land-use planning often remains the exclusive competence of municipalities (Hrelja 2015). The question is how integration is to be achieved in the absence of formal powers. Because of this lack of formal regional power, deliberative governance has been claimed to be associated with more effective transport and land-use integration outcomes (Mcleod, Scheurer, & Curtis, 2017). In previous research, such deliberative governance has been illustrated by on-going interactions between organisations that promote joint understandings and the development of shared visions of regional and urban development that public transport systems can be seen to reinforce (e.g., Hrelja et al., 2017).

This has several consequences for the planning and management of rail. We will exemplify a few consequences of relevance to the goal a*ttractive, connected, and accessible regions* (in

which the railway increasingly fosters interregional interaction). The success in reaching this goal will depend on well-functioning freight and high-speed rail systems. Development effects of highspeed rail are, as already mentioned, highly influenced by the characteristics of national, regional and local contexts. However, international experiences identify several implementation factors that influence the effect high-speed rail have at different geographical scales. Research shows the importance of integrating high-speed rail with other modes of transport, as for example air-rail connectivity, links with local public transport, parking and transfer between transport modes (e.g. Yin et al. 2015). The different influence high-speed rail have on regional development and cohesion can partly be explained by differences in planning and policy, e.g. differences in fares and in the development of connecting local and regional feeding services as well as a supporting integration of transport and land use (Cheng et al. 2015). Effects depend on how rail systems work, including different regions' and cities' access to the high-speed rail network, the existence and location of stations or if there are good connection services etc. The planning of station areas is particularly important and includes local and regional accessibility to the station area and the function of the surroundings of the stations (Yin et al. 2015). Yin et al. (2015) also stresses the importance of a functioning decision making, planning and implementation processes in legal settings that often are highly complex due to organizational fragmentation. This can result in coordination problems, for instance between regional and local authorities.

Similar implementation factors and barriers will also influence how well rail will contribute to reaching the societal goals of r*egional integration and enlargement to reach critical mass* (in which the railway fosters intraregional interaction), and *liveable smart cities* (in which the railway fosters high quality of life and wellbeing for city residents) because of the need to increase the degree of integration between railway projects and land use planning and the share of exchange of people, goods and services between cities.

Rail interoperability

The concept "rail interoperability" describe some of the conditions that need to be put in place when developing seamless international freight transport. Considering the development of freight, and with the ambition to fulfil the modal shift targets in the EU White paper 2011 on transport, the EU has made legal reforms to revitalise rail freight and to create an integrated European freight railway system. The main targets for these reforms have been the national railway monopolies which have been regarded as responsible for operational and market inefficiencies resulting in rail-road competitive disadvantages (e.g. Ludvigsen & Osland 2009). Deregulation and market opening have been the main legal measures chosen by the EU to promote freight rail. Since 2007, freight rail is open for competition. The EU has also had the ambition to improve the interlinking and interoperability (i.e. seamless international freight transport) of the national rail networks through technical standardisation (EC 2001).
Despite legal reforms and ambitions to support interoperability, barriers which increase costs remains for newcomers entering the market and other national railway networks (Laroche et al. 2017). European freight rail has a long way to go before it works as a functionally integrated, liberalised and interoperable system (Walker et al. 2009). There are, despite new

legislation, in several countries too little competition between railway operators (Crozet 2017). Although this is a general pattern there are variations between EU countries. The Nordic countries are a cluster of countries with relatively weak competition. Yet, freight rail nowadays competes successfully with road freight, but without increasing the share of rail freight in the national freight market (Ludvigsen & Osland 2009).

Other countries, as Austria, The Czech Republic, Greece and Romania, lag on EU legislative implementation and their markets are dominated by incumbents. However, private operators have a sizable market share of the domestic rail market in The Czech Republic, Poland and Romania. This indicates that private operators are effectively competing with state railways, and they do so in markets with decreasing share of freight transport and increasing road freight transport (Ludvigsen & Osland 2009). Due to Walker et al. (2009), some of the most important implementation barriers for developing rail interoperability are not technical problems. Instead, Walker et al. (2009) found that the most important barriers were:

- Insufficient mandate and willingness of national regulators to enforce administrative changes due to legislative EU reforms
- Insufficient organizational structures and skills among regulators and infrastructure managers
- Lack of resources to accommodate investments in technological improvements and new business concepts

Several EU countries have, as already mentioned, experienced decreases in rail freight activity in recent years. There is strong evidence that freight rail is experiencing strong competition from road freight transport, and that companies are struggling with high operating costs (Islam et al. 2016), and in some countries, as for example Sweden, too low profitability (Vierth & Landergren 2015). A key issue arising from the above-mentioned is the need to increase the competitive capacity and quality of rail services if the railway sector shall contribute to the goals *greening of society*, *competitiveness and sustainability* and *liveable smart cities*. For example, among the most important barriers to seamless international freight that relate to the railway network (terminals, infrastructure, rolling stock and competence) transport has been found to be financial. One such important barrier identified in research is the industry' ability to accommodate required investments (Walker et al. 2009). Other identified barriers are the competitiveness of freight rail that could be increased by decreasing operating costs by implementing measures as operation of longer trains, higher average speed, and better utilisation of wagon space (Islam et al. 2016). This shows that there is a need of additionally measures to strengthen the competitive capacity of rail freight against road freight transport, and to support a seamless international freight transport system.

7.4 Current status and implementation factors: summing-up

The ambition for this chapter has been to discuss the current status of the railway sector's contribution to achieve the societal goals defined earlier. An additional ambition has been to consider implementation factors that might impede or enable further achievements.

It is an immense task to assess the current status in all relevant aspects and it further is dependent on the geography and planning context, and the differences among the countries are substantial. The way forward has been to take point of departure in the indicators suggested in chapter 5 where data and literature are available. However, often the conclusions in the literature are not clear.

As regards modal split of passenger transport a small increase in modal shift to rail is seen, while for freight rail, the sector has not been able to increase its share of the total freight carriage. When it comes to investments, Europe has seen a reduction in length of track the last decade as well as a reduction in passenger seats, and some countries are preparing to reduce regional and suburban rail. However, a revival of interest in regional and urban passenger rail is experienced, e.g. in light rail. Affordability of rail services seems to have been reduced – at least compared to other transport services, and the quality as measured against speed, punctuality and reliability shows that the railway has not be able to increase its competitive capacity against road transport. For accessibility, some cases indicate improvements due to rail investments, while other cases do not. High speed rail may boost local economies, but it might also lead to an uneven development.

A literature study has been applied to consider relevant implementation factors. A long list of possible factors could be mentioned, which again will depend on the local social, spatial and planning contexts. Above, we consider three implementation factors, namely seamless door-to door mobility solutions, integrated transport and land use planning, and freight rail interoperability.

While these three all constitute important implementation factors for the railway sector's contribution to the societal goals, the Shift2Rail programs contribution to overcome the shortcomings in these implementation factors, seems limited, as overcoming of the barriers is dependent on many other actors and on political decision making.

8 Conclusions

The aims of this deliverable have been to:

- specify and define a number of pre-set societal goals;
- suggest indicators which could be relevant in assessing the rail sector's contribution to goal achievement; and
- discuss current status and important implementation factors for the sector's contribution to achieve the societal goals

In the deliverable, a chapter is assigned to each of the aims. The results regarding the individual goal definition and indicators are summarised in the table below. #

Table 4: Summary of societal goals definition and indicators

Goal	Definition	Indicators
Greening of society	Policy sectors other than the environment are transformed in accordance with environmental goals	A composite indicator for development in greening of rail
		An indicator on development in modal shift from air to rail (passenger and freight)
Competitiveness and sustainability	New business and employment opportunities for the railway industry that make the industry competitive over the longer term while ensuring sustainability	An indicator on the development in investments increasing competitiveness (capacity, reliability, costs)
		A composite indicator for development of railway contribution to sustainability (including social-, environmental- and economic dimensions)
Smart inclusive growth	Coordinated fair, participatory planning	An indicator on development in the degree of coordination between railway projects and land use planning
		An indicator on low income groups' affordability and accessibility of rail passenger services (e.g. price of rail transport and travel time)
		An indicator on development in citizen participation in railway planning processes (e.g. consultation with the affected population when developing plans)
Liveable smart cities	High quality of life and wellbeing for city residents	An indicator on development in travel time proximity (including rail) to designated areas in cities
		An indicator on the development of quality of rail services (e.g. travel speed, punctuality and reliability)
		An indicator on the development of affordability of rail services for city residents
Regional integration and enlargement to reach critical mass	High degree of spatial integration of the cities in a region via intraregional interaction taking place through trade of goods and services, job commuting, and shopping	An indicator on development in regional access to markets: the ease of reaching economically assets (e.g. work places) by trips including railway (door-to-door)
		An indicator on the development in affordability of intraregional rail services (e.g. as percentage of income)

Goal	Definition	Indicators
Attractive, connected, and accessible regions	Improved interregional interaction in Europe, aiming to connect European regions	An indicator on development in the share of exchange of people (for work or leisure) between designated regions by use of rail
		An indicator on development in the share of exchange of goods between designated regions by use of rail
		An indicator on development in the share of exchange of services between designated regions by use of rail

It appears from the table that these very broad societal goals in practice often are overlapping; for example, the notions “smart”, “liveable”, and “sustainable” are all applied to signify or include “greening”. The attempt has been to make the goals clearer, giving each of them their own meaning, though, the goals are linked to one another and overlap in some cases.

It is important to stress that focusing solely on the achievement of one societal goal in planning and policy making will result in the neglect of other important societal aspects. For example, a comprehensive assessment cannot be carried out by analysing only *regional integration and enlargement* or *attractive, connected, and accessible regions* without considering the inclusiveness goal, i.e., *smart inclusive growth*.

Overlapping societal goals imply that also the indicators overlap. This is the case for composite indicator on greening, which is also included as an element in the composite indicator on sustainability. Likewise, affordability is suggested in combination with accessibility as an indicator for the goal on *smart inclusive growth,* while affordability for city residents and affordability in intraregional rail services are suggested for other goals. Accessibility appears in combination with affordability, but accessibility also appears in the indicators on cities (travel time) and intraregional access to markets, as well as indirectly in all three suggested indicators for the goal on *attractive, connected, and accessible regions.*

This deliverable is a step on the way for tasks to be carried out in IMPACT-2. There, an assessment of the potential contribution of railway sector as well as the actual contribution of Shift2Rail to achieve the societal goals will be made. Definition of the societal goals, suggestion of indicators as well as assessment of current status and implementation factors should inspire the work on these tasks. More work on the suggested indicators is needed to be able to apply them when assessing the potential role of the railway to contribute to the goals as well as to assess the specific contribution from Shift2Rail.

The work carried out on current status and implementation factors provides a background for the assessment in IMPACT-2. Measured in relation to modal split, investments, affordability, quality and accessibility, the rail sector is an important contributor to the societal goals, but the development generally is not positive, although positive cases exist. However, the analyses in the chapter are rather general due to the sheer size of the task, and because of the context dependent character of planning outcomes. A deeper assessment of current status and implementation factors for obtaining the six aforementioned societal goals need to be based on contextual studies including the specific spatial, social, institutional and

planning conditions. Such studies for obtaining these very broad societal goals are not possible within the limits of the IMPACT projects.

Regarding the contribution of Shift2Rail to obtain the six societal goals, it should be observed that the goals are very broad, and their achievements dependent on activities and development trends taking place in other industries outside the transport sector.

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10 Annexes

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