TRA
TRANSPORT RESEARCH ARENA
LISBON 2022

Safety and impact assessment for seamless interactions through human-machine interfaces: indicators and practical considerations

Marios Sekadakis

AVL

TU Graz

Together with:
Christos Katrakazas, Philipp Clement, Adrian Prueggler, George Yannis

The HADRIAN project

Sekadakis M., *Katrakazas C., Clement P., Prueggler A., Yannis G.*

HADRIAN
Holistic Approach for Driver Role Integration and Automation Allocation for European Mobility Needs

- **HADRIAN:**

  "Holistic Approach for Driver Role Integration and Automation Allocation for European Mobility Needs"

- **HADRIAN Partners:**

  16 partners from 9 EU-countries

- **Duration of the project:**

  42 months (December 2019 - May 2023)

- **Framework Program:**

  Horizon 2020 - The EU Union Framework Programme for Research and Innovation - Mobility for Growth

Introduction

Sekadakis M., *Katrakazas C., Clement P., Prueggler A., Yannis G.*

- At SAE automation levels up to level 3 (conditional automation) the driving task will still require **human interventions and interactions** with the vehicle.
- **Human-Machine Interfaces (HMIs)** are expected to play a key role in the cooperation between users and vehicles at these levels.
- A detailed **human-centered investigation** of the interaction between the user and the driver should be conducted.
- This study gives directives related to **indicators** for assessing safety and impact, and **practical considerations** for assessing the development of fluid interactions between the user and the HMI.

HADRIAN Innovations & AD Levels

Sekadakis M., *Katrakazas C., Clement P., Prueggler A., Yannis G.*

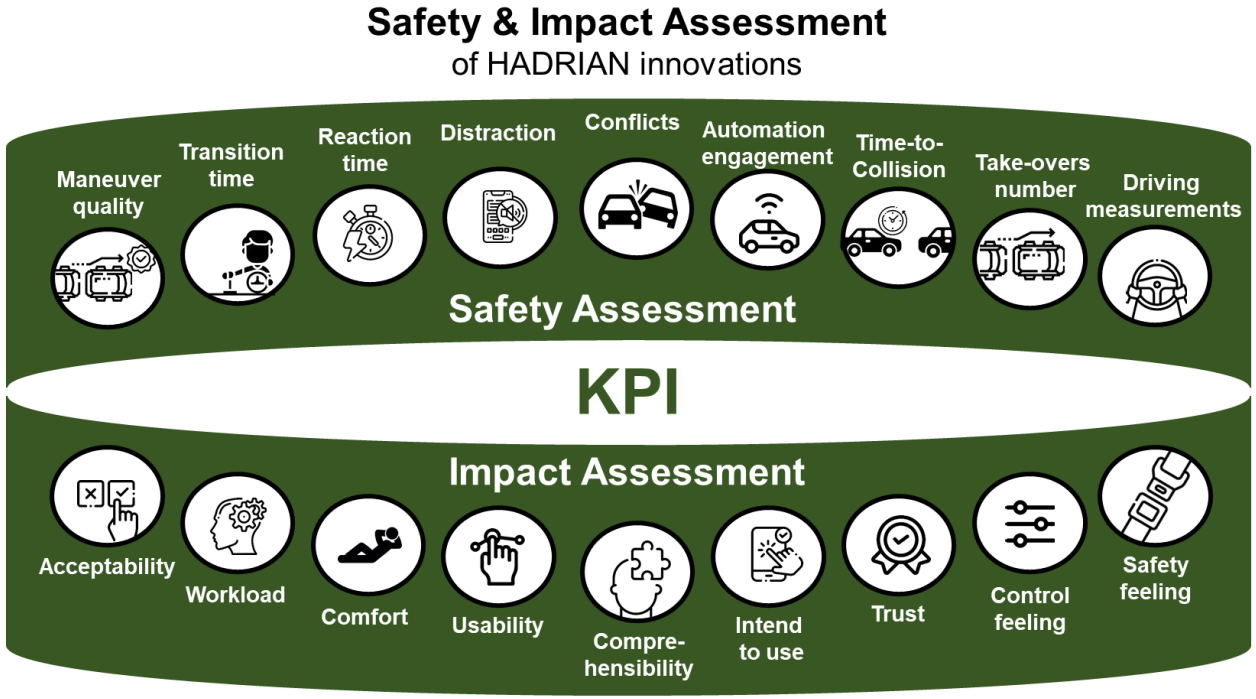
- The HADRIAN developments focus on **seven innovations**, that encompass five HADRIAN-defined levels of automated driving and transitions between them.
- The Automated Driving **(AD) levels** include the environment awareness assistant (EAA), guardian angel (GA) as well as HADRIAN ADL2, 3 and 3+ levels which offer automated driving with guaranteed transition times.
- The **use cases** are
  a) an elderly driver,
  b) a truck driver, and
  c) an office worker driver.
  Each of these has distinct driving and mobility requirements.

Innovation	Symbol	Innovation Description
1		**Awareness assistant** to simplify the manual driving task for elderly drivers
2		Reduce the need for the driver to **monitor** the environment and automation during ADL 2
3		Provide minimum guaranteed **time** for human driver to transition from automated driving to manual driving
4		Guarantee **minimum duration** of automated driving at level 3 / 3+
5		Active driver monitoring & fluid interventions
6		Adaptive **tutoring** to improve driver / user skills, knowledge, and competences to use the automated driving system
7		Guardian Angel as **safety protector** during manual driving

HADRIAN KPI List

Sekadakis M., *Katrakazas C., Clement P., Prueggler A., Yannis G.*

- The **aim** of the assessment is to demonstrate the improvements of the HADRIAN HMI innovations regarding safety and impact.
- A **final list of 18 KPIs** was extracted. The KPI list shows an overview as well as the measurement approach.
- Some of the **measurement approaches** have real-time capability, and some of the values are generated in a postprocessing procedure.



Assessment Development Steps

Sekadakis M., *Katrakazas C., Clement P., Prueggler A., Yannis G.*

- The **KPI identification** started with a literature review of risk factors for automated driving in the defined use cases as well as relevant previous research projects and studies.
- Driving tasks in which the developments are tested were divided into **subtasks** including a detailed description of driver-required actions, traffic requirements, human-machine required interactions, and automation constraints during each developed driving scenario.
- An **analysis** of the driving subtasks revealed the potentially present risk factors in the driving "system".
- This analysis was titled "**hazard identification procedure**" and then the relation of the potential risk factors during the predefined driving scenarios with the key performance indicators was established.
- The goal of hazard identification was to ensure that the calculated **KPIs** were accurate. More KPIs were created and adapted to the HADRIAN requirements.

HADRIAN KPI List

Sekadakis M., *Katrakazas C., Clement P., Prueggler A., Yannis G.*

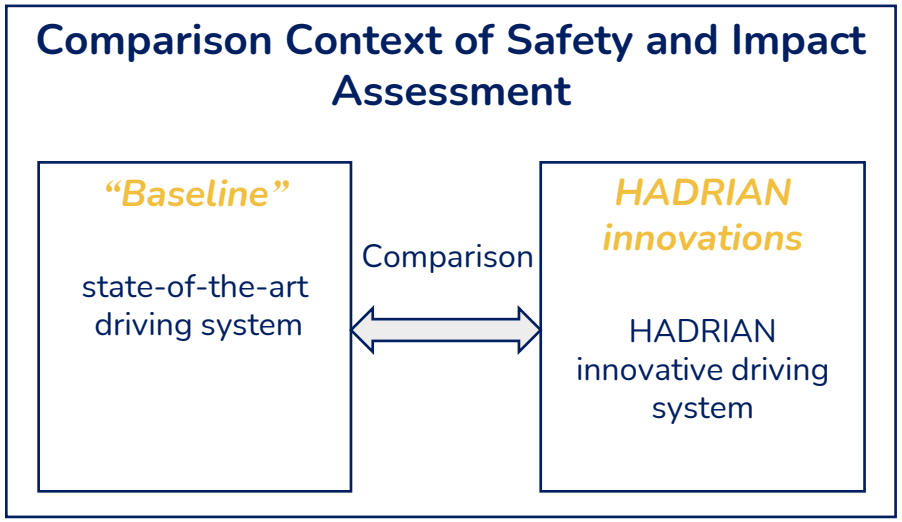
- At the final stage of the assessment, a **total score** will be calculated taking into account the developed KPIs to obtain one total score for "baseline" and one for HADRIAN innovations, which will be exploited for overall comparison.
- The **total score** will be calculated based on weighted averages of KPIs, driver profiling and driving safety efficiency benchmarking.

ID	KPI	Description	Measurement Approach
		Safety - Objectives Measurements	
1.1	Maneuver Quality	Manoeuvre evaluation: Quality of the manoeuvre	Steering wheel torque conflict (i.e., the number of agreements [or disagreements] between human and machine intentions) Percentage of agreements over the trip duration (i.e., agreements/ maneuvers over trip duration)
1.2	Transition Time	Time of transition between automated and manual driving (from the first transition signal to safe control)	Measured in (s) between the moment that the vehicle requests the driver to take over and driver checks all the necessary information
		Impact - Subjective Measurements	
2.1	Acceptability	Acceptability ratings	Do you think the system provides an acceptable driving experience? 9-point Likert scale, strongly disagree–strongly agree
2.2	Workload	Subjective Workload	NASA-TLX questionnaire, 6 dedicated questions

HADRIAN vs. Baseline

Sekadakis M., *Katrakazas C., Clement P., Prueggler A., Yannis G.*

- The **HADRIAN innovations** will be compared to a "baseline condition" to determine the safety and impact enhancement.
- A **common baseline** was established for all driving studies to ensure consistency in assessment.
- All **driving studies** feature situations with state-of-the-art driving systems (without fluid HMI innovations), followed by driving scenarios with innovative HADRIAN driving systems (with fluid HMI innovations).



Practical Applications & Considerations

Sekadakis M., *Katrakazas C., Clement P., Prueggler A., Yannis G.*

- This safety and impact assessment methodology can act as a **guideline for a practical assessment** of innovative systems to be embedded in automated vehicles.
- The holistic nature of the methodology can assist in identifying all the **necessary indicators** needed for assessing a variety of systems, regardless of the sensory capabilities.
- **Aggregation level** of the measurements needed to define the KPIs may need refining. This can be further tailored according to the application of the methodology.

Practical Applications & Considerations

Sekadakis M., *Katrakazas C., Clement P., Prueggler A., Yannis G.*

- The **contribution** to future HMI developments of the established methodology is that it is already harmonized between research facilities and vehicle industry.
- The **active collaboration** between researchers and industrial partners is essential for achieving realistic and evidence-based results, that will lead to actual road safety enhancement for all road users and stakeholders.

Conclusions

Sekadakis M., *Katrakazas C., Clement P., Prueggler A., Yannis G.*

- The current study presents an **assessment methodology** for new types of HMIs for automated vehicles along with measurement guidelines and requirements.
- **Directives** related to indicators for assessing safety and impact and **practical considerations** of the assessment development of fluid interactions between the user and the HMI are given.
- **Future work** on HMIs for automated driving can build on the developed assessment method as its foundation is built on both major development parties, the industry, and academia.

Thank you!

Marios Sekadakis

National Technical University of Athens

Email: msekadakis@mail.ntua.gr

Traconference

Transport Research Arena (TRA)

@TRA_Conference

traconference2022

TRAconference

traconference.eu

HOSTED AND ORGANISED BY:

AGÊNCIA NACIONAL DE INOVAÇÃO

IN COOPERATION WITH:

INSTITUTO DA MOBILIDADE E DOS TRANSPORTES, I.P.

CONSÓRCIO DE ESCOLAS DE engenharia
FEUP • FCTUC • IST • EEUM • UA • FCTNOVA

LABORATÓRIO NACIONAL DE ENGENHARIA CIVIL

magellan
European Affairs Consultancy

CO-ORGANISED BY

European Commission

TOGETHER WITH:

ACARE

alice
Alliance for Logistics Innovation through Collaboration in Europe

CEDR
Conférence Européenne des Directeurs des Routes
Conference of European Directors of Roads

ECTP
INNOVATIVE BUILT ENVIRONMENT

ERTRAC

ERRAC
The European Rail Research Advisory Council

ETRA
European Transport Research Alliance

WATERBORNE