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Evidence based approach to holistic risk analysis

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Evidence based approach to holistic risk analysis

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Risk = f(Hazard, Vulnerability, Consequence)

Hazardous Weather
e.g. extreme heat

Vulnerable Elements
e.g. assets and services

Consequence of Failure
e.g. organisation, users or stakeholders
• How is the UK climate and weather going to change in the future?

• What are the impacts of climate change and extreme weather going to be on the GB railway?

• What is being done already or can be done about the impacts of climate change and extreme weather?

• How can we evaluate the cost and benefits of dealing with impacts of climate change and extreme weather?
Consequence

What is the purpose of a railway? Who are the users and stakeholders?

- Passenger / Freight mobility
- Economic and Social activity
- Environmental mitigation (modal shift)
- It provides a service...
- ...which can sometimes fail (risk)
- Investment / maintenance / renewal / repair activities are justified by mitigating risk
Key metrics in modern rail

- Public Performance Measure (PPM)
- % of trains arriving “On Time”
- Trains are punctual if they are ≤5 mins late for short-distance and ≤10 mins late for long-distance

Key metrics in modern rail

- Cancellations and Significant Lateness (CaSL)
- % of trains which arrive at final destination > 30 mins from planned arrival, or full/part cancelled or missed calls
Delay Minutes

- Total annual Network Rail-caused delay minutes (by category group)

Life can only be understood backwards...

- Delay minutes (and thus PPM/CaSL)
  - Excludes ‘severe’ weather
    “no reasonable or viable economic mitigation was possible against the impact of the weather” (DAB 2014)
  - Calculated verses a daily timetable
  - Poor links to infrastructure condition or cause
  - Therefore not a basis on which to make adaptation (i.e. investment) decisions
  - “Past performance is not indicative of future results”
...but it must be lived forwards

Søren Kierkegaard

What is required:

- basis for adaptation decision making
- scalability across the industry
  - local identification of ‘critical’
  - strategic choices about service
  - next week to next century
- inclusive of different/external stakeholders and interdependencies...

Identifying risks to improve resilience

- Unplanned events (eg. extreme weather) and asset breakdown may disrupt network operations and impact service levels
- Twin challenge of day-to-day incident response & maintenance along with long-term upgrades/renewals
- With finite resources there is a need for efficient resource allocation to prioritise interventions/actions

Allocating resources to high risk locations promotes:

- Value-for-money
- Focused risk management = Improved resilience
Network Criticality

- Identify location-based single points of failure – formalise priority locations with high service performance risk to aid decision-making for resource allocation
- Regional-scale assessment – relative priorities for management regions at high level of granularity
- Based on observed fault/disruption data – captures network behaviour (NR TRUST system) through metrics of asset failure consequence as delay minutes

Infrastructure Service Availability

- In this case ‘journey (un)availability’
- Probability that a given ‘element’ of the system will cause $N$ minutes delay
  - 2 minutes / 5 minutes / 20 minutes
  - May be stakeholder specific

Probability of delay

- Normal
- Adverse
- Critical

Hazard ‘amount’
...it is the journey that matters

- Individual JA/criticality for ‘elements’ can be quantified
  - specific high-vulnerability elements identified and targeted for adaptation in a consistent way
- The vulnerability of a route can be quantified
  - combination of elements along that route
  - for a typical ‘basket’ of hazards (‘stress-testing’)
- The vulnerability of regions, or nationally
  - aggregation of routes
  - weighted by passenger- or service-numbers
  - weighting factors for different stakeholders
    - Infrastructure only
    - Rolling-stock, staffing, stations etc.

Network Rail CP6 Metrics

- Station to station
- Minute to minute
- “Whole journey” focus
- % of trains arriving to the minute at every station from ‘early’ through to ‘30 minutes after’ the timetable
- On Time - % of station stops where train arrived <1min late
- Cancellations - % trains cancelled
Including interdependencies in criticality...

Cross-sector asset information and locations – where are assets and how are they connected?

Cross-sector network criticality – spatial correlations in risk?

Cross-sector consequence metrics – similar fault reporting and service impacts? Where are the system boundaries?
The future depends on what you do today

Mahatma Gandhi

- Poor assumptions:
  - Engineers are representative of general public
  - The future will be just like today (but with extra widgets)
  - Future patterns of service use, climate, maintenance, adaptation measures and/or new services / infrastructure can be evaluated with system modelling

Recommendations

- Identifying failure pathways (from root cause, to failure, to consequence)
- Multiple perspectives/stakeholders (organisations, passengers, governance)
- System-wide – elements beyond infrastructure (people and operations)
- Role of sensing/IoT – observe weather/hazards and asset condition?
- Data and information sharing/requirements? (asset location and condition information)
- Develop new/standardise metrics – role of regulators? e.g. ORR
- End to end journeys across modes and interdependencies
- What is the best for system users/passengers?
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