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Deliverable D 4.3

Reviewed quantitative KPI model

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1 Executive summary

The following deliverable is a documentation of the first version of the quantitative KPI model developed in task 4.1 of IMPACT-2 and is therefore an advancement of the initial quantitative KPI model documented in deliverable D4.1 of IMPACT-2 [7]. In combination with deliverable D4.4 “First SPD integrated assessment” [9] this deliverable documents the methodology and results of the first integrated SPD assessment considering the majority of impacts of the Technical Demonstrators (TDs) on the Key Performance Indicators (KPIs), which have been assessable by the time the deliverables were prepared.

A summary of the initial KPI model, on which the “Reviewed quantitative KPI model” is based on, is given and its further developments are described. More complex topics influencing all three KPIs Life-Cycle Cost (LCC), Capacity and Reliability & Punctuality have been implemented. As the KPI model is based on scenarios and dependent on the definition of the KPIs, restrictions and assumptions have to be applied and are described in this deliverable, too.

Finally, as activities in the Shift2Rail initiative advance, also further detailing of the KPI model will be possible. Some of which are described in this deliverable.

Besides being an important indication of the possible success of innovations developed within Shift2Rail for themselves, the KPI results will also be one of the decisive inputs to the mode choice model developed within work package 3 of IMPACT-2 and therefore will be part of the evaluation of the modal shift triggered by Shift2Rail.

2 Abbreviations and acronyms

Abbreviation / acronym	Description
ATO	Automatic Train Operation
CCA	Cross-Cutting Activities
FINE1	Shift2Rail project “Future Improvement for Noise and Energy - Phase 1
GA	Grant Agreement
HVLD	High value low density
IMPACT-1	Indicator Monitoring for a new railway PAradigm in seamlessly integrated Cross modal Transport chains – Phase 1
IMPACT-2	Indicator Monitoring for a new railway PAradigm in seamlessly integrated Cross modal Transport chains – Phase 2
IM	Infrastructure Manager
IP	Innovation Programme
JU	Joint Undertaking
KPI	Key Performance Indicator
LCC	Life-Cycle Cost
MAAP	Multi-Annual Action Plan
R&I	Research and Innovation
S2R	Shift2Rail
SPD	System Platform Demonstrator
TD	Technical Demonstrator
TMS	Traffic Management System
UCM	Universal Cost Model
WA	Work Area
WP	Work Package

3 Background

The present document constitutes the Deliverable D4.3 “Reviewed quantitative KPI model” in the framework of the Work Area 2 (WA2) “KPI method development and integrated assessment” (see figure 1), task 2 and task 3 of the Cross-Cutting Activities (CCA) defined in the Multi-Annual Action Plan (MAAP) at the time of the start of IMPACT-2 (September 2017) [1].

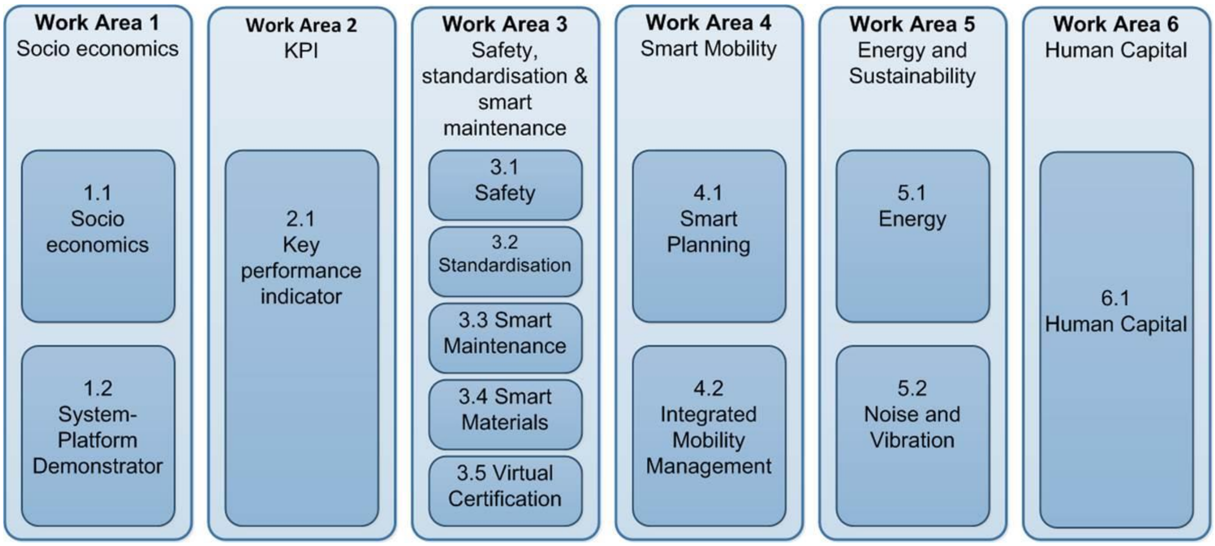

Figure 1: Overview Work Areas

IMPACT-2 constitutes of nine Work Packages (WPs) (see Table 1). The work reported in this deliverable has been performed within WP4 “KPI”.

Table 1: Work packages within IMPACT-2

WP	**Name**
WP1	Project management
WP2	Socio-economic impact
WP3	SPD implementation
WP4	**KPI**
WP5	Standardisation
WP6	Smart Maintenance
WP7	Integrated Mobility
WP8	Human Capital
WP9	Dissemination

4 Objectives/aims

This document has been prepared to provide a documentation of the reviewed quantitative KPI model developed in task 4.1 of IMPACT-2, considering the majority of impacts of the Technical Demonstrators (TDs) on the Key Performance Indicators (KPIs). In the document a summary of the first initial KPI model developed in WP4 of IMPACT-2 [7] is given and the changes from this version to the reviewed quantitative KPI model is described. Additionally, an outlook on the refinement of the KPI model during the next phases of WP4 in IMPACT-2 is presented.

5 Reviewed quantitative KPI model

In the following chapter the development of the KPI model will be described, beginning with a short summary of the first rough model which was developed in the first year of IMPACT-2 and described in the Deliverable D4.1 [7]. The largest development in the model from this first version to the current version will be displayed and finally potentials for further development will be shown. The results to the KPI assessment by means of the model can be found in the Deliverable D4.4 [9].

5.1 Initial quantitative KPI model

The KPI model developed in WP4 of IMPACT-2 is based on the general structure of the KPI model, developed in WP4 of IMPACT-1 [6].

Three separated models have been developed to display the influence of the Technical Demonstrators (TDs) of Shift2Rail on the KPIs Life-Cycle Costs (LCC), Reliability & Punctuality (following simply named Punctuality) and Capacity [6]. Their main impacts are estimated for four different market segments: High Speed, Regional, Urban (metro) and Freight, which are also referred to as System Platform Demonstrators (SPDs) [4].

The definition and agreement of these SPDs for Shift2Rail has been challenging but important as they build the basis for the calculations of the KPI models of IMPACT-2.

The relations of the effects resulting from the TDs towards the top level KPIs have been modelled quantitatively. Previously defined interface KPIs have to be delivered by each TD, to ensure that the model calculates with the correct values without TD-internal interrelations in the overall model.

All models rely on input data, therefore the data selection, collection and validation process are activities closely related to the KPI model development that were partly addressed in the Deliverable D4.1 [7] and further described in Deliverable D4.4 [9].

As a Cross-Cutting Activity project, IMPACT-2 relies on the cooperation and interaction with many other Shift2Rail projects. Two examples are the definition of SPD parameter and the energy calculation. The infrastructure characteristics of the four different train categories are aligned with the System Platform Demonstrators (SPDs) developed in WP3 of IMPACT-1 and IMPACT-2 [4]. For energy related data, results from the project FINE1 (GA 730818) are being used which makes an alignment of specific train data between the two projects necessary [3].

The calculations are implemented in Microsoft Excel, as it allows combining all information in one file, while keeping input data, general information, calculations and results on separate tabs. The following structure has been implemented in the KPI model Excel file:

- Administrative / informative tabs
    - Cover & History
    - Explanation

- Decisions
    - Sources
    - SPD parameters
- Input tabs
    - Input parameters
    - Distribution factors
    - TD Improvements
- Model tabs (with calculations)
    - LCC model related to passenger railway service
    - LCC model related to freight railway service
    - Capacity related to passenger railway service
    - Capacity related to freight railway service
    - Punctuality related to passenger railway service
    - Punctuality related to freight railway service
- Result tab

Input Data for the first estimation have been split in three categories:

Input Parameters: They entail data necessary to describe the reference scenarios [5], meaning values to be influenced by Shift2Rail innovations. Each input parameter has up to six values, one for High Speed, Regional and Urban Traffic as well as three different values for the Freight categories Single Wagon Traffic, Block Trains and combined traffic trains.

Distribution: The distribution tab is for parameters where cost, capacity or punctuality values cannot be collected at the level of detail at which the individual TDs are working on e.g. cost or weight of individual train parts are often not available by component but only for the train as a whole. An approach is used where the overall value is broken down in percentages onto the individual components to ensure a correct allocation of the TD improvements.

Improvement: It is understood as the improvement rate of each TD of their contribution of the models for the LCC, Capacity and Punctuality KPIs, e.g. investment cost of a component. There is one improvement rate per SPD.

Results of the first rough estimation of the KPIs carried out with the simplified model fed by rough low-level KPIs of the TDs can be found in deliverable D4.2 of IMPACT-2 [8]. The results of the model version described in this deliverable can be found in deliverable D4.4 of IMPACT-2 [9].

5.2 Progress from the initial to the current IMPACT-2 KPI model

As the first version of the KPI model was rather rough and only included main aspects excluding also very complicated aspects because of the time constraint, this model was further evolved within WP4 of IMPACT-2.

5.2.1 The adapted Punctuality approach for all Innovation Programmes (IPs)

The punctuality approach has been redefined for all IPs. It now takes into account the distribution of delay minutes on delay causes for each SPD (e.g. 4% of the delays in SPD1 are caused by track failures) as well as the average delay minutes for each cause (e.g. the average delay minutes per track failure are 180 minutes). This means based on empirical data, a value of delay minutes per failure by delay cause has been identified. As most of the innovations in Shift2Rail aim to increase the operational reliability, mainly the probability of occurrence of a failure is influenced, not so much the impact of the specific failure. Therefore, the identified indicator delay minutes per failure can be used to measure punctuality of today and of a future when Shift2Rail is implemented as it is assumed to stay mainly constant whereas the number of failures will decrease.

For all IPs the perceptual distribution of delay causes as well as the relation of delay minutes per failure by delay cause for each SPD has been done by comparing different sources such as input from the Infrastructure Manager (IM) involved in this project as well as published sources as PRIME. The average number of delay minutes per delay cause is given by Infrastructure Managers.

Therefore, the definition of Punctuality of deliverable D4.2 of IMPACT-1 [6] needs to be adapted accordingly. The measuring unit for the Punctuality KPI for passenger trains is no longer “number of unpunctual passenger trains compared to the total number of passenger trains” and for freight trains “number of freight trains delayed with less than 15 minutes compared to the total number of freight trains”. The new measuring unit is “sum of delay minutes within the network”.

5.2.2 Interdependence between vehicle and infrastructure in the LCC model

One of the most significant connections between different subsystems of the railway system is the connection between vehicle and the physical infrastructure. Within Shift2Rail innovations of the vehicle (IP1 and IP5) and the physical infrastructure (IP3) are covered within different innovation programmes wherefore the modelling of the effect needs a special focus within the LCC model structure.

There is an extensive literature on the impact railway traffic has on the deterioration of the infrastructure and on its maintenance costs. The approaches used can be divided into two categories: A top-down approach using empirical models to establish a direct relationship between traffic and costs; and a bottom-up approach that uses mechanistic models to establish relationships between traffic and deterioration of the infrastructure and then links the estimated deterioration to maintenance costs. The (mechanistic) models can also be used to estimate how a deteriorated infrastructure may damage the railway vehicles.

The weight of the vehicles is an important aspect in the deterioration of the infrastructure. Increasing the weight of the trains will cause more wear and tear of the infrastructure and thus increase maintenance costs (in order to keep the service level constant), and vice versa. The revised version of the KPI model includes the impact of axle loads on maintenance costs, using estimates from an empirical top-down approach.

In later versions of the KPI model, additional interdependencies between vehicle innovations and infrastructure costs are foreseen.

5.2.3 Restructuring work done in KPI model concerning IP2 (Command, Control and Signalling)

Necessity for using an adapted approach for IP2

For IP2 the approaches used to measure the effects in the three KPIs LCC, Capacity and Punctuality differ in some ways from the approaches used in the other IPs. Therefore, in the following it will be introduced why it was necessary to find a different solution to generate each KPI and to describe in detail the methodology used.

In IP1 (Rolling Stock), IP3 (Infrastructure) and IP5 (Freight) system-components are being evaluated which exist in the reference scenario and also in the Shift2Rail scenario in a modified or improved version. For the innovations of IP2 however, improvements have an impact on the general system structure. Although some functions of the system are performed by the same components, most components are being replaced or modified in such a way that it is not easily possible to extrapolate the effect due to one Shift2Rail innovation as the individual improvements massively depend on the system effect. Also in some cases, in IP2 developed innovations are targeting to shift functions to different components as of today (e.g. having more functions included on the train instead of the infrastructure) which can result in a change of cause-effect-chains.

The adapted IP2 Capacity approach

For Command, Control and Signalling (IP2) the relevant interface variable for the Capacity model is trains per line for a given SPD-depending infrastructure. Therefore, in the IP2 context, raising capacity means raising line capacity. The line capacity is determined by how close after each other the trains can follow. For the future, this distance will be mainly determined by the moving block technology, very likely assisted by the ATO (Automatic Train Operation) as this allows reducing the distance even more by removing a human unreliability.

The capacity approach in general is different for passenger transport (SPD1, 2, 3) and freight transport (SPD4) as the passenger scenarios focus on the peak-hour whereas freight capacity is measured for a whole day [6]. In any case the approach for capacity effect calculation of IP2 will follow the logic described above. The moving block TD will calculate the possible capacity increase on the line for each SPD with the infrastructure characteristics as described in D4.1 of IMPACT-1 [5]. This value will be influenced by the improvements of different TDs within IP2 which provide input factors for moving block and therefore are a necessary condition to reach the effect moving block has on the capacity improvement.

The adapted IP2 LCC approach

It was identified that for the LCC approach of IP2, a detachment from the TD structure of IP2, which is mostly the basis for the LCC model of the other IPs, was necessary.

As highlighted in the introduction to this subchapter, the signaling system is highly complex and interconnected. The functions of the reference scenario and the future scenario will perform the same task but the components used to perform the functions are in many cases not improved but changed entirely. Therefore an improvement of costs of the future system cannot be mapped directly on each component. A new approach to map the components of the reference system and the future Shift2Rail based on the functions they are needed for was developed. In a second step changes in costs can then be mapped on the functions instead of the components.

The adapted IP2 Punctuality approach

The punctuality approach has been redefined for all IPs as is described in chapter 5.2.1.

In IP2 the main effects are expected to be contributed by the ATO through a reduction of delay failures by staff and by an improved Traffic Management System (TMS).

TMS will not directly reduce a specific delay cause but will provide an enhanced traffic forecast and conflict detection resolutions, resulting in an improved handling of delay scenarios. To model the full advantage of the TMS, all delay causes will be taken into account.

5.2.4 Inclusion of asset management effects in peak-hour capacity

TDs within IP3 (infrastructure) can impact either the line capacity (number of trains per time unit) or (allowed) train capacity (passengers or tons per train).

A central impact on capacity among the TDs within IP3 concerns the downtime for maintenance. A reduced downtime implies that less capacity is consumed, which may allow more trains on the railway line. The infrastructure manager may also choose to keep the number of trains constant in this case in order to increase the reliability of the railway system; a lower capacity utilisation implies fewer reactionary delays.

The impact on downtime for maintenance was only considered for planned maintenance in the first version of the KPI model. Hence, this impact was only calculated for the freight trains in the model (SPD4), while its impact on passenger traffic (SPD1, SPD2 and SPD3) could not be covered as the capacity calculations of the KPI model for passenger transport is carried out for peak hour traffic. Specifically, planned maintenance is not carried out during peak hours and reduced downtime of planned maintenance will thus not influence the line capacity during this time of the day.

Peak hour traffic does however experience failures requiring (corrective) unplanned maintenance and lowering this type of downtime may allow the infrastructure manager to increase the number of trains during peak hours (again, the infrastructure manager may also keep the number of trains constant in order to increase the reliability of the railway system).

This impact is considered in the revised version of the KPI model. It is based on a preliminary estimation of the correlation between the number of trains on a line and the capacity reserve for downtime because of corrective maintenance. To benefit from a capacity increase through this correlation, it has to be assumed that the reliability and punctuality of the network should stay steady and is not increased in parallel. Also it should be noted that this preliminary estimate cannot be interpreted as a causal relation in which reduced downtime results in more trains running on the line.

5.2.5 Progress in the LCC Freight model

Several aspects in the freight LCC model have been redefined. To better cover the different freight wagons developed in Shift2Rail TD5.3 and to incorporate the improvements from the TDs in more details, the LCC freight model has been clustered into two wagon types, the extended and core market wagon.

The extended market wagon is representing a wagon for high value low density (HVLD) goods with lower tara weight, higher speed and optimised for container transport (combined traffic). Extended market wagons are coupled with a fixed short coupling and with automatic couplers at each end of the wagon train. Due to the lower tara weight and the short coupling, the extended market wagon can carry more goods per train length than conventional wagons. This increases the transport capacity and reduces the LCC.

The core market wagon covers other freight goods. It is equipped with an automatic coupling. Both wagons are equipped with electronic sensors to allow condition-based maintenance and wagon localisation.

Within the three train categories in the LCC freight model, the single wagon train only consists of core market wagons. The block train consists to 50% of each wagon type whereas the combined traffic train consists to 100% of extended market wagons.

For both wagons reference state-of-the-art wagons of the same length are defined, Lgns 583 for the extended market and Habbins 345 for the core market.

Consequently all LCC parameters that refer to a wagon or that are dependent on wagon parameters have been updated.

Since the loco- and wagon utilisation depends a lot on the process time of the whole freight transport process from terminal to terminal, the process is analysed. Reference process times are evaluated and improvements due to Shift2Rail TDs are collected. Within the LCC-model the loco- and wagon utilisation is considered by means of the required loco- and wagon fleet for operation on the reference line.

5.2.6 The integration of Noise reduction effects

The main focus of the KPI model is to capture the positive effects of the technical developments within Shift2Rail towards the KPIs LCC, Punctuality and Capacity, but there are also activities within Shift2Rail, which are improving other aspects of the railway system. For the ones directly directed towards the improvement of the attractiveness of rail towards the end-customer information are available in Annex 1 of deliverable D4.4 [9].

Another non-technical topic is noise and vibration. Interior noise and vibration, as a factor of comfort for passengers, as well as exterior noise and vibration, as a factor of acceptance and external costs for residents, are topics covered within the FINE1 project.

In cooperation with FINE1 three topics concerning noise and vibration have been identified, which can have an effect on the KPIs: Interior noise and vibration, noise depended track access charges and noise based capacity restrictions [2]. Figure 2 shows their relation to the measured KPIs and how they are implemented in the KPI model.

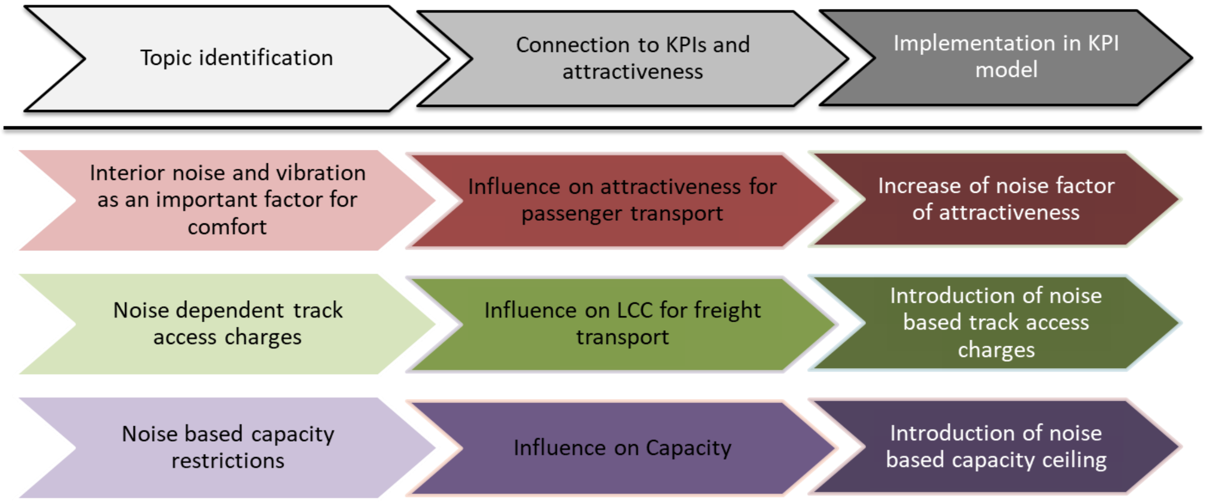

Figure 2: Noise topics for potential evaluation within LCC, Capacity, Punctuality and attractiveness

<u>Interior noise and vibration</u>

Interior noise and vibration influence the passenger comfort and are as such input factors for the attractiveness model described in D4.4 annex [9], with a reduction of the noise and vibration level resulting in a positive effect on the attractiveness. The weighted influence noise has on comfort will be analysed and like all other KPI parameter stated for the different train categories, in this case the ones concerning passenger transport. Noise and vibration are not caused by one single component but by the design of the vehicle as well as the layout of the infrastructure, maintenance condition of both vehicle and infrastructure and the interaction between wheels and track. The challenge will therefore be to analyse which TDs contribute directly or indirectly to an improvement and how to value a specific improvement level.

Noise dependent track access charges

The aspect of noise dependent track access charges is mainly relevant to freight trains and by a small extent to passenger trains. In the model they are included in two different aspects. To quantify the value of a reduction of noise emission, noise dependent track access charges have been used in the KPI model based on the system used in the Netherlands. There is a bonus per kilometre per axle with silent brakes for both regional and freight trains and additionally a bonus per kilometre for trains consisting of wagons with silent brakes for freight trains. The value of this bonus has been applied to the fleet in the KPI model as negative costs for the reference scenario as the wagons are not modified to the new noise standard yet and set to zero in the future Shift2Rail scenario.

Noise based capacity restrictions

Similar to a limitation of airplanes between 22 pm and 6 am there are noise ceilings for trains as well in some European countries and in others their introduction is prepared. Those noise ceilings limit the number of trains that are allowed to run on a certain corridor in a defined time period. The limitation is not set to a number of trains but to the emission of a certain noise level. To integrate this limiting factor into the Capacity model, the percentage of trains that were not permitted to run due to the noise ceiling has been applied to the freight model for the reference scenario. As it is assumed that in the future Shift2Rail scenario the improvements on noise emission are in such a way that a noise ceiling is no longer violated by any trains, it is set to zero.

5.3 Restrictions and Assumptions

The KPI model as described in this deliverable has been developed under a set of restrictions and assumptions which are important to take into account when interpreting the results which will be published in D4.4 [9]. They also help to understand the chosen approach and set its limitations:

- IMPACT-2 is a research project, evaluating all improvements worked on with the technical demonstrators (TDs). In the field each operator can decide for himself which and how the Shift2Rail innovations are to be used and integrated. For the KPI model a fictional railway is assumed which has integrated all innovations at the point of the future scenario in the model. We acknowledge that the resulting system will not be representative, however it serves the aim to show what is possible with a maximum integration.
- Each of the three KPIs (LCC, Capacity and Punctuality) is looked at and optimised separately and not towards an overall optimum as the decision to weight the importance of the KPIs against each other is in the scope of the railway operators (compare point one). Nevertheless, the interrelation between the three KPIs is considered as for each individual KPI optimum, the other two KPIs are assumed constant.

- The derived KPI are maximum values which will not be obtained when repeating the calculation for one specific railway, corridor and operational programme as each section has its own characteristics and the KPI have been calculated on a generic line being specifically constructed to provide customised conditions for the respective KPI.
- For all parameters concerning energy usage, values from the Shift2Rail project FINE1 (GA 730818) will be used as they are calculated with a lot more detail than would be possible in the scope of the IMPACT-2 project.
- Improvements made in IP4 (IT solutions for passengers) are not as yet included in the KPI model. They will be calculated in a separate model ("attractiveness model") which incorporates all improvements gained by making the railway system more attractive to end-customers by reducing elementary barriers to travel by train.
- To avoid an improvement of the KPI by side effects not related to the innovations of the TDs, framework parameters such as the operational service or the speed profile of the reference and the future scenario are being kept the same. If the change of a parameter however is due to a TD innovation, it will be incorporated e.g. the average speed for freight will change due to improved process time in the yards and terminals.
- The KPIs are calculated and compared for two points in time; a reference scenario before Shift2Rail (2013) and a future Shift2Rail scenario, when the roll out of all innovations is completed. The migration period between these two points in time will not be evaluated in this project.
- Factors that limit the capacity improvements stated in the KPI model such as a weight restriction per wagon due to a maximum axle load of bridges still need to be identified and if applicable calculated into the result.
- The *Passenger Train Capacity [passenger/train]* has been changed from solely using the passenger weight to a ton per seat ratio to estimate the number of passengers for future trains. This is a more accurate estimation than the initial approach in the initial model; however a calculation using a train layout is still the ultimate goal if available at a later point.
- Because the capacity is calculated for the whole day in the freight SPD, a traffic mix needs to be considered for SPD4. For the initial model a simplification in the SPD was assumed by sorting the traffic during the day. This means, that there is no real traffic mix, but that first all trains for one kind of traffic, e.g. high speed, and then all trains of another kind of traffic, e.g. freight traffic, are operating. This assumption simplifies the time tabling radically. Nevertheless, this assumption does not reflect the praxis in a suitable manner and will therefore be changed for a future advanced model.

5.4 Opportunities for further detailing

Even though the reviewed quantitative KPI model is significantly more advanced than the initial KPI model described in deliverable D4.1 of IMPACT-2 [7], there are still topics identified for further detailing. Following topics are currently under further assessment, but not conclusive for further developments:

- Some components within the KPI model do have potential to be further split into more defined components. One example is switches and crossings. As these components are targeted within one TD, they have been treated as one unit within the models yet. As the developments within the TD are getting more mature during the run-time of Shift2Rail, predictions can be further detailed and therefore a separated consideration will be possible in future model releases.
- For the same reason, also secondary effects can be further evaluated such as virtual certification of trains and train parts. With ongoing developments in the TD related projects, the estimations of possible improvements of aspects of the railway system can be evaluated more precisely. Therefore single aspects of e.g. the capital cost of components can be broke down in more detail and more aspects can be incorporated.
- In the current model, improvements in reliability of components are considered within the Punctuality calculations. But those improvements can also have an influence on LCC by increasing the life span of components and in this way reducing renewal costs. This relation is not yet considered within the LCC model, but will be further examined with IMPACT-2.
- As described in Chapter 5.3 are neither the effects of IP4 (IT solutions) nor accordingly the results of the attractiveness model, which is currently under development (cf. Annex of D4.4 of IMPACT-2 [9]), included within the KPI results. It is foreseen, once results from the attractiveness model are available, to include those in the LCC calculation. This will be done by transferring the results of the attractiveness model into a change in the demand and therefore the load factor of the trains. This will reduce the cost per passenger further. As there has been no development of a similar attractiveness model for freight yet, it needs to be assessed later on, if this can also be applicable for the LCC calculation for freight.
- One of the most complex topics for the KPI models, especially for the LCC calculation, is the interdependence between the vehicle and the infrastructure. The weight and driving behaviour of a vehicle have a considerable influence on the wear and tear of the infrastructure and thus on its maintenance cost. This interdependence will be further examined in an open call of Shift2Rail within the so-called Universal Cost Model (UCM) 2.0. As these results are not available yet, the described interdependence is built in the LCC model based on empirical data (see chapter 5.2.2). Once the UCM 2.0 is ready, it is foreseen to integrate its results within the KPI model.

6 Conclusions

The conclusion reached at this stage of the R&I and highlighted in this report is the further development of the KPI model for the key targets LCC, Capacity and Reliability & Punctuality. The initial quantitative KPI model [7] could be further detailed and more complex aspects of the railway system have been implemented. Therefore not only the main impacts of the TDs on those KPIs in passenger transport and freight transport have been considered, but the majority of considerable effects could be included.

Nevertheless, with further advancing of the Shift2Rail initiative, the findings within the TDs will progress, which will bring further opportunities for detailing the KPI model. Yet the KPI model as well as its corresponding data base is in a distinctly more mature state than described in the initial KPI model [7].

7 References

[1] Shift2Rail - *Shift2Rail Multi-Annual Action Plan (MAAP)* – 2015

[2] Hainz S., Leth S., Garburg R., Vannier E., Fast D. – *Noise Assessment of Railway Innovations* – 2019, The Science behind Hands on Sustainable Mobility Conference

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[4] IMPACT-1 – *D3.3 "Use cases for SPDs"* – 2017, Vol. 1

[5] IMPACT-1 – *D4.1"Reference Scenario"* – 2018, Vol. 1

[6] IMPACT-1 – *D4.2 "Subsystem structure and Sublevel KPIs"* – 2018, Vol. 1

[7] IMPACT-2 – *D4.1 "Initial quantitative KPI model"* – 2018, Vol. 2

[8] IMPACT-2 – *D4.2 "Initial estimation of the KPIs"* – 2018, Vol. 2

[9] IMPACT-2 – *D4.4 "First SPD integrated assessment"* – 2019, Vol. 1

8 Annexes

No annexes attached to this deliverable.

9 Antitrust Statement

While some activities among competitors are both legal and beneficial to the industry, group activities of competitors are inherently suspect under the antitrust/ competition laws of the countries in which our companies do business.
Agreements between or among competitors need not be formal to raise questions under antitrust laws. They may include any kind of understanding, formal or informal, secretive or public, under which each of the participants can reasonably expect that another will follow a particular course of action or conduct. Each of the participants in this initiative is responsible for seeing that topics which may give an appearance of an agreement that would violate the antitrust laws are not discussed. It is the responsibility of each participant in the first instance to avoid raising improper subjects for discussion, notably such as those identified below.

It is the sole purpose of any meeting of this initiative to provide a forum for expression of various points of view on topics

- (i) that are strictly related to the purpose or the execution of the initiative,
- (ii) that need to be discussed among the participants of the initiative,
- (iii) that are duly mentioned in the agenda of this meeting and
- (iv) that are extensively described in the minutes of the meeting.

Participants are strongly encouraged to adhere to the agenda. Under no circumstances shall this meeting be used as a means for competing companies to reach any understanding, expressed or implied, which restricts or tends to restrict competition, or in any way impairs or tends to impair the ability of members to exercise independent business judgment regarding matters affecting competition.

As a general rule, participants may not exchange any information about any business secret of their respective companies. In particular, participants must avoid any agreement or exchange of information on topics on the following non-exhaustive list:

1. Prices, including calculation methodologies, surcharges, fees, rebates, conditions, freight rates, marketing terms, and pricing policies in general;
2. any kind of market allocation, such as the allocation of territories, routes, product markets, customers, suppliers, and tenders;
3. production planning; marketing or investment plans; capacities; levels of production or sales; customer base; customer relationships; margins; costs in general; product development; specific R&D projects;
4. standards setting (when its purpose is to limit the availability and selection of products, limit competition, restrict entry into an industry, inhibit innovation or inhibit the ability of competitors to compete);
5. codes of ethics administered in a way that could inhibit or restrict competition;
6. group boycotts;
7. validity of patents;
8. ongoing litigations.