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The KPI-Model – An integrated KPI assessment methodology to estimate the impact of different innovations in the railway sector

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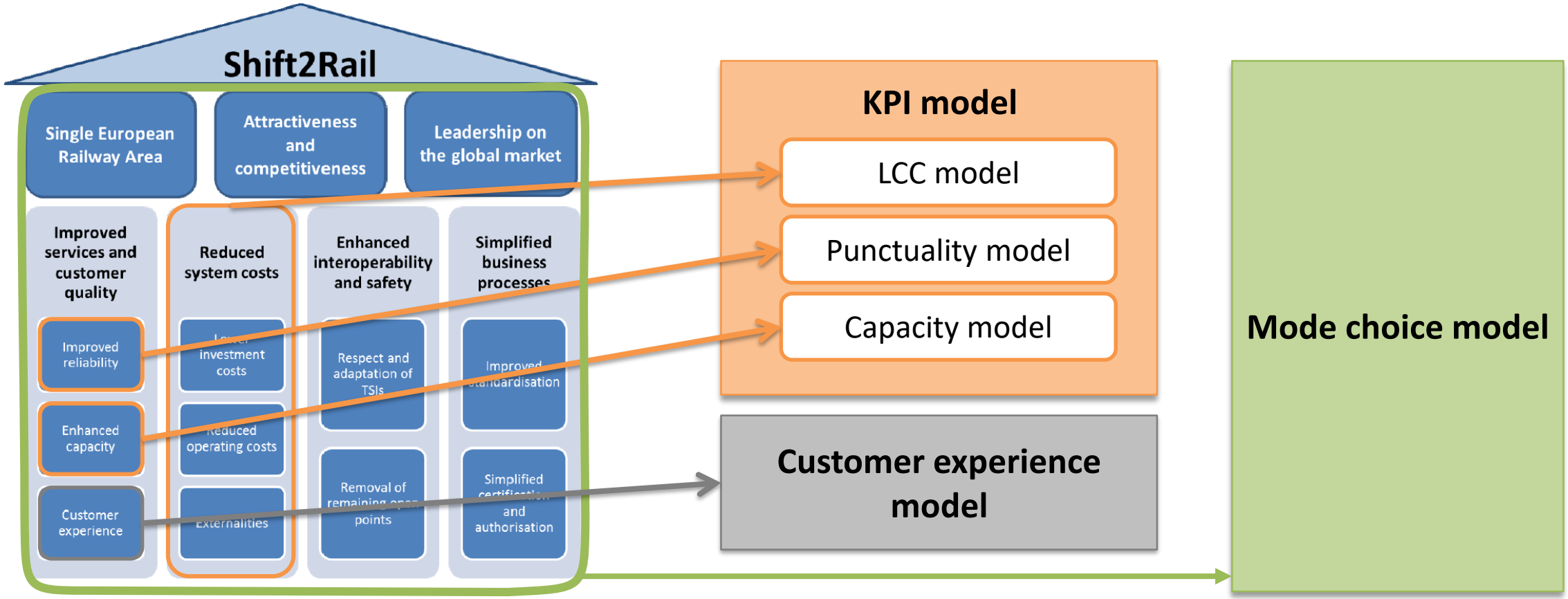
Overview of the IMPACT-2 model of Shift2Rail



Source: www.shift2rail.org

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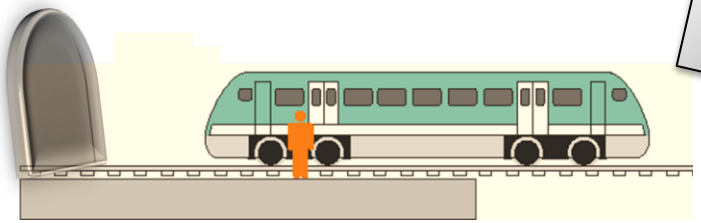
Methodology – Common Approach

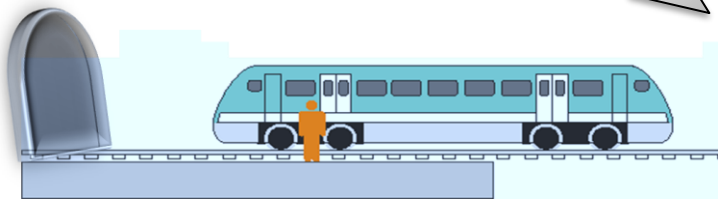
Baseline scenario



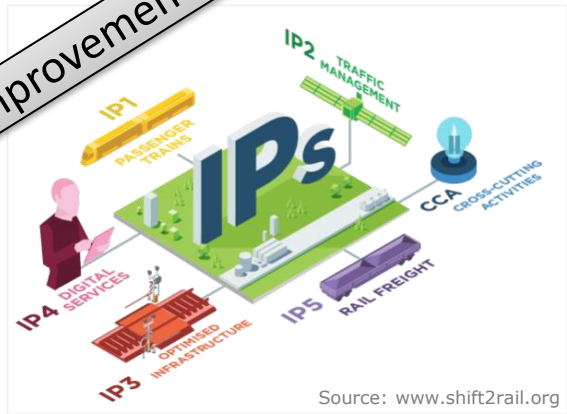
Data input

Improvement Values

Future scenario



Shift2Rail innovations



Source: www.shift2rail.org

System Platform Demonstrators (SPD):


SPD1: High Speed


SPD2: Regional


SPD3: Metro


SPD4: Freight

Source: www.pixabay.com

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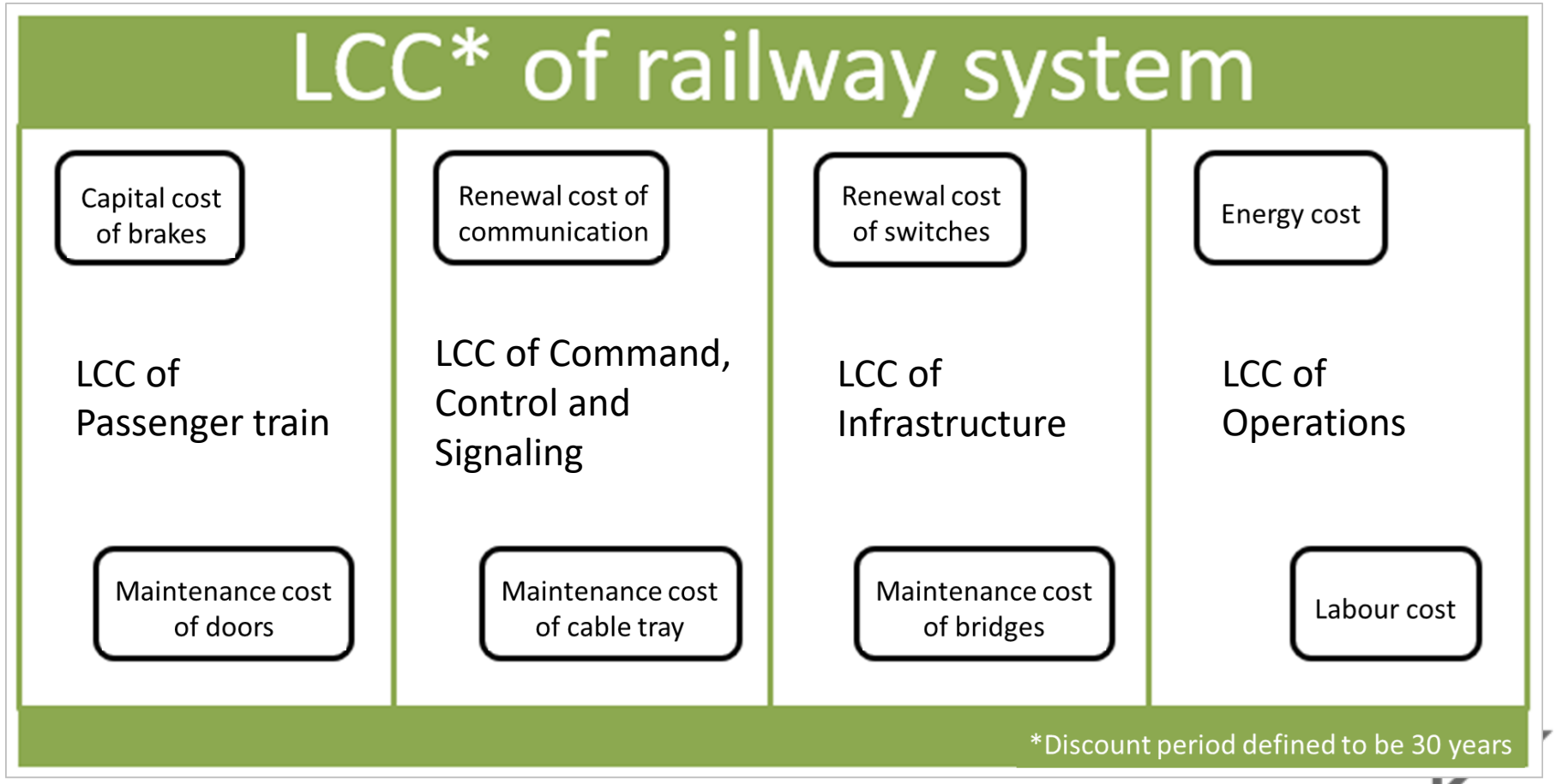
Passenger Specific Model – LCC Model



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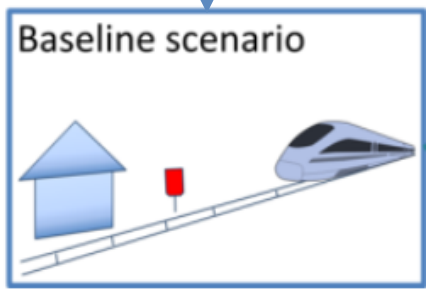
Passenger Specific Model – Punctuality Model

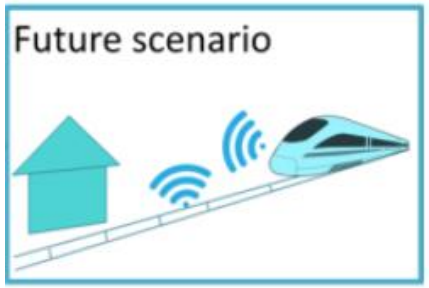
Input data:

- number of failures per specific failure cause
  e.g. failure due to defective switches
- number of delay minutes caused by specific failure
  e.g. delay minutes caused by defective switches

S2R-Improvements setting up the future scenario:

- % improvement of failure probability due to technical innovations





Outcome:

Estimation of the impacts of the S2R innovations on the future on-time performance

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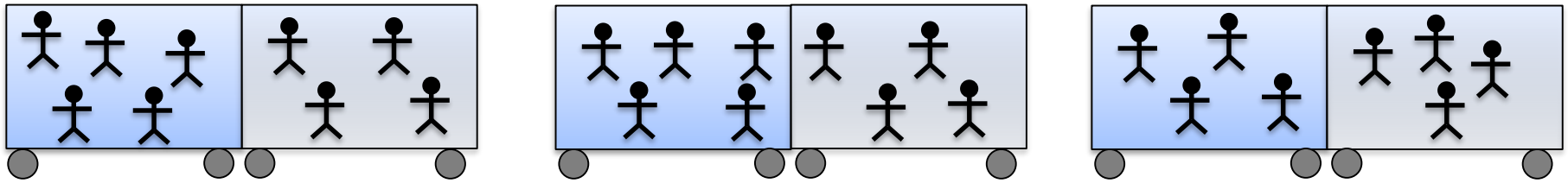
Passenger Specific Model – Capacity Model

The capacity is defined as the number of people that potentially could be transported per peak hour on a specific track. This includes the combination of the capacity of the infrastructure, the trains and the signaling system.

Capacity calculation consist of three main parts:

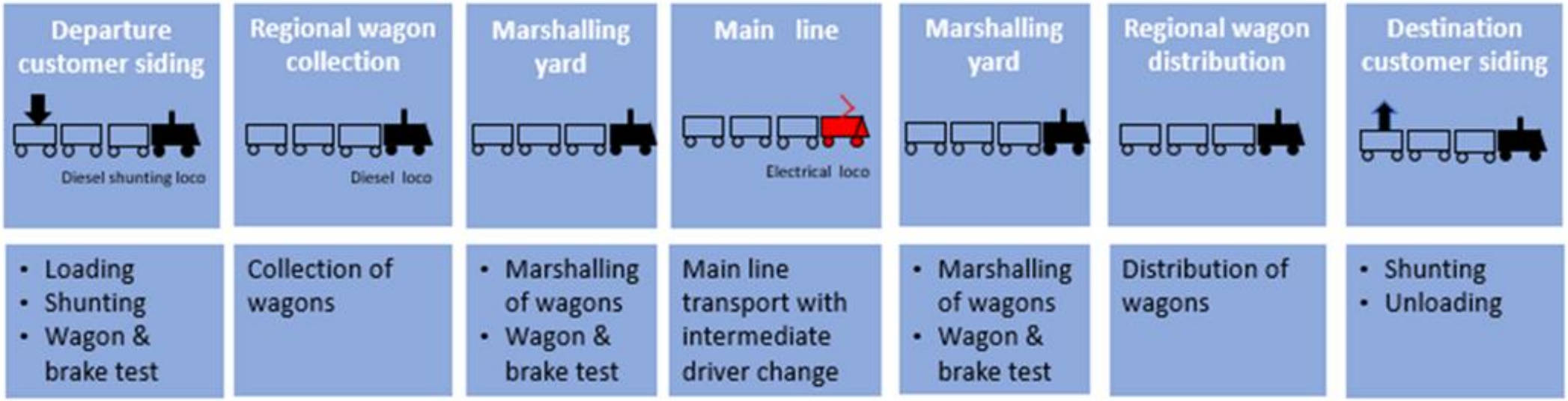
- Track Capacity (number of trains per peak hour / day)
- Train Capacity (passenger / metric ton per train)
- Coupling ability (coupled units per train)



Freight Specific Model – LCC & Punctuality Model

The model for freight transport is more complex than for passenger transport:

- Three different freight transport categories are considered: single wagon, block, and intermodal transport.
- Total freight transport process from terminal is considered



Freight Specific Model – LCC & Punctuality Model

Consequences for the LCC- and punctuality model:

- beside trains, infrastructure and CCS, additional assets are considered such as terminals and yards
- trains are split into locomotives and wagons since they are decoupled in terminals and yards
- operational delays and costs play an important role due to the complex process
- Shift2Rail Freight innovations not only have an impact on the assets itself but also on the freight process time
- Due to the digitalization incl. automatic coupling the process time is significantly reduced
- This has a direct impact on the utilisation of the locomotives and wagons (increased yearly km)

→ Hence, the process time has to be calculated in a separate model. Therefore, LCC-reduction is possible although the capital costs of the locomotives and wagons increase.

Freight Specific Model – Capacity Model

The **capacity model** considers two different freight innovations:

- Longer freight trains and coupled trains
- Wagons with increased load per train length

→ Both innovations reduce the LCC per ton since more load or containers can be transported with one train.

Another difference to the passenger model is **energy** consumption, which is influenced by different innovations:

- Improved wagon aerodynamics
- Increased speed
- Connected driver assistant system

→ Special energy simulations must be carried out to determine the changes in energy consumption.

Results – Elements of the KPI Model in Excel

Sheet 4: InputParameters
Sheet 5: Distribution
Sheet 6: Improvements
Sheet 7: Accuracy levels

Sheet 9: LCCSubsystem
Sheet 12: LCCSubsystem_Freight
Sheet 10: UnreliabilitySubsystem
Sheet 13: UnreliabilitySubsystem_Freight
Sheet 11: Capacity_Subsystem
Sheet 14: Capacity_Freight

Sheet 8: Overview

Sheet 1: Cover & History
Sheet 2: SPD Parameters
Sheet 3: Decisions
Sheet 15: Sources
Sheet 16: Sensitivity Analysis

Results – Input Information Sheets

Sheet 4: InputParameters
Sheet 5: Distribution
Sheet 6: Improvements
Sheet 7: Accuracy levels

- **Input Parameters:**
  Data is collected to describe the baseline scenario for all four SPDs.
- **Distribution:**
  A percentage share of total values is determined for innovations where cost, capacity or punctuality data cannot be captured at the level of detail at which the individual TDs work, e.g., the costs or weights of individual train components are often not available for each component, but only for the train as a whole.
- **Improvements:**
  Percentage improvement values provided by the TDs are collected in this sheet.
- **Accuracy levels:**
  This is understood as the level of precision under which the TDs have delivered their improvement values.

Results – Sub-models & informative sheets

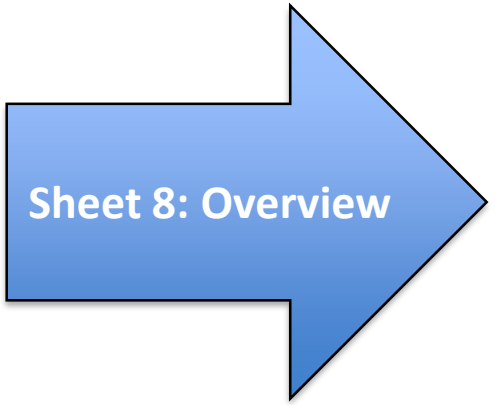
Sheet 9: LCCSubsystem
Sheet 12: LCCSubsystem_Freight
Sheet 10: UnreliabilitySubsystem
Sheet 13: UnreliabilitySubsystem_Freight
Sheet 11: Capacity_Subsystem
Sheet 14: Capacity_Freight

- 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

Sheet 1: Cover & History
Sheet 2: SPD Parameters
Sheet 3: Decisions
Sheet 15: Sources
Sheet 16: Sensitivity Analysis

- Otherwise there are further administrative or informative sheets, that supply information on the cover and history, explanations, decisions, sources and SPD parameters.

Results – Overview Sheet

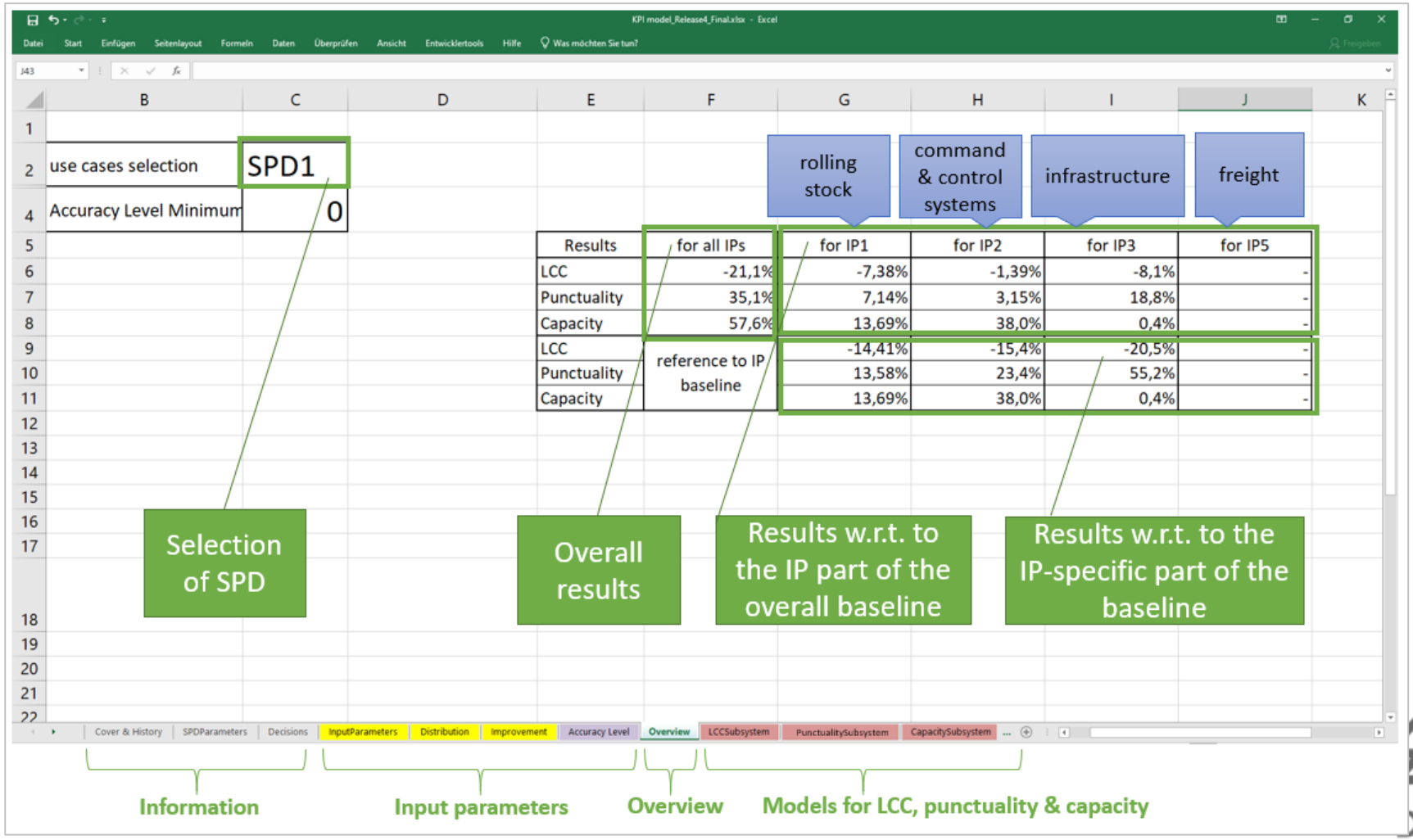


- with the help of a drop-down list it is possible to select the required SPD
- after selecting the respective SPD, the table calculates the results of the S2R innovations on the respective high-level KPIs LCC, Punctuality and Capacity
- KPIs for the overall results are calculated, meaning when all S2R innovations have been implemented
- the KPI estimation provides:
  a.) the results with regards to the IP part of the overall baseline
  b.) the results in relation to the IP-specific* part of the baseline (IP1, IP2, IP3, IP5)

*IP4 is considered within the customer experience model: estimating innovation's potential to improve the customer experience.

Results – Overview

Sheet 8: Overview



Conclusion

- With the KPI approach, a powerful tool for the impact estimation of the technical developments in the Shift2Rail project has been developed
- Due to the model structure, it is possible to adapt it to other comprehensive assessments in the railway system
- When the necessary data is available, the parameters used in the input sheets can be applied to other use cases
- The general calculations, that are used for the three high-level KPIs in the six model sheets, are written in such a way that they calculate the results for any changes in the input sheets.
- There are, however, a number of special calculatory approaches, which are necessary due to the high complexity of the railway system
- This have the effect that these calculations cannot easily be transferred to other use cases as they are specifically designed for the project requirements of Shift2Rail.

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Thank you for your attention!

Feel free to ask questions

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