

The Day 1 C-ITS Application Green Light Optimal Speed Advisory (GLOSA)

A Mapping Study

Niklas Mellegård

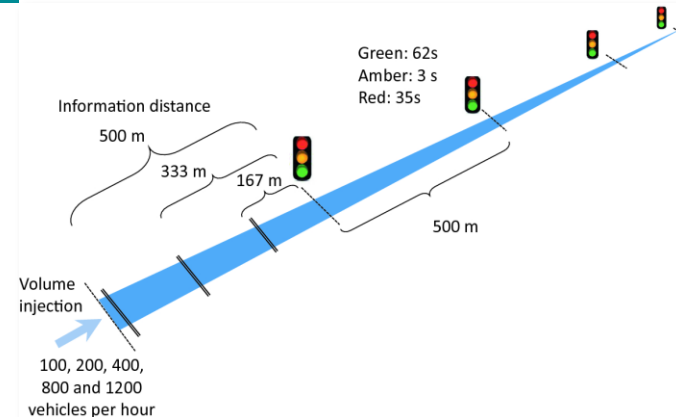
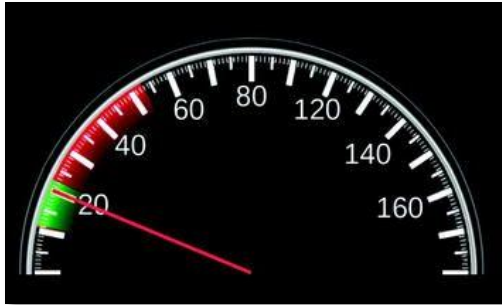
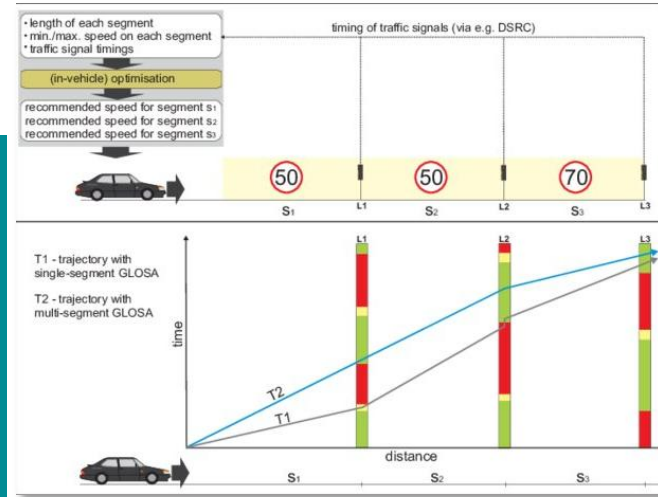
Frida Reichenberg

RISE Research Institutes of Sweden AB

Introduction

GLOSA – Green Light Optimal Speed Advisory

- ✓ Driver support function—recommends optimal speed to arrive at green light (“green wave”)
- ✓ C-ITS application, enabled by V2I-communication
- ✓ Expected to improve traffic flow, reduce emissions and increase safety



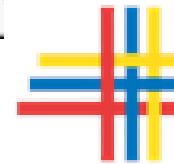
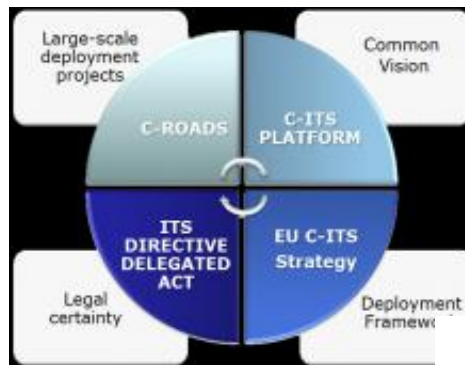
C-ITS | C-ROADS | Nordic Way 2



- **C-ITS** – Cooperative Intelligent Transport Systems
- **EU Directive 2010/40/EU**
- Enabled by **vehicle-to-vehicle** and **vehicle-to-infrastructure** communications
- **Improve** safety, comfort and transportation efficiency, e.g. by reducing congestion



- Launched in 2016, **joint initiative** of European Members and road operators
- Platform for **harmonizing deployment** of C-ITS
- Jointly **develop and share** technical specifications
- **Verify interoperability** through cross-site testing
- **Day-1 and Day-1.5** services—enabled by mature technologies, has short-term benefits

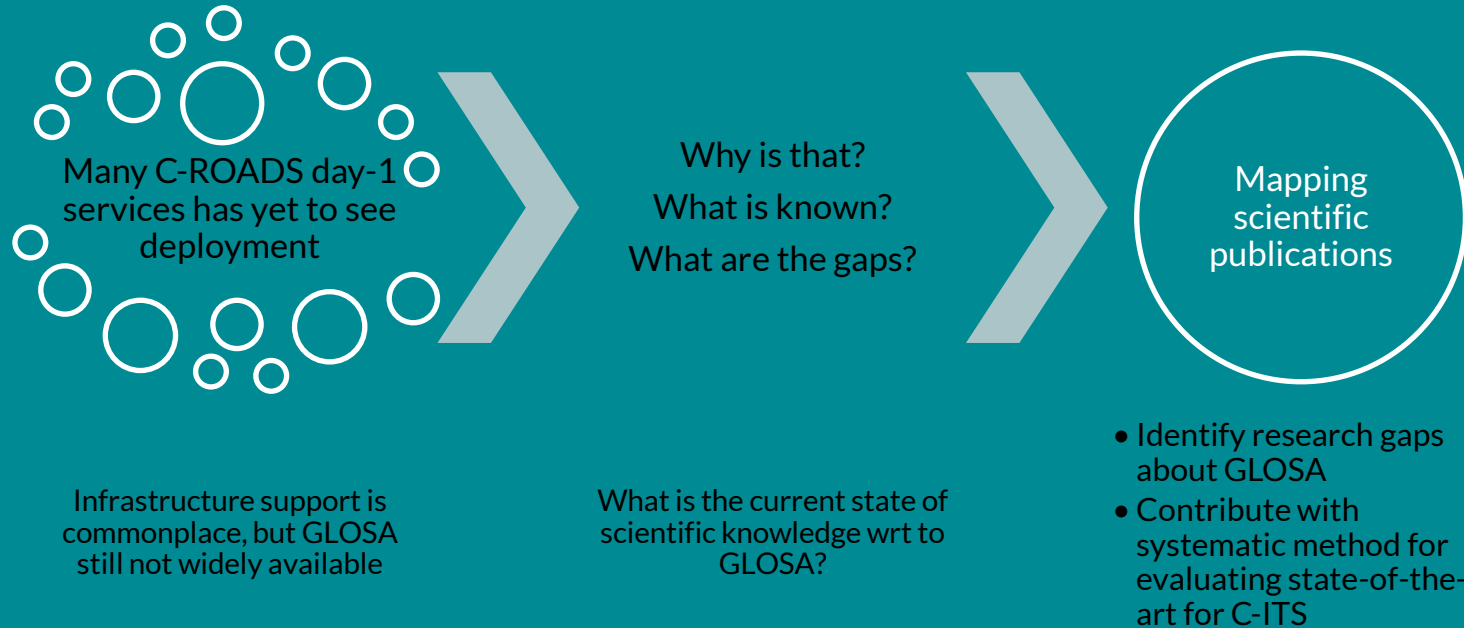


- **Test the interoperability** of several C-ITS services in the nordics
- **Test the infrastructure readiness** for connected and automated driving
- **Explore requirements for automated driving** in snowy and icy conditions
- **Demonstrate and highlight future services** and challenges connected to vehicles with higher SAE levels



The Day-1 C-ITS application GLOSA

Why a mapping study?



Research Question

What is known about GLOSA
and what gaps are there?



Specifically

When and **where**
are GLOSA
studies done?

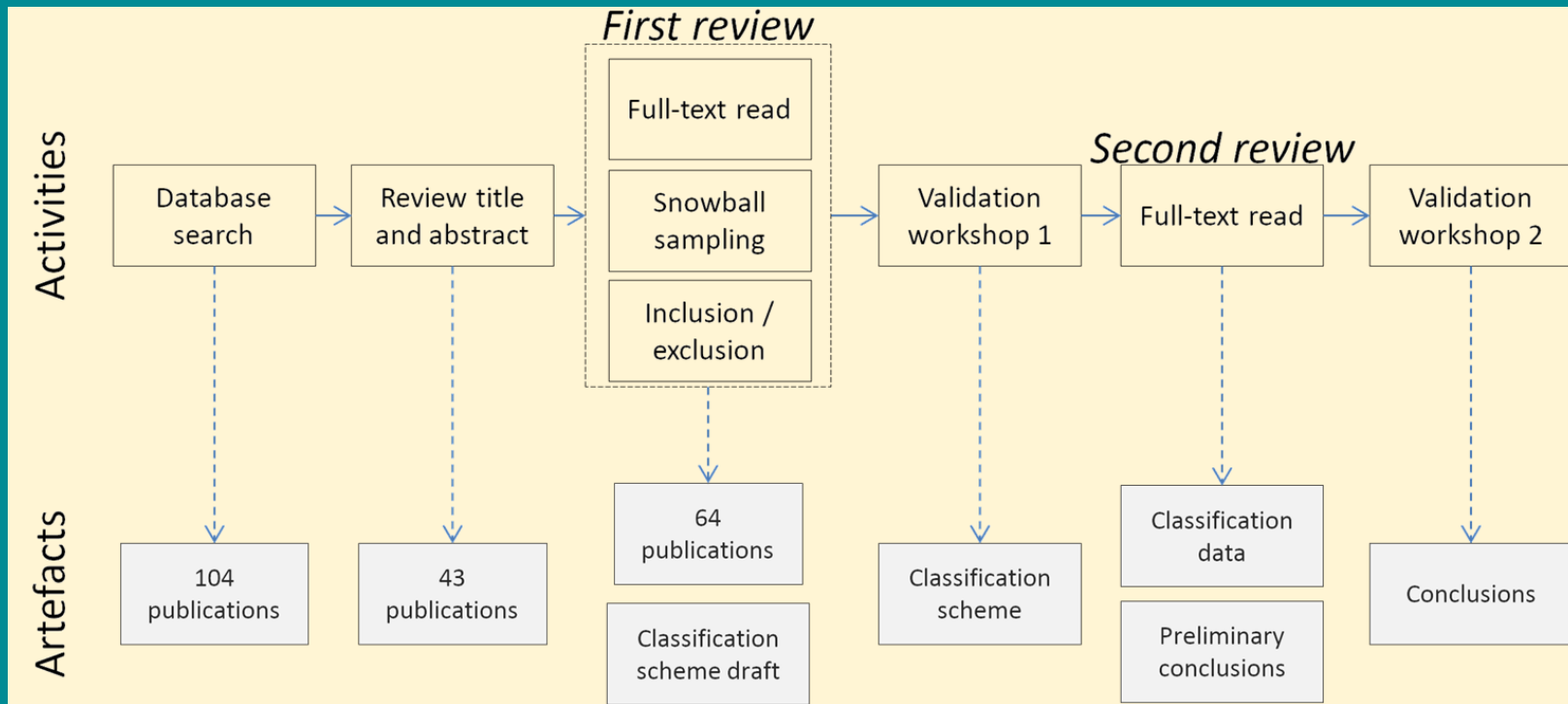
What are GLOSA
publications
about?

What **effects** can
be expected?

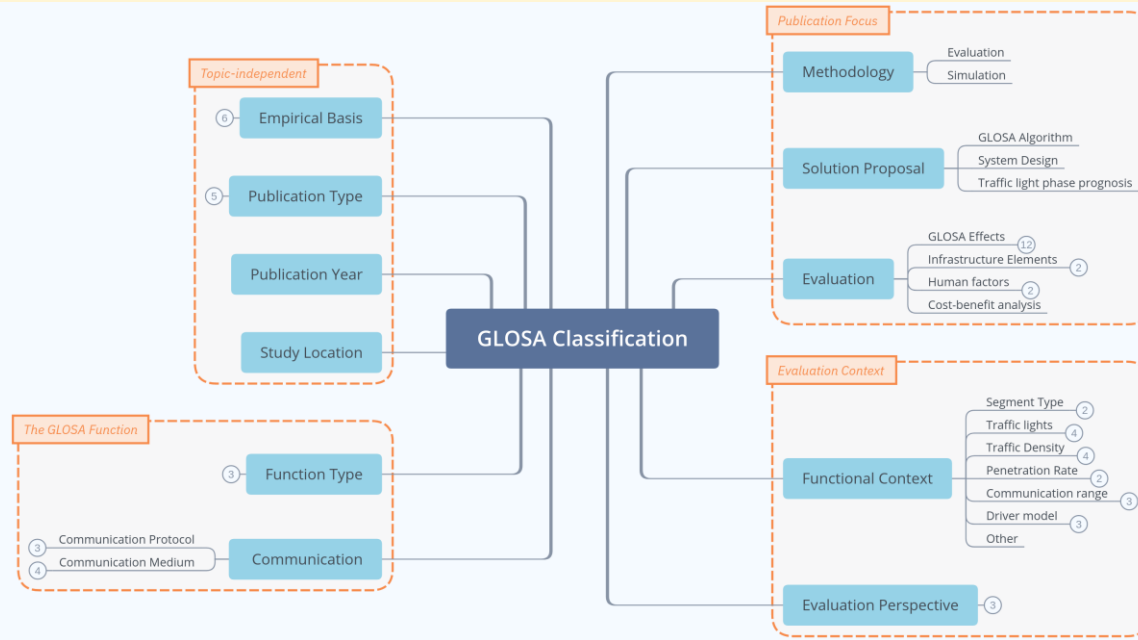
How is GLOSA
evaluated?

What is the current state
of scientific knowledge?

Method



Classification Scheme



NB. A paper may have any number of tags

TOPIC-INDEPENDENT

- **Empirical Basis**
What data was used as evidence, analytical evidence only, simulation, or in a pilot in real traffic?
- **Publication Type**
Indicates maturity of research.
- **Publication Year**
The year the publication was published.
- **Study Location**
Where the study was conducted, if disclosed and relevant.

THE GLOSA FUNCTION

- **Function Type**
Specifies the target user for the GLOSA function.
- **Communication consideration**
What kind of communication media and/or protocol is considered?

PUBLICATION FOCUS

- **Methodology**
The paper focuses on methodology for evaluation or simulation
- **Solution Proposal**
The paper proposes a solution, typically a specific GLOSA algorithm, a whole system setup, or providing prognoses for dynamic traffic lights.
- **Evaluation**
The paper evaluates some aspect of GLOSA, typically some effect on the equipped vehicle.

EVALUATION CONTEXT

- **Functional Context**
In which context was the effects examined? E.g. type of traffic light, single or multiple junction, traffic density, communication range, type of driver mode, penetration rate.
- **Evaluation Perspective**
From which perspective are effects were examined, the equipped vehicle, unequipped vehicles or traffic/society generally.

Results

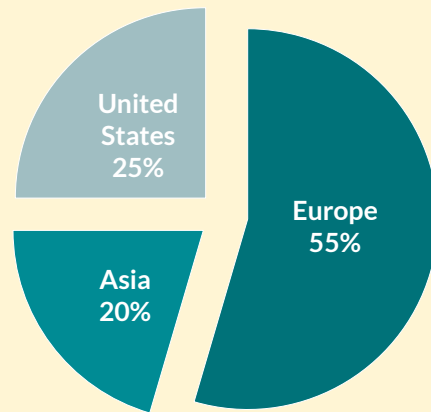
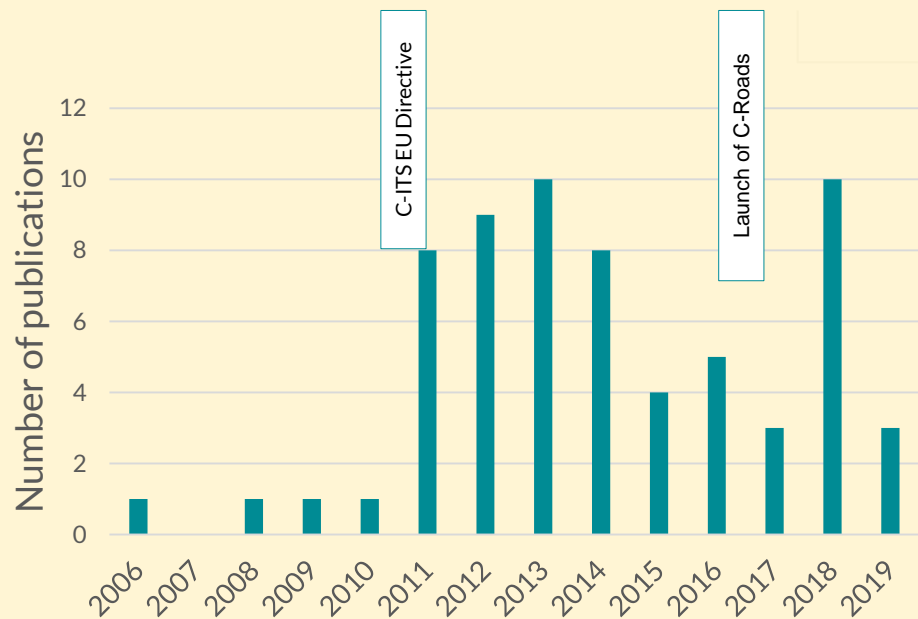
Publication Trends

The typical GLOSA paper:

Is published from 2011...

...and location is not relevant...

...but where it is, it's mostly **Europe** (Germany) or the US.

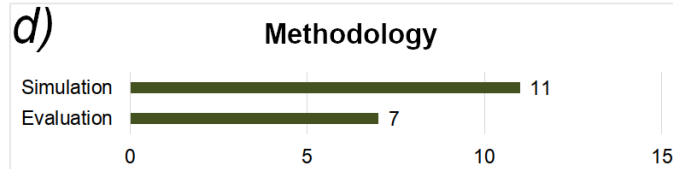
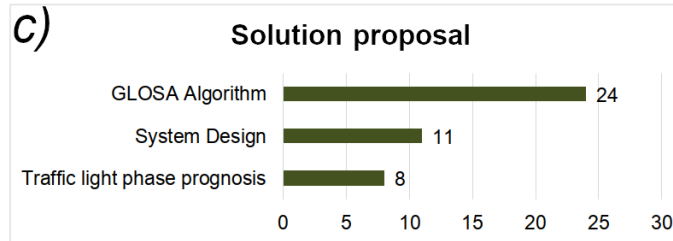
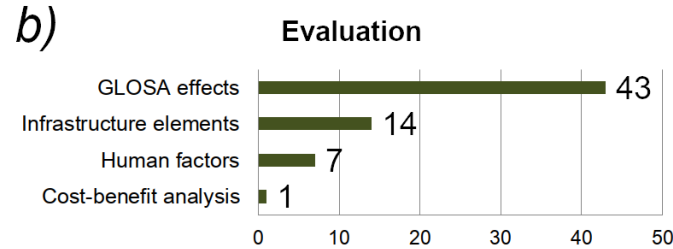
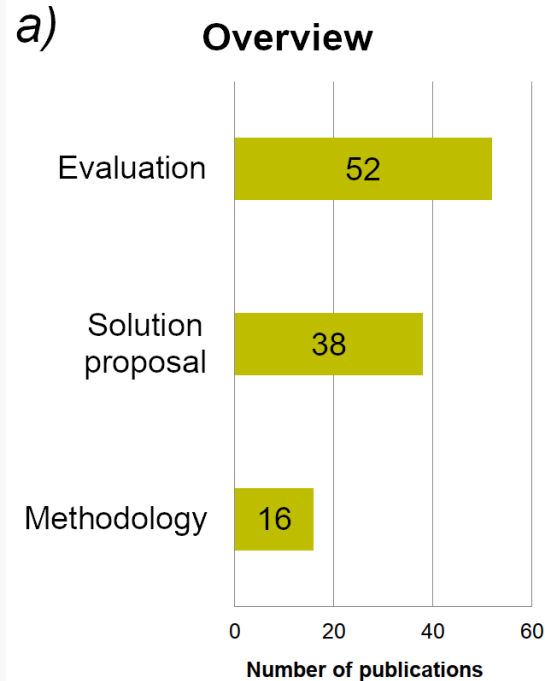


Country	#
N/A	20
Germany	16
US	11
Japan	4
Singapore	3
Sweden	2
UK	2
Austria	1
China	1
Italy	1
Korea	1
Netherlands	1
Spain	1

Results

Publication Focus

The typical GLOSA paper:
Proposes an on-board algorithm, and...
...evaluates effects for the equipped vehicle

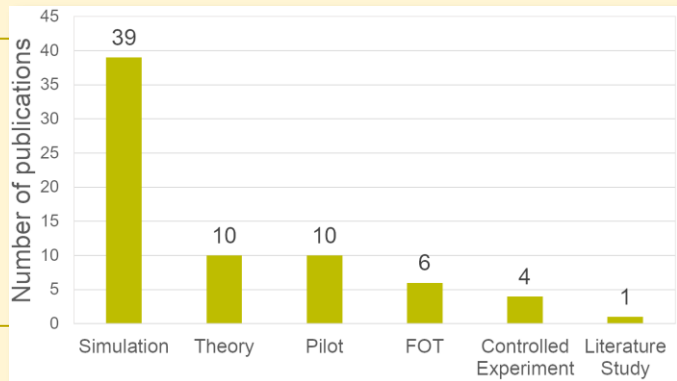


Results

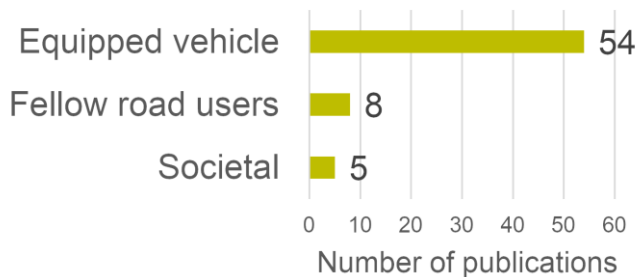
Evaluation details

The **typical GLOSA evaluation**...
 ...focus on effects for the **equipped vehicle**...
 ...in **simulation**...
 ...for the more **simple cases**...
 ...often using **ideal models** and/or

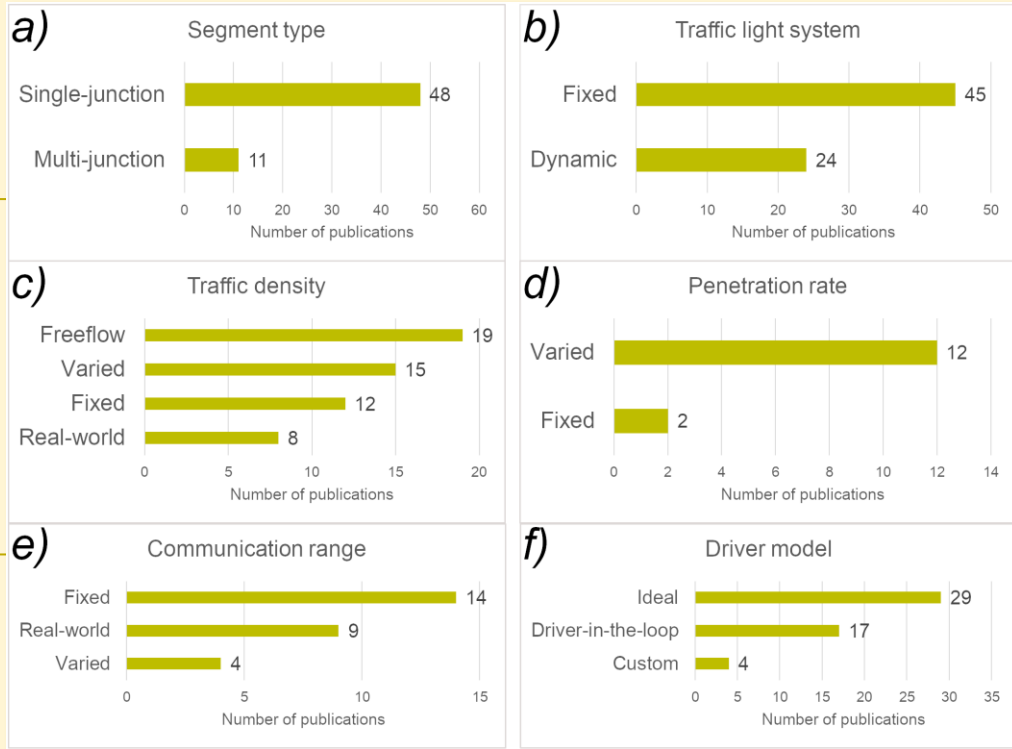
Empirical Basis



Perspective



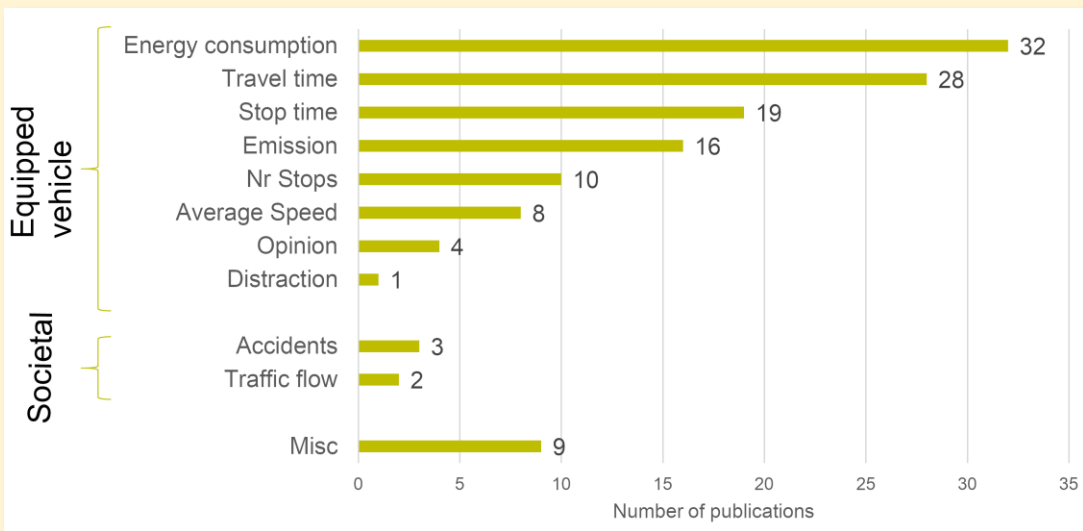
Evaluation Context



Results

Observed Effects

The typical GLOSA evaluation paper:
Focus on fuel consumption and travel time...
...only for the equipped vehicle...
...with widely varying results!



Overview observed effects

❖ *Fuel consumption*

Simulation ($n=25$)

Reduction 0.5—69.3%

Pilot ($n=4$)

Reduction 6—20%

❖ *Travel time*

Simulation ($n=20$)

Reduction 0.96—50%

Pilot ($n=2$)

Little or no effect found

Conclusions

Driver and fellow road user (FRU) behaviour

- Lacking accurate models—are simulation results reliable?
- How does GLOSA impact safety?
- What is the impact on recommending wrong speed?

Little focus on societal effects

- Much focus on equipped vehicle
- How is traffic flow affected?
- Is enabling GLOSA always a good idea?
How to target intersections/areas?

Lacking reports from real-world tests

- Validate simulation results
- Investigate driver and FRU behaviour
- Performance with adaptive traffic lights?

Technical aspects are well-investigated

- On-board algorithms
- Traffic signal phase shift prognosis

Significant variation in reported results

- Evaluations mainly in simulation
- Simple models and many assumptions, some are stated explicitly
- Difficult to compare results
- Challenging to assess reliability

Harmonized validation methods needed

- C-ROADS aims to harmonize deployment
- How to systematically...
 - ...evaluate effects?
 - ...investigate when and where C-ITS is efficient?
 - ...investigate unintended effects, e.g. feature interaction?

Niklas Mellegård

niklas.mellegard@ri.se

Frida Reichenberg

frida.reichenberg@ri.se



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