IRF WORKSHOP

Innovation Driving the Future of Sustainable Mobility

30 March 2022 – RAI Amsterdam

Big Data for Sustainable and Innovative Roads

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Introduction

Rapid technological advances and new and big data are everywhere: IoT, AI, increased connectivity and sensor coverage, open for Connected & Automated Vehicles, Traffic and Transport

Road infrastructure scope is changing:
bearing loads/opening pathways and also as networks for:

- communication
- information and data collection
- potential energy sources

…in parallel with main activities

How can technology and new and big data lead to more smart, green, efficient, safe and resilient transport?

Smart Roads and Adaptive Infrastructure (1/2)

Smart systems are dynamic, adaptable & at least partially automated, requiring low human discretion to function:

- Smart intersections & traffic signal optimization reducing emissions and traffic delays for both conventional and connected vehicles.
- Smart lighting: traffic flow/demand-based lighting when, where and as much as needed, increasing energy efficiency and leading to more harmonious/livable cities.
- Smart road maintenance in the form of crowdsourcing: Pothole detection via crowdsourcing (image uploading, social media web scrapping).

Smart Roads and Adaptive Infrastructure (2/2)

Other Key Smart Road Examples:

- Dedicated lanes for Connected and Automated Vehicles
- Optimising on-street parking
- Green Light Optimal Speed Advisory
- Road-use pricing

Several impacts are expected from smart traffic and related infrastructure interventions:

1. Direct impacts (road user level, e.g. delays)
2. Systemic impacts (within the transport system boundaries, e.g. modal split)
3. Wider impacts (exceeding transport system boundaries, e.g. emissions)

… we need to estimate and anticipate these impacts.

Smart Motorways

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Smart Motorways are quickly expanding

Mandatory speed control, automatic signal setting in response to traffic conditions and speed enforcement using automatic camera technology

Gains in environmental impacts are expected to upscale as traffic volumes and platooning percentage increase

However, Smart Motorways have not improved road safety uniformly, and more than 50% of drivers are not aware of the new traffic, safety and environmental potential

Key Challenges for Smart Roads

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- Smart infrastructure needs open big data flows:
  The 'silo' effect hinders data sharing due to privacy, legal liability, intellectual property, competition, cybersecurity or cost-related issues
- Smart solutions need systemic resilience, scalability, timelessness, interoperability
- Artificial Intelligence explainability and fairness are critical for full exploitation of big data
- Policymakers will have to develop digital skills themselves
- Multidimensionality of smart road transition is evident to align with United Nations sustainable development goals: Cost-benefit analyses and legal frameworks must be formulated.


Big Data &
Artificial Intelligence
for Smart Safe &
Sustainable Roads

Key Big Data Contributions

- Big data can provide real-time (or nearly real-time) problem detection and prompt customized decision support on every level.
- Big data can support proactive assessments of interventions, either overall or with emphasis on safety, mobility, environmental impacts.
- Big data can provide quantified feedback to support choices of both the Authorities and the travellers
- Big data can drive innovation: Allows for more infrastructure elements & devices to be meaningfully connected through IoT and cover additional aspects of transport networks.
- Big data can provide better understanding of rare events (such as road crashes).

Key Big Data Challenges (1/2)

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- Big Data must be given context and purpose: It cannot provide informed prioritization of interventions alone
- Full analyst contextual knowledge will always be needed to keep up with developments and the ethical dimension.
- Complete absence of parameters/coverage in the area(s) of interest cannot be circumvented by data imputation
- Big Data operations cannot be fully automated as many transport aspects change constantly (e.g. micromobility, e-scooters etc.)
- Big Data cannot encourage engagement or awareness of citizens if not fully supported by communication channels and applications

Key Big Data Challenges (2/2)

- The consequences of using data which are not always representative of the whole population (bias towards some user groups) should be assessed and properly corrected.
- It is easy to wrongly consider a dataset as unbiased if it covers a specific dimension in detail (e.g. covering different road users) while it can fail in another (e.g. not covering modal split/exposure).
- Desired conclusions should not drive the research approach or outcome, especially when selecting features for analysis.
- Proper results require serious effort and budget:
  There is a high risk for decision makers to be misled by the opportunistic analysis of seemingly low-cost data in absence of qualified data scientists and statisticians.

Key Big data Recommendations (1/2)

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- Road safety practitioners can rapidly gain by copying best practices for data sharing and privacy protection from other fields.
- More secure alternatives to data exchange, such as the exchange of structured queries and responses can be explored, instead of raw information.
- Multiple-criteria based exploration and decision analysis to determine the most efficient Key Performance Indicators that can be mined or obtained in priority from the available Big Data.
- Establishment of data harmonization and fusion protocols – Investigation of the best approach to reconcile different data scales (e.g. country, city, city block, road segment, road user).

Key Big Data Recommendations (2/2)

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On a high-level, Governments and Road Safety Authorities should:

- Mandate the sharing of aggregate vehicle data.
- Define a minimum dataset for all vehicle manufacturers to report in an anonymous standard aggregate format.
- Collect data on traffic volume, speed distribution, and locations where vehicles' active safety systems (ABS/ESP/AEB) are engaged.
- Clarify regulatory frameworks for data protection.
- Governments should also examine how Freedom of Information laws articulate with data protection laws.

Conclusions

Innovative solutions are ready today to reduce emissions, delay times, crashes & casualties, energy consumption and other key indicators, while maintaining or even improving safety levels overall.

Main barriers are:
(i) data flow and sharing,
(ii) transport system robustness and scalability and
(iii) Artificial Intelligence fairness and equality.

Cross-discipline cooperation and increased familiarity with new technologies are crucial to overcome multi-dimensional challenges.

Big Data applications are powerful emerging tools that nonetheless need constant steering and attention to yield the desired outcomes.

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