

## Indicator Monitoring for a new railway PARadigm in seamlessly integrated Cross modal Transport chains – Phase 1



### Deliverable D 1.1 Concluding Report – Best Practice and Lessons Learned

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## 1 Executive summary

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IMPACT-1 has been a project with many relations to other Call for Member (CFM), Open Call (OC) and Tender projects. During its term the project was re-planned and the Grant Agreement (GA) amended. This document intends to document the main results and the lessons learned.

The biggest challenges faced and insights learned were in the communication as well as the preconditions of IMPACT-1. The experience made in this project was that effort and time for cooperation was very challenging. This experience was used to organise the continuation in the follow-up project IMPACT-2 in a more structured way. The newly implemented modelling and management teams have proven to be promising for efficiently developing the model and to consider the specific requirements of each IP. By intensifying the interaction with other member-projects, the JU, the IPs and the Governing Board a common understanding of the requirements towards the evaluation of the effects across all Stakeholders of Shift2Rail will be ensured.

## 2 Abbreviations and acronyms

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<b>Abbreviation / acronym</b>	<b>Description</b>
BT	Bombardier Transportation
CA	Collaboration Agreement
CAF	Construcciones y Auxiliar de Ferrocarriles S.A.
CAWI	Computer Assisted Web Interviewing
CCA	Cross Cutting Activity in S2R
CFM	call for members
COLA	Collaboration Agreement
DB	Deutsche Bahn A.G.
DLR	Deutsches Zentrum für Luft- und Raumfahrt e.V.
DMP	Data Management Plan
DoA	Description of Action
DOW	Description of Work
EU	European Union
FINE	Future Improvement for Energy and Noise
GA	Grant Agreement
GB	Governing Board
H2020	Horizon 2020
IMPACT	Indicator Monitoring for a new railway PARadigm in seamlessly integrated Cross-modal Transport chains
IP	Innovation Programme in S2R
JU	Joint Undertaking
KPI	Key Performance Indicator
LCC	Life-Cycle Cost
MAAP	Multi-Annual Action Plan

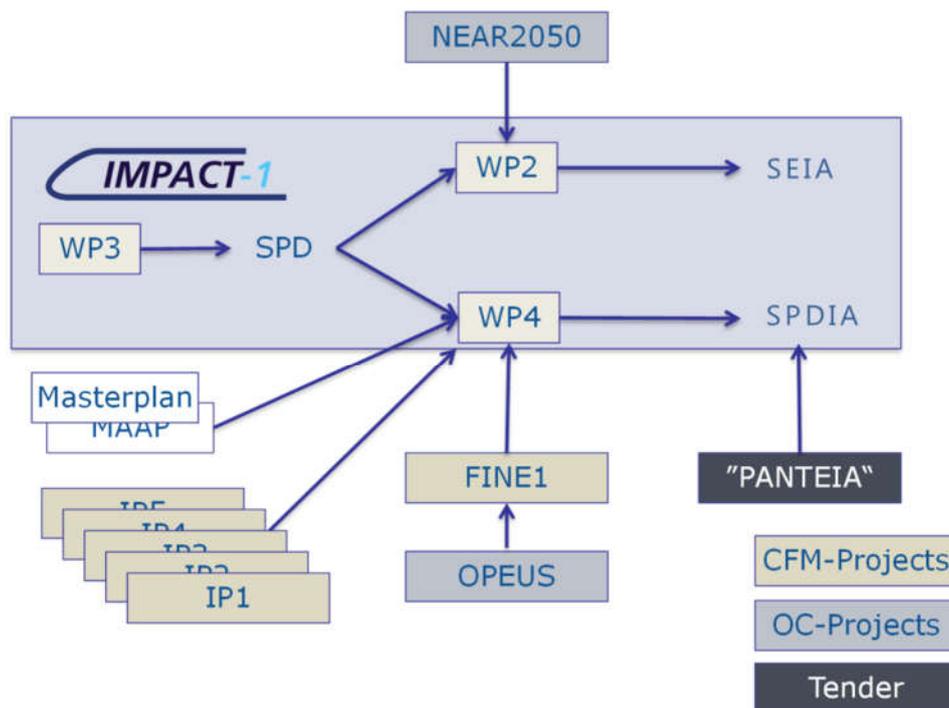
<b>Abbreviation / acronym</b>	<b>Description</b>
OC	Open Call
PM	Project Manager (coordinator)
PRIME	Platform of Rail Infrastructure Managers in Europe
S2R	Shift2Rail
SAG	Siemens A.G.
SEIA	Socio-Economic Impact Assessment
SPD	System Platform Demonstrator
SPD-IA	System Platform Demonstrator Integrated Assessment
TD	Technical Demonstrator
TMT	Technical Management Team
TRV	Trafikverket
VTI	Statens väg- och transportforskningsinstitut (Swedish National Road and Transport Research Institute)
WA	Work Area
WP	Work Package

### 3 Background

The present document constitutes the Deliverable D1.1 “Concluding report – best practice and lesson learned” in the framework of the work areas (WA) “Long-term needs and socio-economic research” WA 1.1, “System Platform Demonstrators” WA1.2 and “KPI method development and integrated assessment” WA2 of CCA defined in the Multi-Annual Action Plan (MAAP) at the time of the start of IMPACT-1 (September 2016) [1].

It contributes as well to WA 5.1 of CCA defined in the Multi-Annual Action Plan at the time of the start of IMPACT-1 (September 2016) [1].

The overall structure as well as the targets of Shift2Rail are defined in the Master Plan [2] and the Multi-Annual Action Plan [1]. All Technical Demonstrators (TDs) of all Innovation Programmes (IPs) are contributing to the overall targets. Hence all TD-related Work Packages (WPs) of the member-projects are requested to quantify their impact on the master plan targets.



**Figure 1. Project Interaction**

The relation of the Work Areas (WA) WA1.1, WA1.2 and WA2 is reflected in the WP-structure of project IMPACT-1 and the follow-up project IMPACT-2 (GA 777513): The Socio-Economic Impact Assessment (SEIA) defined in the work area WA1.1 is an objective of WP2 of both projects, the definition of the System Platform Demonstrators (SPD) defined in WA1.2 is done

in WP3 and the modelling for the SPD Integrated Assessment (SPD-IA) defined in WA2 is an objective of WP4. The relation of the WPs and the projects is shown in Fig. 1 above.

The complex interaction with other projects is shown in Fig. 1, too. IMPACT-1 with the three work packages related to the work areas of the CCA is shown in the central blue box. Projects executed by other members of Shift2Rail, the so-called “call for members” (CFM) projects, are shown by beige boxes. Open Call (OC) projects are represented by light grey boxes.

All TD related work packages of all the CFM projects done in the five IPs are concluded in the five boxes in the lower left corner marked with IP1 to IP5. One specific CFM-Project of the Cross-Cutting Activities (CCA) is contributing a major share to IMPACT-1 and subsequently to IMPACT-2: The Project FINE1 (GA 730818) defines the energy baseline, reference trains and reference speed profiles, which are all very valuable input for the detailed definition of the SPDs and the reference scenarios [3]. One OC-project has a direct input on IMPACT-1: The project NEAR2050 defines scenarios and related analyses which are used as input for the SEIA in WP2. Another OC project has an indirect input: the project OPEUS (GA 730827) configures the energy simulation tool for FINE1 and executes the energy simulations for the reference scenarios.

A further interaction takes place with the companies which are performing the Shift2Rail tender 2015/S 251-459831 under the lead of the company Panteia and including TNO, Abirail and the Railway department of the University of Newcastle. The tender is represented by a dark grey box in Fig. 1 and the marking “PANTEIA”.

## 4 Objective/Aim

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This document has been prepared to provide an overview over the main results of IMPACT-1, the resulting lessons learned, best practices and the conclusions for the subsequent project IMPACT-2 (GA 777513) and further similar projects. The Work Area 1 and 2 of the Cross-Cutting Activities prepare the Socio-Economic Impact Assessment (SEIA) and the Integrated Assessment of the System Platform Demonstrators (SPD-IA). The second has the target to assess the results of all the projects executed by the members of Shift2Rail with respect to overall targets of reduction of Life-Cycle Cost (LCC) and improvement of Capacity and Reliability & Punctuality. As a consequence, the project IMPACT-1 had - untypically for a Horizon 2020 project - an important dependency on the results and cooperative contribution of a relatively high number of other projects. Hence the lessons learned and the resulting conclusions are to be documented in this document to ensure a smooth execution of the subsequent project IMPACT-2.

## 5 Project progress and development

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### 5.1 Initial concept and methodology

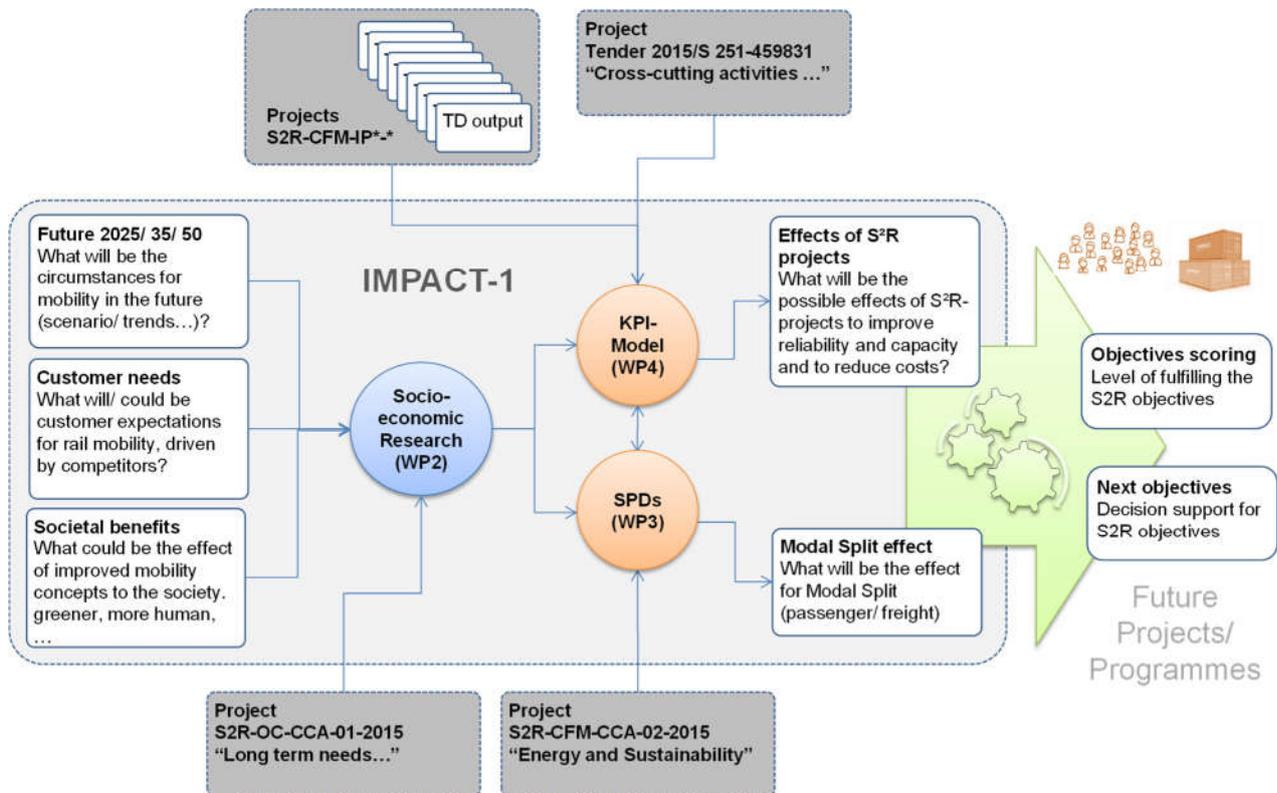
#### 5.1.1 Concept according to Description of Action (DoA)

The general aim behind IMPACT-1 as well as IMPACT-2 is to understand how to attract more carriers and passengers to use the railway in Europe. Hence - in addition to powerful improvements of technical components and systems - a better understanding of customers, an analysis of upcoming challenges and possibilities as well as a trend analysis of the competitors' efforts is needed. Future application use cases must be analysed and described as scenarios. Finally, the performance and the impact of technologies developed must be monitored. Hence the three Work Areas described in the Multi-Annual Action Plan (MAAP) [1] "Socio-Economic Impact Study", "System Platform Demonstrators" and "SPD Integrated Assessment" are carried out within three work packages:

- A socio-economic impact assessment (SEIA) will be done to understand the customer needs and societal developments (WP2). Trends for the mobility of the future are analysed, the customer needs which will be driven by competing modes of transport are identified and the societal benefits of improved mobility are estimated.
- By using the future customer needs and expectations, scenarios are defined to identify the System Platform Demonstrators (SPD) for Shift2Rail (S2R) (WP3). Those scenarios are identified on the basis of today's equivalent scenario to estimate the effect on the modal split for passenger or freight rail transport.
- A structure of the Key Performance Indicators (KPI) is modelled to enable the integrated assessment of the impact of Shift2Rail. The expected effect of the impact the initiative Shift2Rail is going to have on the future railway is shown for the SPD scenarios (WP4). Since this KPI-tree will be consisting out of several complex modules a suitable modelling methodology has to be developed and verified.

The general concept and the most important internal and external relations are shown in Fig. 2 below.

The developed KPI model will be used to capture and monitor the impact of Shift2Rail, the socio-economic effects will represent the challenges and chances of tomorrow and the System Platform Demonstrators will be the basis for the demonstration of the changes in mode choice between today and after applying the Shift2Rail results. The entire three together have the potential to become an indispensable decision support in Shift2Rail and beyond for all the players in the sector as e.g. railway undertakings, infrastructure managers and railway operators.



**Figure 2. IMPACT-1 general concept w.r.t WP Interaction and outside linking**

Within the project IMPACT-1 there are guiding questions for the technical work packages:

- WP2: What are the mobility needs of today and tomorrow which the S2R initiative has to take into consideration? What kind of disruptive technologies do we expect in the next 5 - 35 years?
- WP3: How can today's passenger and freight transport modelling and forecasting tools be used as a basis for development of the Shift2Rail System Platform Demonstrators? (I.e. Identification of required development work for relevant SPD use cases)
- WP4: How and through which synergies between the Innovation Programmes are the overall Shift2Rail goals (from the Master Plan) achieved?

The System Platform Demonstrators will be based on state of the art regarding passenger and freight traffic and transport models and forecasting tools. These modelling tools enable analyses of passenger and goods transport with a holistic perspective from effects on land-use and travel and freight demand to modal choice and routing. These models are to be

adopted and modified to allow analyses of Shift2Rail innovations. The SPDs will thereby not only serve as demonstrators of S2R results but will also contribute to the state of the art traffic and transport models. Use cases are selected for each market segment; high speed/mainline passenger rail, regional passenger rail, urban/suburban passenger rail (metro) and rail freight. This will enable concrete results on societal effects of a broad range of Shift2Rail innovations.

The anticipated methodology is based on research projects, including theoretical and practical analysis, decision points and implementation of experts. In specific, it includes:

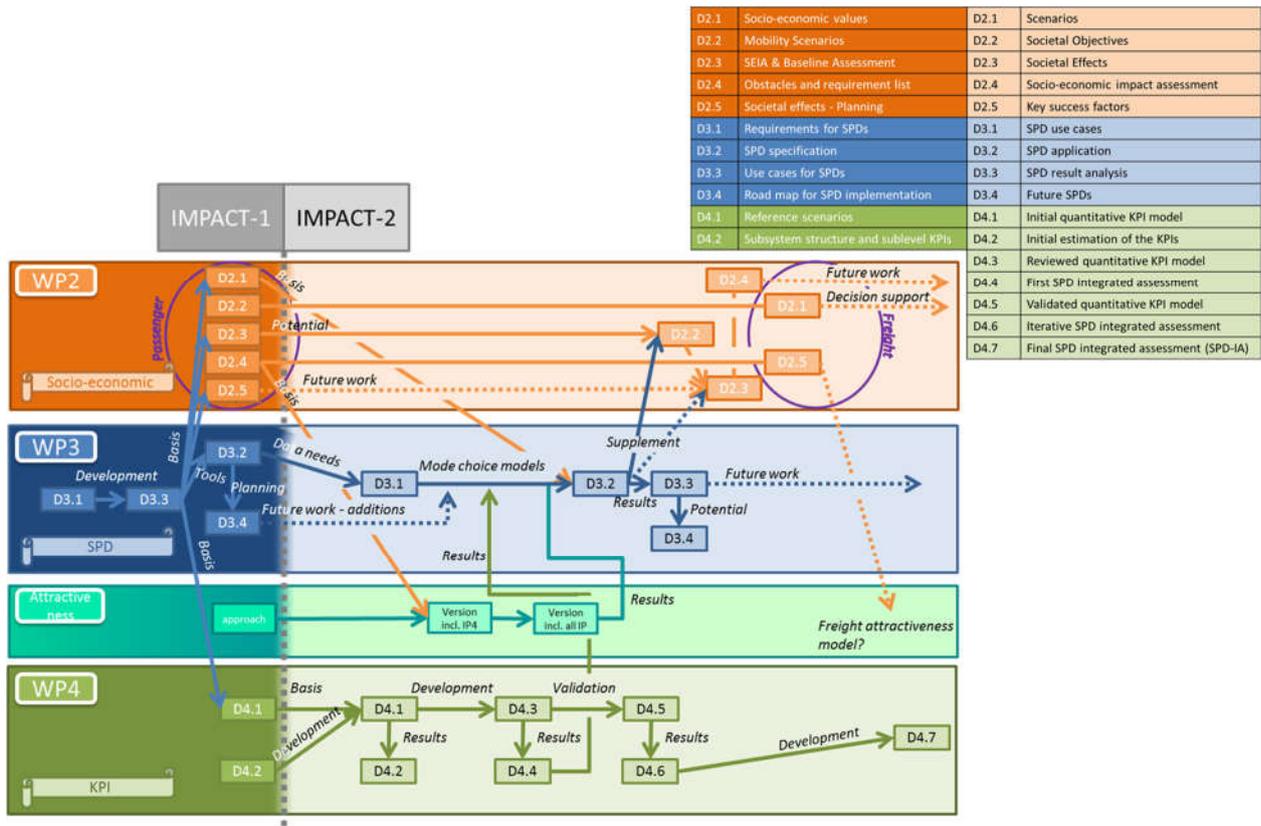
- Web research related to available studies and concepts, surveys and studies with restricted access (e.g. company insights) as far as possible,
- Integration of expert knowledge, perspectives from target groups and stakeholders within guided and planned workshops,
- Applications of up-to-date methods to plan, analyse, prepare and realise different research topics.

For the KPI model, existing models or tools are analysed in terms of their suitability for the purpose of interlinkage. For example, the KPI model from Roll2Rail (GA 636032 - WP 9) has been considered [4]. This lighthouse project delivered modules, which are integrated after evaluation. Further publicly accessible KPI models e.g. from standards (as e.g. ISO 22400), handbooks (as e.g. PRIME [5]), previous projects (as e.g. FP7 Automain) or other Joint Undertakings (as e.g. Clean Sky) have been used as input or reference. Nevertheless, the existing models do not fit exactly and do not cover Shift2Rail completely in the same level of detail. Therefore, further modelling work is required. For these, the KPIs have to be developed from scratch. When a first draft for a number of modules is finished, the industry and railway partners are reviewing them e.g. by going through or by comparing them to real historical data from their experience. The wide range of industry and railway partners ensures that all aspects of KPIs are reviewed – operational data, vehicle data, customer data etc. This process is intended to continue with the quantitative part in IMPACT-2.

### **5.1.2 Interrelation between WPs**

The described general concept already gives a clue about the high interrelations between the three content-related WPs in IMPACT-1, but they are not only linked with each other, but also with their sister WPs in the successor project IMPACT-2.

Figure 3 below is showing the interconnections of the different WPs based on their deliverables as well as the further link to the subsequent project IMPACT-2.



**Figure 3: Relation of WP2, WP3 and WP4 in IMPACT-1 and IMPACT-2**

It can be seen that especially WP3, the SPD description, is highly linked to both WP2, the socio-economic impact study, and WP4, the KPI model. D3.3, the use case description of the SPDs, is key for all three WPs not only within IMPACT-1, but also for the following work in IMPACT-2. While WP3 is setting the basis for all three WPs, it will in IMPACT-2 also be the main recipient of the results of WP2 and WP4, to implement them in the mode choice model.

For WP2 the shift of focus between IMPACT-1 and IMPACT-2 should be highlighted. While in IMPACT-1 WP2 is focussing on aspects of the passenger transport, in IMPACT-2 the focus will be more on freight transport.

Within the work of WP4 in IMPACT-1 it was identified, that the three target KPIs, LCC, Capacity and Reliability, are not suitable to take all of the positive effects of Shift2Rail innovations into account. Especially the innovations targeting to increase the customer satisfaction cannot be reflected correctly by those more technical KPIs. Therefore, an approach has been developed to do justice to those innovations, the so-called attractiveness model. The attractiveness model will be connected to all WPs during IMPACT-2, too. The model structure is based on the same principles as they have been developed within WP4, the basic input for the model will be provided through the results of WP2 of IMPACT-1 and the results will be integrated in the mode choice model of WP3 in IMPACT-2.

It should be noted that the mode choice model differs from the KPI model developed in WP4 of IMPACT-1 with respect to the modelling approach as well as target of results. Hence the assumptions are aligned within WP2, WP3 and WP4 as much as possible but are nevertheless not always identical.

### **5.1.3 Interrelation with other projects**

#### **5.1.3.1 Interrelation to FINE1 and OPEUS**

One very important element in the life-cycle-cost for railways is the energy consumption. As trains normally are running quite deterministic their energy consumption can be estimated by simulation. The development and application of such a simulation is – amongst others – aim of the CFM-project FINE1 (GA 730818) and the aim of the OC-project OPEUS (GA 730827) is the development of the simulation tool itself.

FINE1 supported IMPACT-1 mainly with the results of the scenario modelling documented in the following deliverables:

- Energy Baseline (D3.1)
- Sub Level Energy KPIs (D3.2)
- Future Railway System (D3.3)
- Requirement Specification for Energy Simulation Tool (D3.4)
- Evaluation of Energy KPI – interim (D4.5)
- Evaluation of Energy KPI – update (D4.6)
- Evaluation of Energy KPI – final (D4.7)

Many of the assumptions, definitions and values were considered for the KPI model in WP4 of IMPACT-1. Intensive discussion was held between members of the consortia of FINE1 and IMPACT-1 as e.g. by staff of CAF, DB and DLR being active in both projects.

The input from OPEUS was the results of the different energy consumption simulations which were transmitted by FINE1 to IMPACT-1.

#### **5.1.3.2 Interrelation to NEAR2050**

The objective of the OC-project NEAR2050 (GA 730838) was to determine the long-term needs of different actors in the railway sector. In the focus were developing technologies, new societal trends, and changing demographics among others in order to obtain a full account of what users currently need and expect from the rail sector and what they will need and expect from the rail sector based on mega trend based scenarios in 2022, 2030 and 2050. Hence the supported the WP2 of IMPACT-1 with a related focus by defining the scenarios to be analysed.

## 5.2 Project results

The work performed in the project is divided into three work streams which are first the definition of the basis for the socio-economic impact analysis in WP2. This again is done on the basis of four use cases named “System Platform Demonstrators (SPDs)” which are defined and detailed in WP3. The same SPDs are used for the integrated assessment of the Shift2Rail innovations on the railway system in WP4.

### 5.2.1 Results of the Socio Economics (WP2 / WA1.1)

The “Socio-economic Impact Analysis (SEIA)” (WP2) addresses the interaction between technological developments and the development of the surrounding ecosystem in which they are implemented, such as development of societal values or trends in behaviour, trade patterns or global supply chains. First, research has been carried out on socio-economic values and needs of the passengers in the context of the railway system (Task 2.1). The second Task (2.2) analyses important trends and potential disruptions that might impact the railway system within the upcoming years. Differentiation is made between short-term scenarios and long-term developments up to the year 2050. Task 2.3 investigates how the railway system can be used to drive necessary social developments and to which extent Shift2Rail can be used to leverage the achievement of these objectives. Task 2.4 of this WP points out key factors that promote or hinder the railway system from being the indispensable backbone of connected mobility systems.

### 5.2.2 Results of the SPD Definition (WP3 / WA 1.2)

The required four use cases needed for the socio-economic impact analysis as well as the integrated assessment of the KPIs were defined in WP3. For each of the market segments High Speed passenger rail, Regional passenger rail, Metro and Rail Freight, a generic platform was defined where the technical developments and innovations of Shift2Rail demonstrate their application and impact. The aim of the SPDs is to provide a better understanding of the effects of Shift2Rail on the entire railway system as well as its socio-economic environment. The first step was to collect the requirements of the SPDs, considering the characteristics of the Shift2Rail innovations (Task 3.1, D3.1). In Task 3.2, the SPDs are specified for each of the four market segments mentioned above. The work resulted in D3.2 “SPD definition”. Closely to the definition of the SPDs, use cases needed to be defined in Task 3.3 in order to apply the Shift2Rail TDs and describe the context of the future usage. These use cases are described in the Deliverable D3.3 and listed as an overview in the table below. The last Task of WP3 was to define a road map for the application of the SPD concept in subsequent projects (Deliverable D3.4).

The SPD use cases developed within deliverable D3.3 will be used in IMPACT-1 as well as in the continuation in the project IMPACT-2 as basis for reference scenario development for the KPI analysis and as basis for the implementation of mode choice models. The SPD use cases might need to be adjusted as the work continues. If so, the adjustments and motivation for changes will be shown in later deliverables.

**Table 1: Generic SPD Use Cases**

	<b>SPD 1: High-speed</b>	<b>SPD 2: Regional</b>	<b>SPD 3: Urban</b>	<b>SPD 4: Freight</b>
FINE1 service profile	High-speed 300 Max 300 km/h	Regional 160 Max 160 km/h	Metro Max 80 km/h	Freight mainline Max 120km/h
Generic reference track	Double-track high speed only	Double track	Double track Metro only	Double track
Train concept	Single-deck, distributed traction	Single-deck, distributed traction	Metro	Electrical loco, four axles plus waggons

### 5.2.3 Results of the KPI integrated assessment (WP4 / WA2)

The integrated assessment of the SPDs (SPD-IA) uses estimated improvements delivered by the other Shift2Rail projects and evaluates how the operational Shift2Rail targets for the KPIs LCC, Capacity and Reliability & Punctuality are achieved through the carrying out the multi-annual action plan (MAAP) and the resulting projects. The basic concept and structure of the KPI model was developed and documented. The reference scenarios of the KPI model were detailed with technical and operational data based on the SPD definition and the requirements coming from the Shift2Rail innovations. An extensive exchange took place with the Shift2Rail member project FINE1 to ensure the applicability of the results of the energy simulations done by the open call project OPEUS. The results and findings were documented in the D4.1. Alignment with all Technical Demonstrators (TDs) in Shift2Rail were carried out via comprehensive coordination and communication to ensure the extensive and correct coverage of Shift2Rail innovations in the KPI modelling. The overall conceptual model in the form of the subsystem structure and the related sublevel KPIs were defined and documented in D4.2.

The mode choice model for the freight system is based on a model which was already used in Sweden. It was adopted to be included in the concept of IMPACT-1 for the three-step approach. The final adjustment will be done during the sub-sequent project. For the passenger systems, new mode choice models will be developed in the sub-sequent project based on logit model specifications and official values on value of travel time from European countries.

IMPACT-1 has proven to be a highly integrated project within Shift2Rail. An overview of the interactions is given in Fig. 1 above: It shows the overall cooperation inside IMPACT-1 and to other Shift2Rail activities. Internally the SPDs are provided by WP3 and used in WP2 to prepare the SEIA and in WP4 for the SPD-IA. The outline of this activity is given in the S2R Master Plan and refined in the Multi-Annual Action Plan (MAAP). The input for the improvements is coming

from the member projects in all the IPs and especially with respect to energy consumption from FINE1 and the open call project OPEUS which is performing the energy simulations for the SPDs. In a tender, a consortium led by the company Panteia was providing a visualization of the simulation. Finally, a fruitful cooperation was done with the open call project NEAR2050 which was used for the analysis of socio-economic conditions for the SEIA.

#### 5.2.4 Exploitation & Dissemination activities (WP5)

The following activities for exploitation and dissemination were carried out with respect to the results of IMPACT-1: All IP steering committees have been regularly informed about the progress and the current results as well as asked for comments. The work done in IMPACT-1 is continued in the subsequent project IMPACT-2 where the models are refined, updated with more parameters, and integrated.

A series of Logos was developed, which was used in IMPACT-1 and IMPACT-2.



Figure 4: Logos of IMPACT-1 and IMPACT-2

Two publications were made during the execution of IMPACT-1 to inform the wider scientific public about the approach and progress and third one was prepared, but presented during IMPACT-2:

1. A poster and an abstract was published and presented at the Transport Research Arena (TRA) 2018 in Vienna, Austria [6] under the title: paper “Impact of Shift2Rail - a KPI model for the entire railway system”
2. A bilingual English and German article has been published in the German Journal Signal+Draht in the issue 1+2 in 2018 [7] under the titles: “Bewertungsmethodik für die Projektergebnisse im Joint Undertaking Shift2Rail / The methodology for assessing the project results of the Shift2Rail Joint Undertaking”
3. Preparation of RTDM presentation and paper “Passenger demand in a technical world” (Presented in 2018) [8]
4. Final event held in Stockholm 25.04.2018

Two websites present the projects results:

1. [https://projects.shift2rail.org/s2r\\_ipcc\\_n.aspx?p=IMPACT-1](https://projects.shift2rail.org/s2r_ipcc_n.aspx?p=IMPACT-1)
2. <https://verkehrsforschung.dlr.de/de/projekte/impact-1-railway-future>

### 5.3 Progress beyond the state of the art

Modelling railway systems is a well-established science. Nevertheless, the individual technical, operational, economic, and social models have well-defined focuses which are normally not integrated with each other. Socio-economic approaches typically use abstracted descriptions

of technologies to derive the demand and resulting mode choice. The progress beyond the state of the art within the IMPACT-1 project is the use of defined common SPDs across the modelling and thus the adjusted approach by using the SPD integrated assessment (SPD-IA). Hence the evaluation of the socio-economic impact as well as the wider societal implication of the entire Shift2Rail program are the main objective of IMPACT-1 as well as the subsequent project which aims to integrate the approaches as well as the quantification.

Regarding rail passenger and rail freight modelling, the state of the art focuses on the use of forecasting tools to analyse the modal shift to rail. Within IMPACT-1, WP3 goes beyond this state of the art and identifies suitable transport modelling and forecasting approaches for the analysis of S2R solutions. Over and above the goals for the current program, new goals and aims for the development of the railway system beyond the time frame of H2020 can be derived if divergences between the determined societal needs and the SPDs are identified.

The integrated assessment of the improvement of the KPIs is well reflected in the state of the art but typically with a clear focus on targeted optimizations, as e.g., cost, capacity, or demand. One main step beyond the state of the art is here, that the balance between the different targets of the railway's optimization is typically subject of political or managerial decisions. Therefore, it was required to develop a model, which was able to show the maximum improvement for a specific KPI, if this was the target of optimization, while keeping realistic conditions for the others. Additionally, KPI models usually focus on specific parts of the railway system e.g., the rolling stock or the physical infrastructure. So, the consideration of the whole railway system in one model can also be seen as an advancement in comparison to the state of the art. The qualitative and quantifiable KPI model on a coherent granularity level is hence a major step beyond the state of the art and will serve as a solid basis for the quantification in the sub-sequent project.

The work of the IMPACT-1 project has paved the way to an evaluation of the innovations developed within Shift2Rail in terms of their impact on Life-Cycle-Cost, Capacity, Reliability & Punctuality, and customer experience to finally come to profound forecast of the change of mode choice. So, the sub-sequent project IMPACT-2 can further assess the impacts on KPIs, customer experience and shift to rail.

## 6 Adoptions during project execution and lessons learned

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Due to the high level of communication and cooperation with other projects and parties, IMPACT-1 faced some challenges, which were not foreseen in the very beginning.

For the work carried out by WP2 (Socio-Economic Impact Study) of IMPACT-1 there was an interaction with the OC project NEAR2050 (GA 730838) which required a specific collaboration agreement (COLA). Besides the complex legal issues, the cooperation was completed without major issues.

For WP3 (System Platform Demonstrators) the approach to use common, coherent and integrated scenarios elaborated in the System Platform Demonstrators (SPD) turned out to be scientifically more challenging than expected, because the Socio-Economic Impact Assessment (SEIA) needed much different data than the KPI assessment. The SEIA needs data such as population, social and economic environment of the nodes in the scenarios and even cultural aspects. For the KPI model detailed technical data such as e.g. number of interlocking and switches, length and construction type of bridges and tunnels, number of Balises etc. is needed. The level of detail varied between the IPs as well. For all the SPDs, but especially for the freight SPD, there were many technical, operational, commercial and other aspects to be defined in a coherent and consistent way, which required more effort than expected.

For WP4 (KPI model) there were a couple of unexpected challenges that made it necessary to adapt the work plan several times. The initial aim of the WP was to deliver a qualitative KPI model at the end of the project duration and to perform the first structural review by then. Shortly after the start of the project it became clear that for the purpose of demonstrating the value of the activities of Shift2Rail it was highly relevant to accelerate the quantification of the effects. The first quantitative results were needed to be presented by autumn 2017 to the Governing Board (GB) of Shift2Rail. It was identified, that this task could not be done within the scope of IMPACT-1.

In parallel to IMPACT-1, the JU had contracted a tender with a consortium under the lead of PANTEIA with the aim to produce an IT-tool for the visualisation of the results of the KPI model. This project was depending on requirement specifications for an IT-Tool which should be used for the demonstration of the SPD-IA. As this was initially not planned in the IMPACT-1 workplan, the necessary expertise was not immediately available as it was initially not foreseen in IMPACT-1 to develop a public application based on the KPI model. It was proposed by the JU to commission the task of providing first visualisations for the GB to the consortium under the lead of PANTEIA. The task was supported by IMPACT-1, especially by accelerating data collections for the SPD definitions as well as data about the expected future improvements that were expected from each TD. Further, the work on identifying the most relevant parameters (the ones that the TDs are going to influence most) had to be sped up.

To ensure a competent support for the PANTEIA consortium, the IMPACT-1 tasks had to be reprioritised. This led to significant changes within the IMPACT-1 workplan and tasks

execution. It was planned to continue according to the original work plan after the first quantitative results were presented to the GB in October 2017.

Gathering the needed input data proved to be one of the major challenges to IMPACT-1. On the one hand the collection of data for the SPD definition was difficult because of availability and confidentiality of the needed data. On the other hand, the projects of the different IPs and TDs, which had to deliver input to the KPI model to show their individual impact, were not prepared for such a major speed-up. Hence effort had to be spent explaining the urgency of the requests to the IPs. While IP1 was very well prepared on the basis of the KPI-model already developed [4] in Roll2Rail (GA 636032) to answer to the requests, other IPs needed more time. Many of the TDs of IP2, IP3 and IP5 had not even started their projects at that time. The CFM-Projects of the AWP 2015/16 were not having any reference to support the KPI activities and therefore not planned it. For the later AWP this was improved. Also, the project FINE1 (GA 730818) was in the middle of the definition of the reference trains and reference scenarios and therefore not able to deliver final reviewed deliverables with their results.

The GB decided upon the first estimations carried out by the PANTEIA consortium, which were presented in October 2017, that there was the necessity to customise the KPI model closer to the organisational structure of Shift2Rail. This task was committed to IMPACT-1 and requested to be fulfilled by March 2018. Therefore, the original work plan of IMPACT-1 could not be followed after October 2017. For this reason, an amendment of the IMPACT-1 contract became necessary to extend the project duration by two additional months.

In order to fulfil the request of the GB and to make the cooperation between IMPACT-1 and the IPs more efficient, three further measures were implemented: A **“modelling team”** was installed for the development of partial models for the three KPIs. It consisted of IMPACT-1 representatives, each responsible for one certain IP in order to consider the specific properties and requirements of each IP. Furthermore, a **“core group”** was installed to serve as the link between the modelling team, the IP steering committees and the S2R GB and in order to solve critical issues which were not under the influence or the responsibility of IMPACT-1, but needed to be coordinated with other Shift2Rail Stakeholders. Hence in the core team were IP-representatives who had a commitment from their IP Steering Committees and the JU program officer was present, too. Finally, a **“management team”** was set up to ensure a fast and continuous flow of information between the teams, the CCA coordinator and the JU.

With the joint forces of those work groups and the support of all IMPACT-1 partners and the contributions from the IPs, the project was able to develop and deliver a preliminary KPI model which contained not only qualitative, but also already quantitative results of the evaluation of the effects of Shift2Rail for the entire railway system. Partially, this was already an anticipation of the work of the planned follow-up project IMPACT-2. In this project, the KPI model will be further developed, reviewed by the railways and finally refined and the initial quantification will be updated on a regular basis.

IMPACT-1 was one of the first projects of Shift2Rail and probably one of the ones with the most interactions and dependencies on other Shift2Rail projects. Therefore, especially for the WP4 (KPI model) there were challenges, which were not foreseen in the beginning of the project. There were legal and confidentiality-related discussions with the IPs, which took time and were not planned in the preparation of IMPACT-1.

Nevertheless, during the course of the project, it became clear for all participating parties that the relevance of the evaluation of the impact of Shift2Rail is of major importance. The KPI evaluation has an important significance in all Shift2Rail steering bodies, like the Governing Board and the Steering Committees of the IPs and CCA. It was not clear to the WPs implementing the TDs that they were expected to estimate their impact and support IMPACT-1. Depending on previous activities in the area of KPI the starting basis of the IPs was different. Also, the different Shift2Rail projects had not allocated budget and resources for this activity. As soon as this had been recognised, all later started projects were requested to foresee activities to support the evaluation.

The experience made in this project was used to organise the continuation in IMPACT-2 in a proper way. The modelling team as well as the management team have proven to be promising for efficiently developing the model, to consider the specific requirements of each IP and to handle all appearing operative issues. It will be necessary to continue the interaction with the other member-projects, the JU, the IPs and the Governing Board in order to have the common understanding of the requirements towards the evaluation of the effects across all stakeholders of Shift2Rail.

## 7 References

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## 8 Annexes

### 8.1 Annex 1: Ownership of the results

**Table 2: Ownership of results by Partner**

Deliverable number	Deliverable title	WP number	Lead beneficiary	Type	Dissemination level	Due Date [M]	Ownership [%]
D1.1	Concluding report, best practice and lesson learned	WP1	1 – DLR	Report	Public	20	DLR [100%]
D2.1	Socio-economic values	WP2	7 - TRV	Report	Public	18	TRV [100%]
D2.2	Mobility Scenarios	WP2	5 - DBAG	Report	Public	18	DBAG [100%]
D2.3	SEIA & Baseline Assessment	WP2	7 - TRV	Report	Public	18	TRV [100%]
D2.4	Obstacles and requirement list	WP2	5 - DBAG	Report	Public	18	DBAG [100%]
D2.5	Societal effects - Planning	WP2	7 - TRV	Report	Public	18	VTI [100%]
D3.1	Requirements for SPDs	WP3	7 - TRV	Report	Public	6	TRV [70%]; DBAG [10%], DLR [10%], SAG [10%]
D3.2	SPD specification	WP3	7 - TRV	Report	Public	18	TRV [100%]
D3.3	Use cases for SPDs	WP3	7 - TRV	Report	Public	15	TRV [40%], DLR [15%], CAF [15%], DBAG [15%], SAG [15%]
D3.4	Road map for SPD implementation	WP3	7 - TRV	Report	Public	18	TRV [100%]
D4.1	Reference Scenario	WP4	1 - DLR	Report	Public	20	DLR [25%], ASTS [5%], BT [10%], CAF [15%], DBAG [15%], TRV [15%], SAG [15%]
D4.2	Subsystem structure and sublevel KPIs	WP4	1 - DLR	Report	Public	20	DLR [25%], ASTS [5%], BT [10%], CAF [15%], DBAG [15%], TRV [15%], SAG [15%]

Deliverable number	Deliverable title	WP number	Lead beneficiary	Type	Dissemination level	Due Date [M]	Ownership [%]
D5.1	Data Policy and Data Management Plan	WP5	7 - TRV	Report	Public	3	TRV [50%], DLR [50%]
D5.2	Communication Plan (incl. Project Website and leaflet)	WP5	7 - TRV	Websites, patents filling, etc.	Public	6	TRV [100%]
D6.1	POPD - Requirement No. 1	WP6	1 - DLR	Ethics	Conf.*	2	DLR [100%]

Conf.: Confidential, only for members of the consortium (including the Commission Services)

## 8.2 Annex 2: Relation to other Shift2Rail projects

**Table 3: Relation IMPACT-1 to other Shift2Rail CFM- and OC-Projects**

Related Project	Acronym	Call	GA	Period	Related WP of IMPACT-1
Indicator Monitoring for a new railway PARadigm in seamlessly integrated Cross-modal Transport chains	IMPACT-2	S2R-CFM-CCA-01-2017	777513	01/09/2017 - 31/08/2022	WP2, WP3, WP4, WP6
Future challenges for the rail sector	NEAR2050	S2R-OC-CCA-01-2015	730838	01/10/2016 - 31/03/2018	WP2
Future Improvement for Energy and Noise	FINE1	S2R-CFM-CCA-02-2015	730818	01/09/2016 - 31/10/2019	WP3, WP4
Modelling and strategies for the assessment and OPTimisation of Energy USage aspects of rail innovation	OPEUS	S2R-OC-CCA-02-2015	730827	01/11/2016 - 31/10/2019	WP4
SMaRTE - Smart Maintenance and the Rail Traveller Experience	SMARTE	S2R-OC-CCA-01-2017	777627	01/09/2017 - 31/10/2019	WP2