Visualising railway service quality

Gemma Nicholson
Research Fellow

Outline

- Motivation
- Quality of Service (QoS) framework
- QoS quantitative evaluation
- Example of application – ON-TIME project
- Conclusions and future work
Motivation

• Differing perspective depending on the stakeholder

• Evaluation of quantity and quality of operational behaviour

• Whole system approach
  – Decomposition of system into properties
  – Measure the effect of changing system properties, i.e., quantitative evaluation

Quality of Service framework

- Key measures
- KPIs
- Railway system
- System properties
- Influencing factors
- Railway system decomposition
- Quantitative output
QoS framework applications

The QoS framework broadly has 4 applications:

– benchmarking of simulation tools
– comparison of timetables or operational control systems
– visualisation of delay propagation
– linking of real operational data and microscopic simulation

QoSQE methodology
The full Quality of Service framework...

QoS framework

Railway system

Key measures

KPIs

System properties

Influencing factors

QoS framework outline
QoSQE performance indicators

Railway system

TV key measures

Transport volume

passenger seat km = \text{number of km travelled} \times \text{number of seats available on the service}

freight tonne km = \text{number of km travelled} \times \text{freight train cargo capacity in tonnes}

total values for selected O-D pairs during time $T$
JT key measures

**Journey time**

The average journey time [seconds] of all journeys that make scheduled stops at O and D, in that order.

CN key measures

**Connectivity**

The average interchange time of all interchanges at I for journeys that both depart O and arrive at D during the simulation time T.
PC key measures

Railway system

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RS key measures

**Resilience**

Based on the system deviation measurement:
- maximum deviation during time period T [seconds]
- time to recover [seconds]
- deviation area [seconds²]

PT key measures

**Punctuality**

At station S, during time period T, the sum of arrival delays to all services departing S during T

- at intermediate stations
- at terminal stations
**EG key measures**

**Energy**

For a given O-D pair, the average energy consumed per service for all services that both depart from O and arrive at D during time period T.

**RU key measures**

**Resource usage**

- **RU1: track usage**: the average number of trains passing a point per hour during time period T.
- **RU2: rolling stock**: the total number of rolling stock units in use during time period T.
Example: ON-TIME project

- Project aim: an improvement in capacity by reducing delays and improving traffic fluidity

- Evaluation and comparison of traffic management approaches
  - For minor perturbations
  - For major perturbations

QoSQE applied in ON-TIME

Benchmarking
- Network, timetable, time period
- Simulation
- Comparison between simulation and schedule at service level

Evaluation
- Simulation
- Timetable
- Simulation + real-time perturbation management method
- Delay introduced
- Delay introduced
- Outputs
- Key measure values
- Visualisation of KPIs
ON-TIME case studies

- Iron Ore line, Sweden and Norway
- East Coast main line, UK
- Section of Dutch network, The Netherlands

- Minor perturbations
  - e.g. temporary speed restriction, signal failure
- Major perturbations
  - e.g. complete line blockage

ONTIME case studies

- Iron Ore line, Sweden and Norway
- East Coast main line, UK
- Section of Dutch network, The Netherlands

- Minor perturbations
  - e.g. temporary speed restriction
- Major perturbations
  - complete line blockage
IOL simulator benchmarking

Comparison between timetabled and simulated event times for IOL simulation...
IOL quantitative evaluation

Quantification of key measures...

1. Demonstration of resilience KPI
   - using in-built simulator logic only

2. Key measure results
   - using perturbation management algorithms
Key measure results with perturbation management

Punctuality

Algorithm 1
Algorithm 2

FCFS

Resilience
Conclusions

• The QoSQE showed that the perturbation management approaches applied in ON-TIME resulted in improvements
  – in particular to the resilience and punctuality KPIs
  – less significant, but still positive outcome for the other KPIs

• Since the built-in simulator dispatching logic is used in the benchmark simulations, no quantitative conclusions can yet be drawn about the effects of perturbation management systems in real railway networks

• General implications
  – Extension to platform independence
  – Applicable to the assessment of operational data
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Gemma Nicholson
Birmingham Centre for Railway Research and Education, UK

g.l.nicholson@bham.ac.uk


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