Key Performance Indicators (KPIs) for Assessment of Impacts of Automated Driving

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Background

- EU-US-Japan Trilateral Working Group on Automation in Road Transportation (ART WG) is working to develop a harmonized approach for addressing the complexity of impacts of automated driving
- As field tests are expensive and mostly done on a small scale, everyone would benefit from international harmonization
- The Trilateral ART WG recently published version 2.0 of a framework which aims for high-level harmonization of impact assessment studies globally
  - The first attempt to do harmonization by the three regions (EU, US and Japan)
- To identify the most important KPIs for measuring and expressing impacts, an international survey was conducted, this poster presents the key results

Method

- The survey was conducted with an online questionnaire, open June – November, 2017
- Invitations
  - By email to stakeholder groups in Europe, the US and Japan
  - Open invitation on CARTRE website in Europe
  - Promotion in the 2017 AVS and SIP-adus conferences
- In total, 77 answers were obtained
- Region: 69% from Europe, 19% from Japan and 12% from the US
- Organization: 56% research organizations, 18% policy makers or authority and 14% automotive or other industry, a few responses from consultants and from the public transport sector

Structure of survey

- Identification of respondent
- Selection of impact areas of interest
- Selection of a vehicle type and SAE level that they would assume when answering the questions
- Ratings for KPIs for 12 impact areas
- Additional KPIs for the impact area

Discussion

- Report includes average ratings calculated for all responses and broken out for different levels of automation (SAE 1-2, SAE 3 or SAE 4-5) in mind or specifically for automated passenger cars or for mixed traffic
- No KPIs received very low ratings
  - Likely due to a careful selection of KPIs during survey design
  - Furthermore, as the impacts of automation are still partly unknown, we can expect broad interest in many potential impacts
- To shorten the list of alternative KPIs to rate, some KPIs were not precisely defined
  - Need to make them unambiguous before use in practice
- Survey results are used to develop KPI recommendations for:
  - Impact assessment studies
  - Trilateral framework, version 2.0

Full reports

Innamaa S, Smith S, Barnard Y, Rainville L, Rakoff H, Horiguchi R, Gellerman H (2018). Trilateral Impact Assessment Framework for Automation in Road Transportation, version 2.0. 42 p.

Innamaa, S. & Kuisma, S. (2018). Key performance indicators for assessing the impacts of automation in road transportation - Results of the Trilateral key performance indicator survey. Research Report VTT-R- 01054-18, VTT. 36+1 p.

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Three highest rated KPIs for each impact area

Scale: from 0 = 'not at all important' to 6 = 'extremely important', see full lists in the report

Vehicle operations

- Number of instances where the driver must take manual control / 1000 km or miles (average rating 5.69, n=29)
- Mean and maximum duration of the transfer of control between operator/driver and vehicle (when requested by the vehicle) (average rating 5.63, n=30)
- Mean and maximum duration of the transfer of control between operator/driver and vehicle (turning automated driving system on/off, manual override) (average rating 5.03, n=29)

Use of automated driving

- Number of instances where the driver must take manual control / 1000 km or miles (average rating 5.55, n=31)
- Use of automated driving functions (% of km of maximum possible use) (average rating 5.32, n=31)
- Comprehensibility of user interface (expressed on a Likert scale, e.g. 1–9, low–high) (average rating 5.21, n=29)

Safety

- Number of crashes (distinguishing property damage, and crashes with injuries and fatalities), in total and per 100 million km or miles (average rating 5.73, n=40)
- Number of instances where the driver must take manual control / 1000 km or miles (average rating 5.36, n=39)
- Number of conflicts encountered where time-to-collision (TTC) is less than a pre-determined threshold / 100 million km or miles (average rating 5.30, n=40)

Energy or environment

- Energy consumption of a vehicle (liters/100km or miles per gallon or electric equivalent) (average rating 5.29, n=21)
- Tailpipe carbon dioxide (CO_2) emissions in total per year and per vehicle-km or mile (average rating 5.00, n=21)
- Tailpipe criteria pollutant emissions (NOX, CO, PM10, PM2.5, VOC) in total per year and per vehicle-km or mile (average rating 5.00, n=21)

Personal mobility

- Type and duration of in-vehicle activities when not operating the vehicle (high levels of automation) (average rating 5.12, n=33)
- User perceptions of travelling quality (expressed on a Likert scale, e.g. 1–9, low–high) (average rating 5.06, n=35)
- User perceptions of travelling reliability (expressed on a Likert scale, e.g. 1–9) (average rating 4.88, n=34)

Travel behavior

- Share of transport modes (modal split) per week (based on number of trips) (average rating 5.09, n=32)
- Number and type of trips per week (in total and per inhabitant) (average rating 4.84, n=32)
- Total duration of trips per week (in total and per inhabitant) (average rating 4.69, n=32)

Network efficiency

- Throughput i.e. number of vehicles per hour through a particular road section or intersection approach, normalized to number of lanes and proportion of green time (where relevant) (average rating 5.38, n=24)
- Maximum road capacity (for a given road section) (average rating 5.00, n=24)
- Peak period travel time along a route (average rating 4.83, n=23)

Asset management

- V2I infrastructure for automation (average rating 5.18, n=11)
- Frequency of pothole occurrence (number of potholes per 100 km or miles) (average rating 5.18, n=11)
- Use of hard shoulder (for hard-shoulder running or as emergency stop area for mal-functioning automated vehicles) (average rating 4.90, n=10)

Costs

- Capital cost per vehicle for the deployed system (infrastructure, monetary value) (average rating 5.08, n=12)
- Cost of purchased automated vehicle (market price, monetary value) (average rating 5.00, n=13)
- Operating cost for the deployed system (per vehicle-hour or per vehicle-km or mile, monetary value) (average rating 4.92, n=13)

Public health

- Modal share (%) and total mileage travelled (kms) by active modes of transportation (walking and bicycle) (average rating 5.80, n=5)
- Number of fatalities and injuries per year per million inhabitants (average rating 5.40, n=5)
- Proportion of people with improved access to health services (average rating 5.00, n=5)

Land use

- Number of parking slots (average rating 5.00, n=11)
- Density of housing (average rating 4.91, n=11)
- Location of parking (average rating 4.91, n=11)

Economic impacts

- Work time gained due to ability to multitask while traveling (hours per year, overall and per capita; monetary value) (average rating 4.95, n=19)
- Socio-economic cost benefit ratio (average rating 4,80, n=20)
- Work time lost from traffic crashes (hours per year, overall and per capita; monetary value) (average rating 4.75, n=20)

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