HADRIAN Safety Impact

HADRIAN

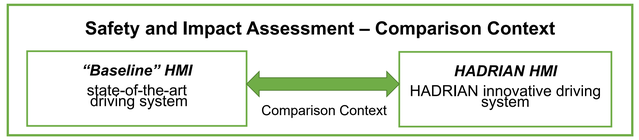
Holistic Approach for Driver Role Integration and Automation Allocation for European Mobility Needs

Safety and Impact Assessment

Methodology

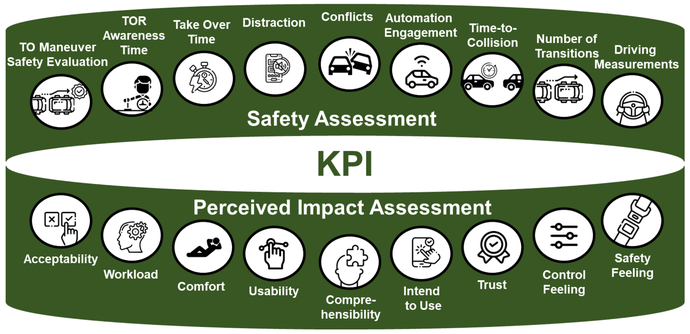
The **purpose of the Safety and Impact Assessment** is to evaluate the improvements achieved through HADRIAN HMI innovations by analyzing the results from the experimental driving simulator studies.

In order to assess the HADRIAN system enhancements, the HADRIAN system was compared with state-of-the-art in-vehicle systems, serving as "baseline" systems.



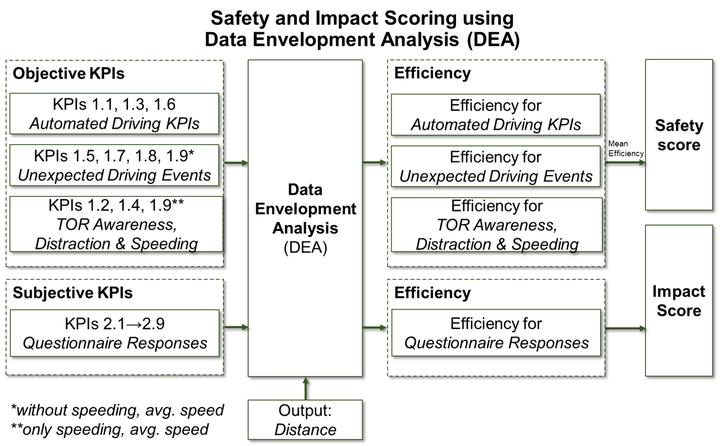
Comparison context within the safety and impact assessment

A safety and impact assessment methodology tailored to HADRIAN was developed using **Key Performance Indicators (KPIs)**. The KPIs were estimated through driving, eye-tracking metrics, and subjective measurements obtained during HADRIAN studies using driving simulators. The assessment included 9 KPIs for safety and 9 KPIs for the perceived impact of drivers.



KPIs for Safety & Impact Assessment of HADRIAN innovations

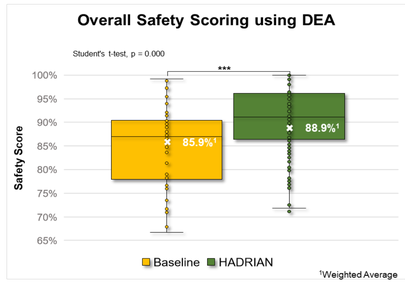
At the final stage, a **scoring method** was applied using Data Envelopment Analysis (DEA) to obtain scores based on KPIs for both the "baseline" and HADRIAN innovations for comparison purposes.

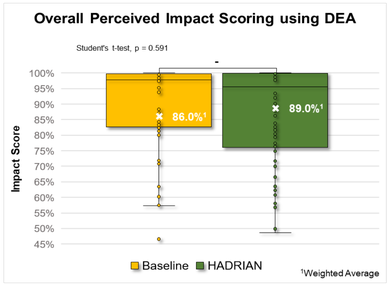


Architecture of Scoring Method for Safety and Perceived Impact Assessment using DEA

Results

The **DEA scores** of overall safety and perceived impact applied on 225 observations of 3 studies and are presented in boxplots:





- The HADRIAN overall weighted **safety score was improved by 3.40%** compared to baseline HMI.
- The HADRIAN safety score revealed to have a **statistically significant higher safety performance**.
- The overall weighted **perceived impact score was improved by 3.46%** to HADRIAN HMI.
- The HADRIAN **"Integrated fluid HMI"** had a great improvement in takeover performance and distraction prevention as well as outperformed with less mental or cognitive effort, higher comfort in use, and control feeling.
- The HADRIAN **"Visual HUD Support System"** improved performance on limiting safety-critical events i.e., conflicts, TTC events, speeding and harsh corneringsand outperformed with higher comprehensibility, intent to use, and safety feeling.
- The HADRIAN **"Haptic Feedback on the Steering Wheel"** was found to be capable of reducing mainly harsh cornering events, conflicts and close TTC events as well as outperformed with higher usability, intent to use, and control feeling.

Human Error Probability (HEP) Assessment

DEVELOP A TASK MODEL

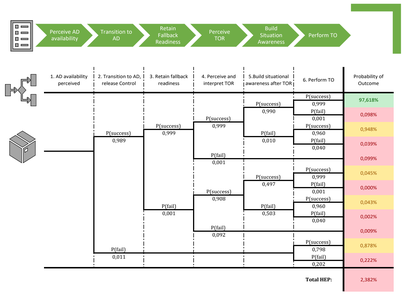
BUILD AN EVENT TREE

DERIVE BASELINE **HEP**s

DERIVE **HADRIAN HEP**s

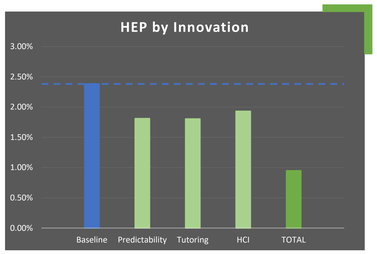
COMPARE CALCULATIONS

- Development of a tool to estimate **HEP**s in the context of automated driving.
- Safety-evaluation of **HADRIAN** innovations on ADL2 & ADL3.
- Estimation of error probability reductions: 45-60% with **HADRIAN** innovations compared to state-of-the-art baseline.



The process diagram (above) depicts the developed task-model for a complete ADL3 period from activation of automaton to taking over manual control. From the task model an event tree (below) is derived showing every possible sequence of events. Subsequently each fork in the tree is evaluated. Shown here are the estimates for the baseline. At the end of each sequence the respective error probability is given.

To derive the **HEP**s for the baseline and **HADRIAN** systems we used a theory based approach based on the **SPAR-H** method.This was backed by insights from empirical simulator and real vehicle studies.



Our results show the estimated error probability for each **HADRIAN** innovation and the complete **HADRIAN** system. The interaction of the innovations leads to an additional decrease in error probability in the complete system.

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virtual vehicle