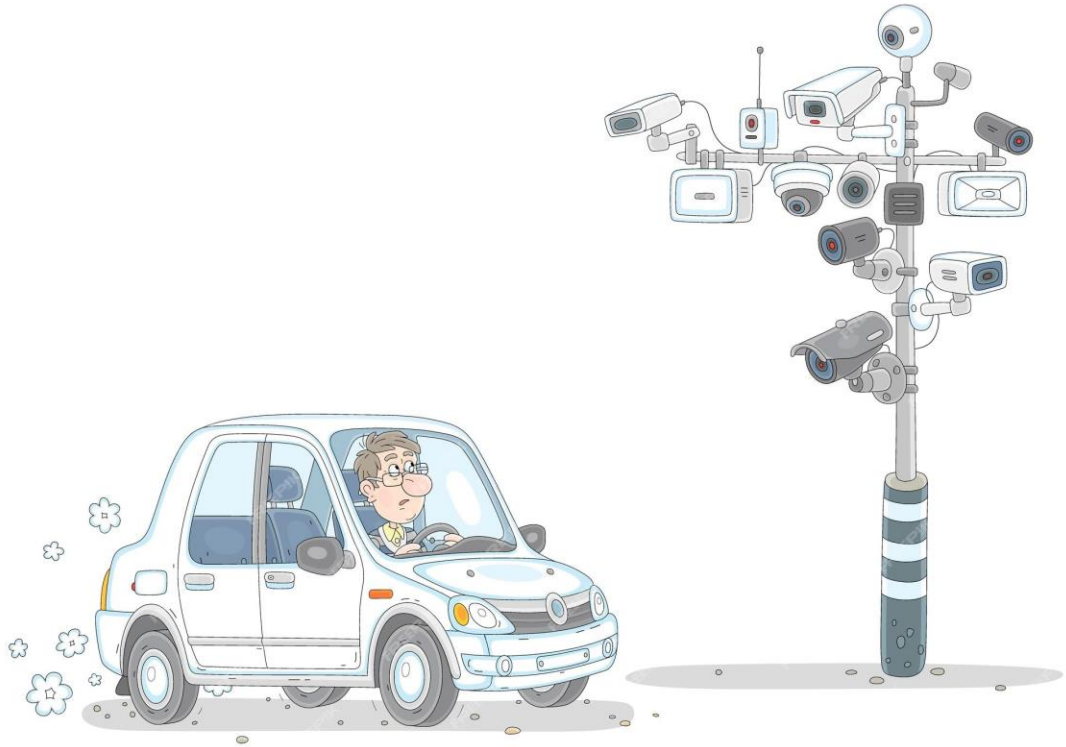
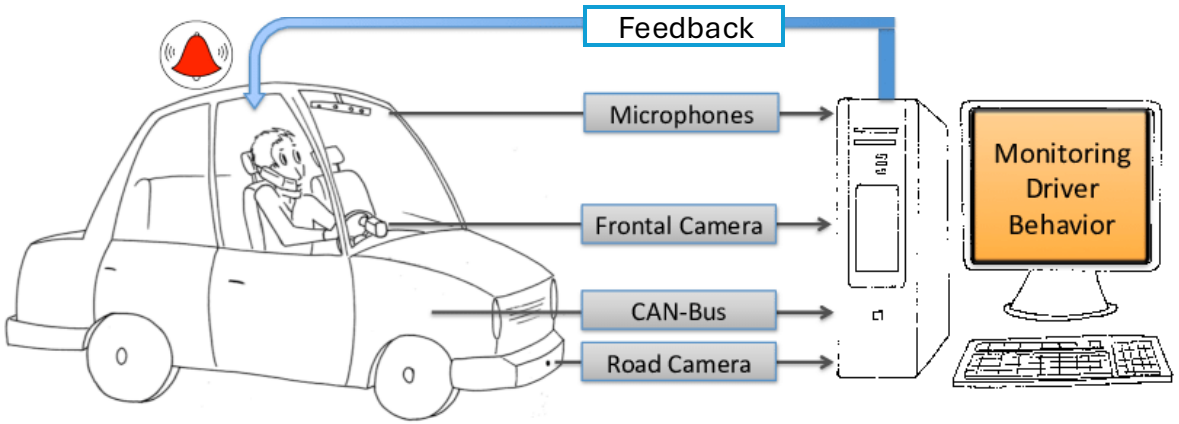
Road safety through surveillance? A framework for Harsh Event detection

Dr Evita Papazikou, PhD, FHEA

Lecturer in Transport Engineering, SoE, UWE





3 July 2025

Presentation Structure

- Introduction
- Data
- Methodological framework & results
- Broader implications

Historically...

Road Safety Evolution

Reactive Road Safety approach

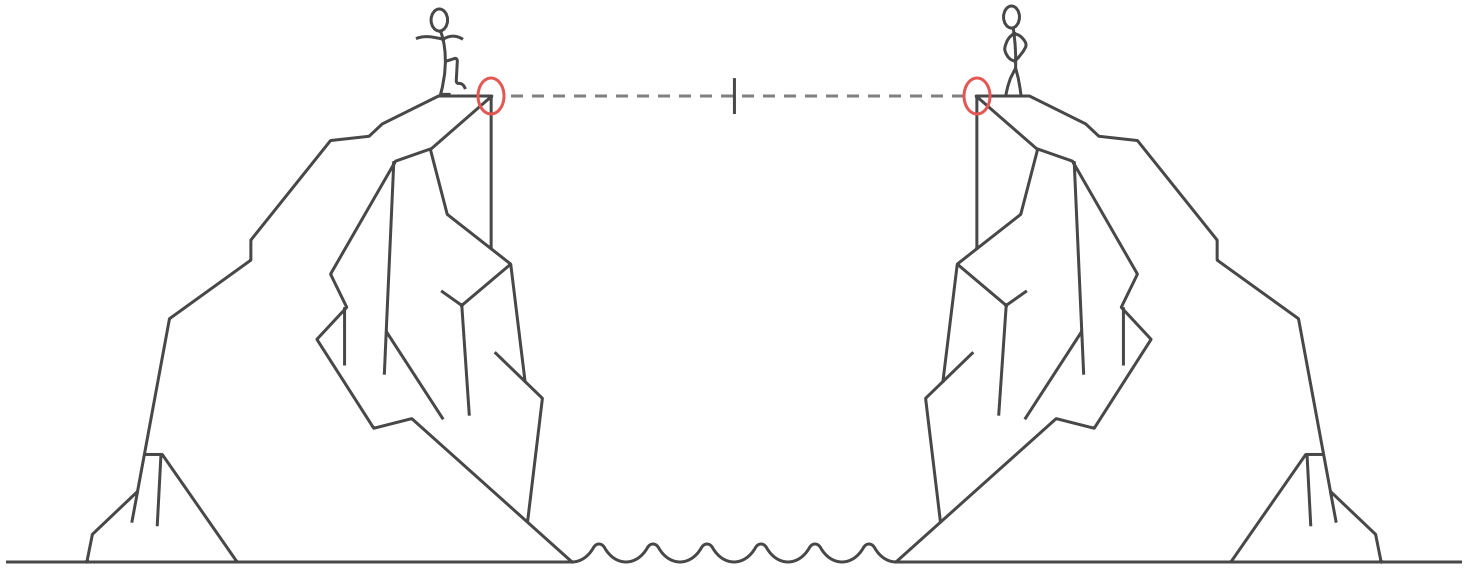
Post-crash actions & analysis

Predictive Insights

Leverage data for risk mitigation

Proactive Road Safety

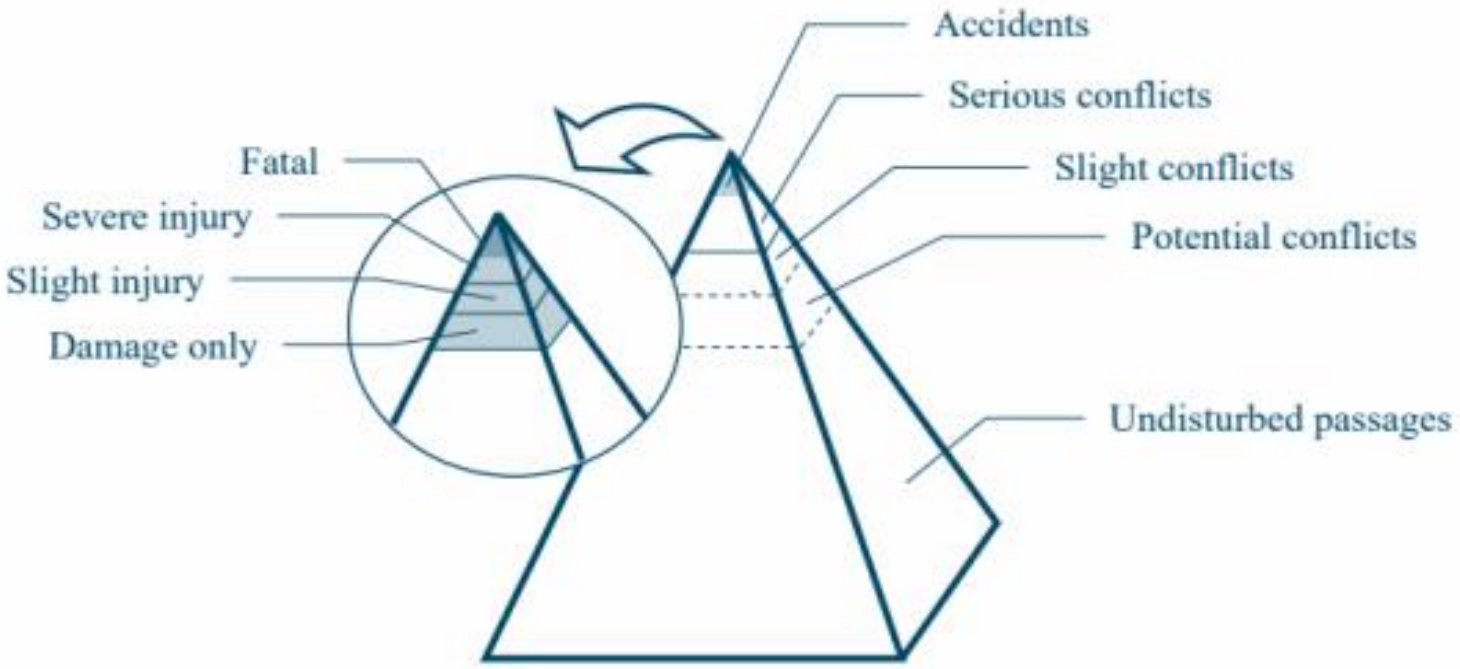
Pre-incident risk mitigation strategy



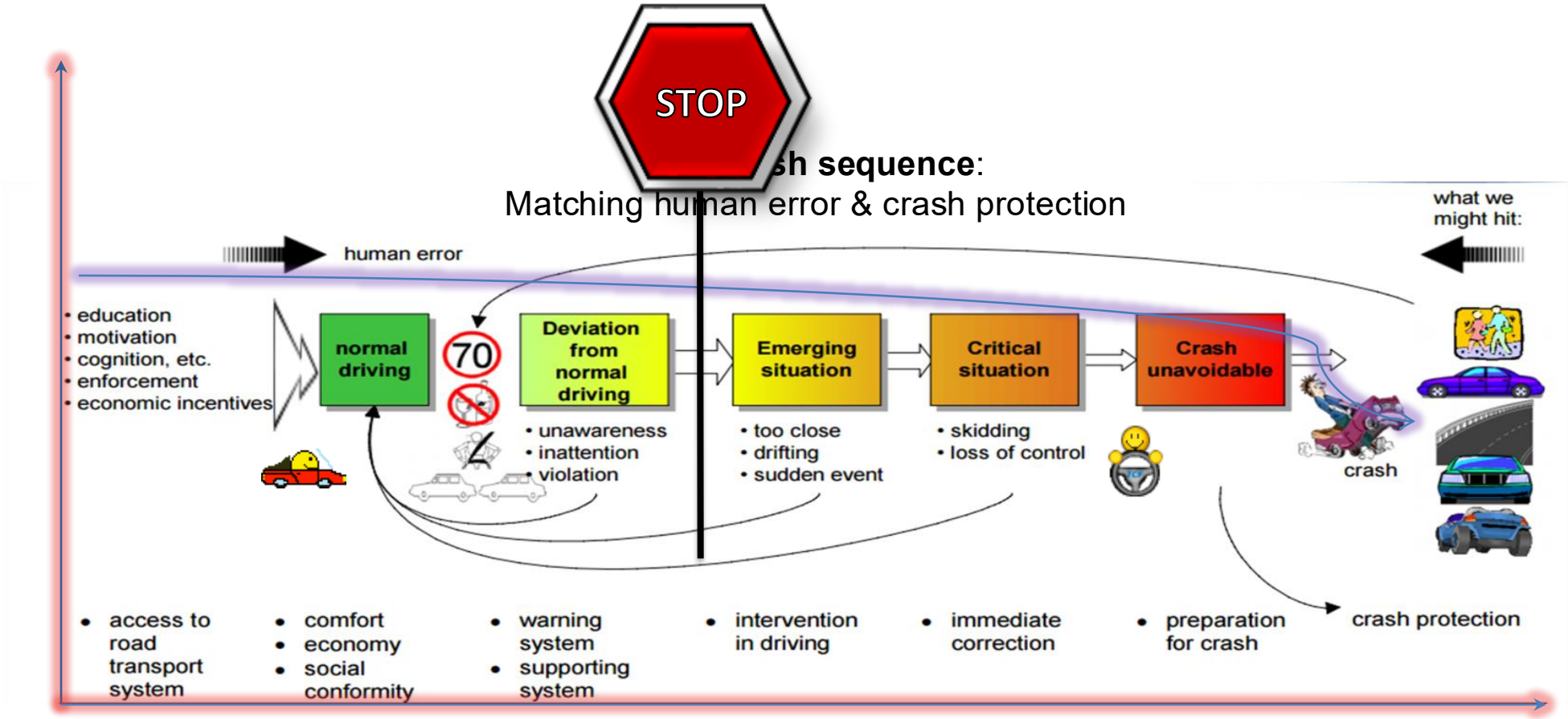
Safety Pyramid (Hyden, 1987)

The Swedish Traffic Conflict Technique (TCT) assumes that ***near-crashes or traffic conflicts*** share the same underlying causes

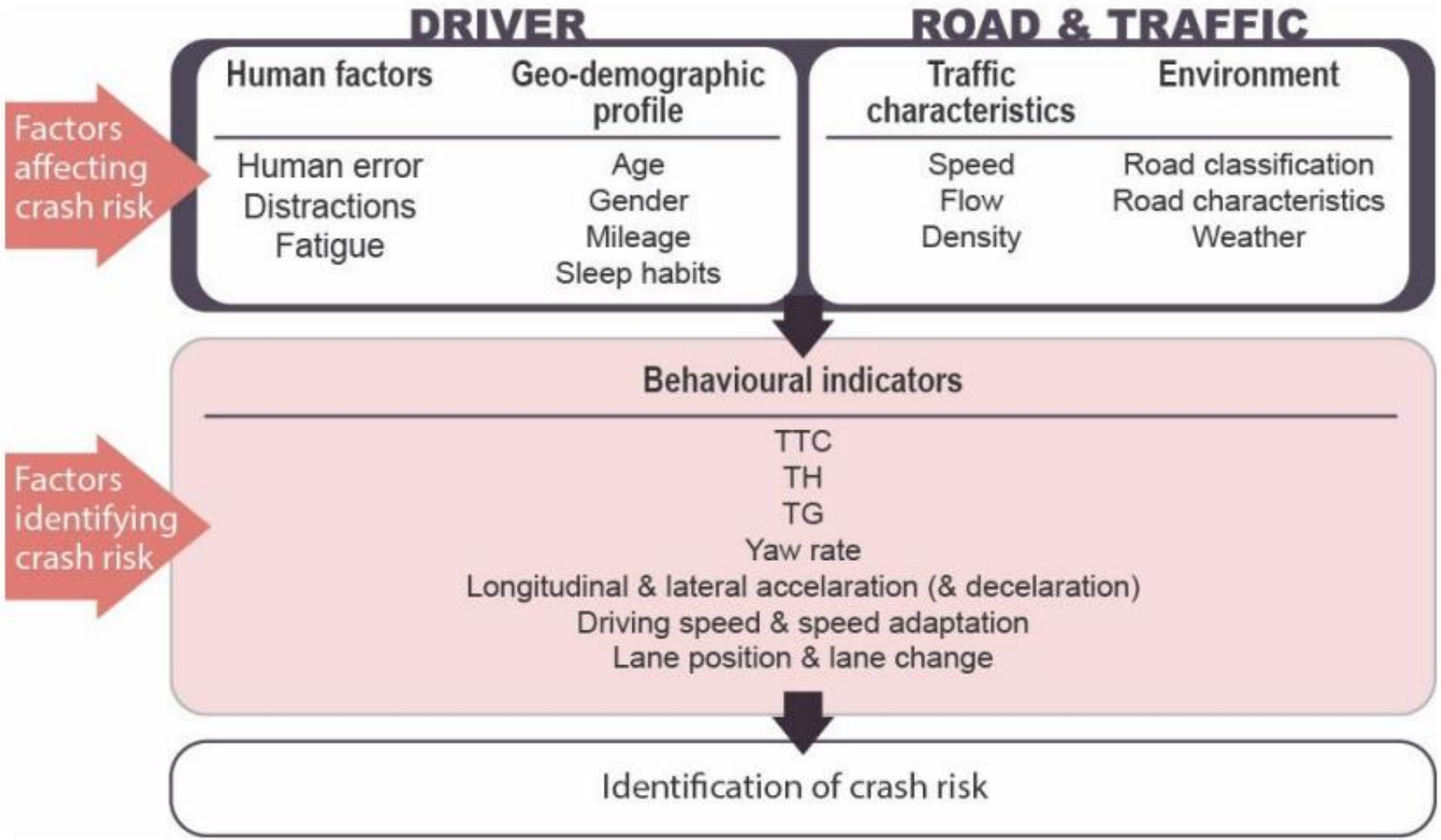
They can act as a tool to evaluate & reduce hazardous situations.



The stages of crash development



Claes Tingvall, 2009

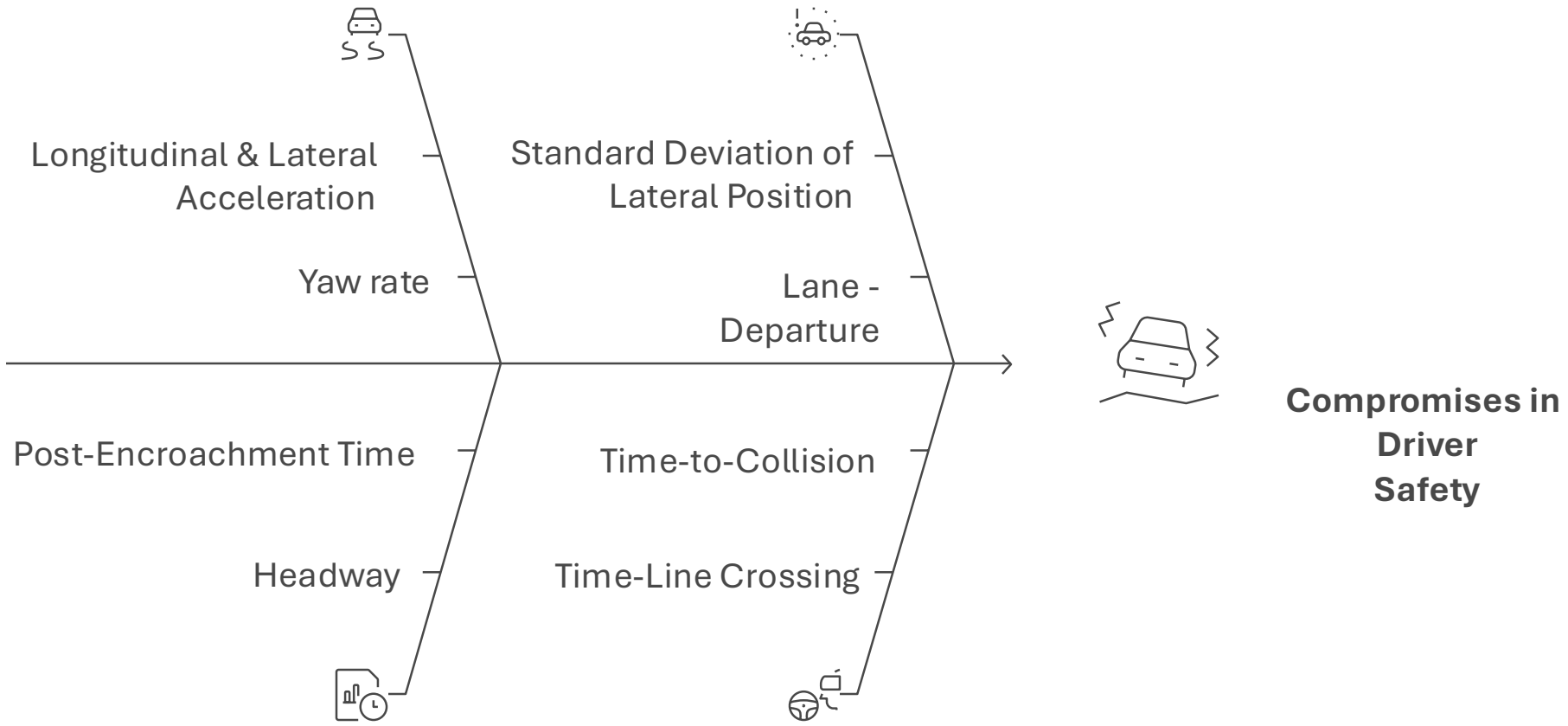


Theoretical framework of Factors that affect or identify crash risk (Papazikou, 2019)

Investigating Driver Behaviour

Indicators

Vehicle Dynamics
Spatial Metrics
Time-Related Metrics



Project & Data overview

Data collection context:

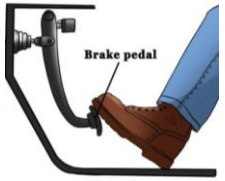
- Real-World data
- 110 vehicles
- Urban environment – London
- In vehicle monitoring
- Data sources: MDI technology

•**Purpose:** develop a methodology for harsh events detection from direct behavioural metrics

Driver behaviour metrics

Accelerator pedal position

Brake pressure



Ste ering wheel angle

Methodology

6 **Insight Generation**
Gaining insights into nature, frequency & location of events.

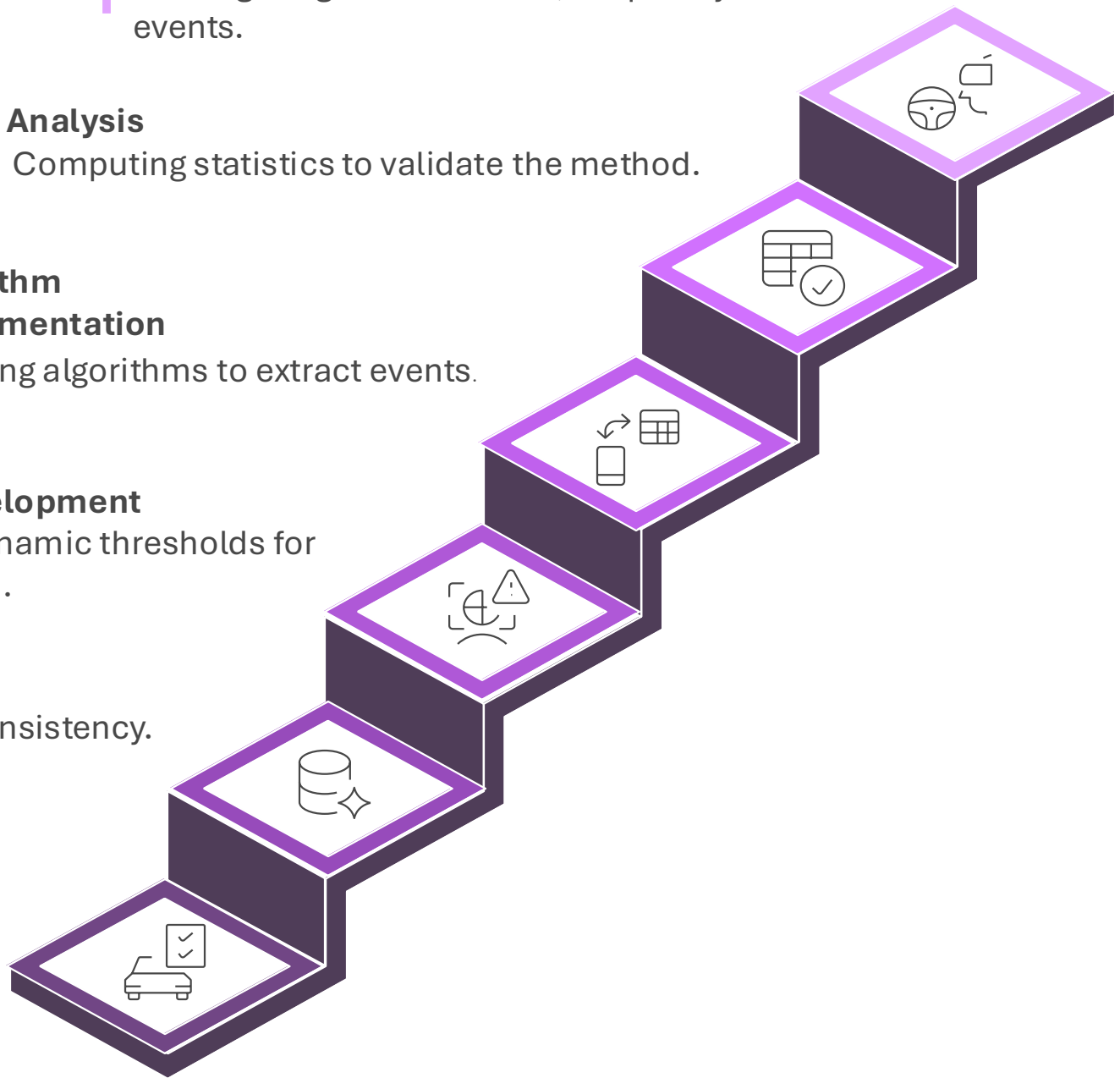
5 **Analysis**
Computing statistics to validate the method.

4 **Algorithm Implementation**
Applying algorithms to extract events.

3 **Threshold Development**
Establishing dynamic thresholds for event detection.

2 **Data Cleaning**
Ensuring data accuracy & consistency.

1 **Data Collection**
Gathering data from 110 vehicles in London.



Data Cleaning & Pre-processing Flowchart

Data Collection

Data Filtering

Data Transformation

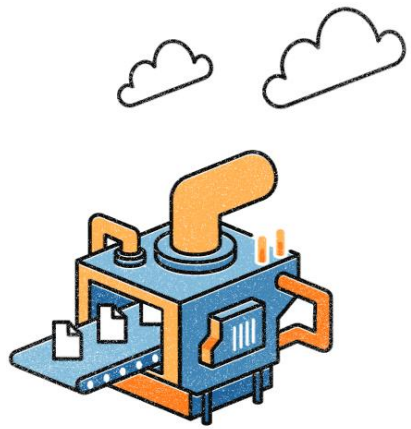
Steering Wheel Angle change per sec

Accelerator Pedal Position change per sec

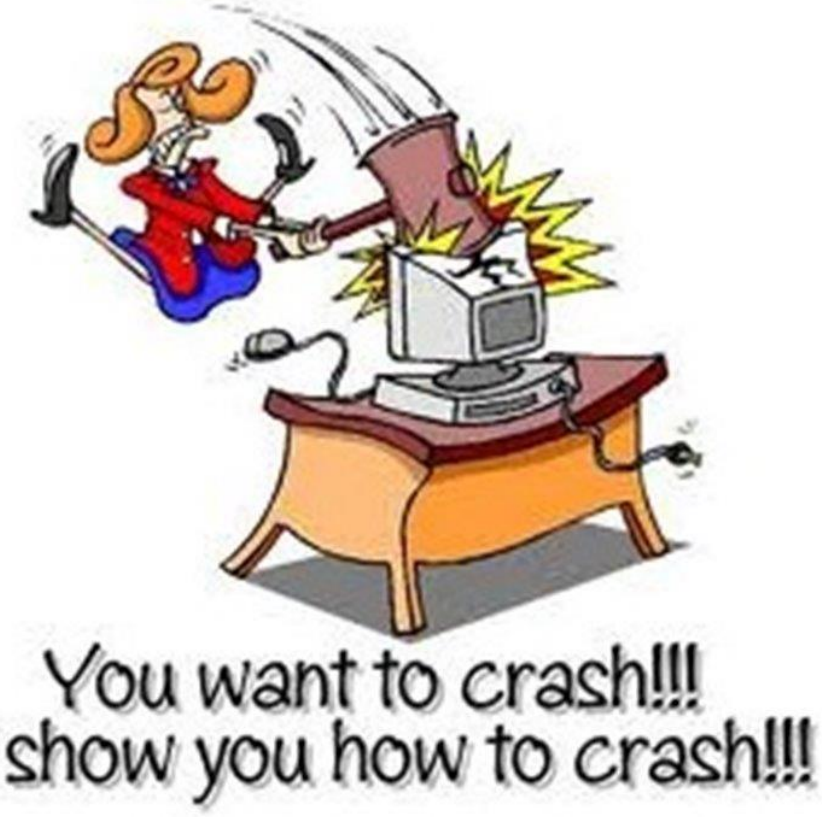
Outlier detection

Account for vehicle architecture

Final dataset



Meanwhile in the real-world...



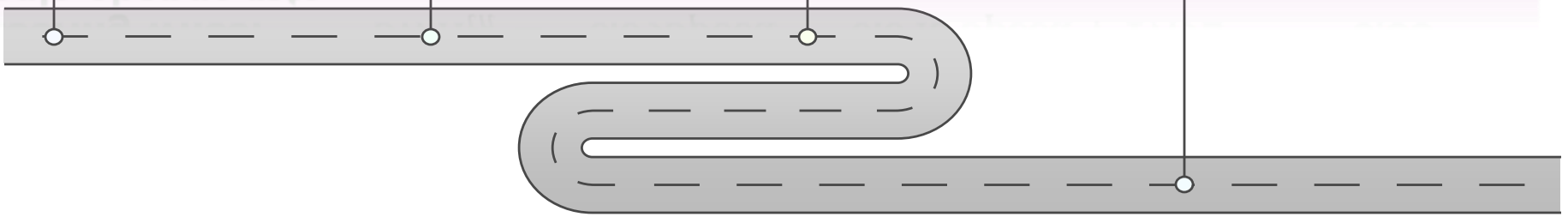
Development of Dynamic Thresholds for Driving Indicators

$$\mathrm{BPth} = \beta o + \beta_1 Speed + \beta_2\, Speed^2 + \cdots + \beta_n\, Speed^n$$

C1MCA – Brake Pressure

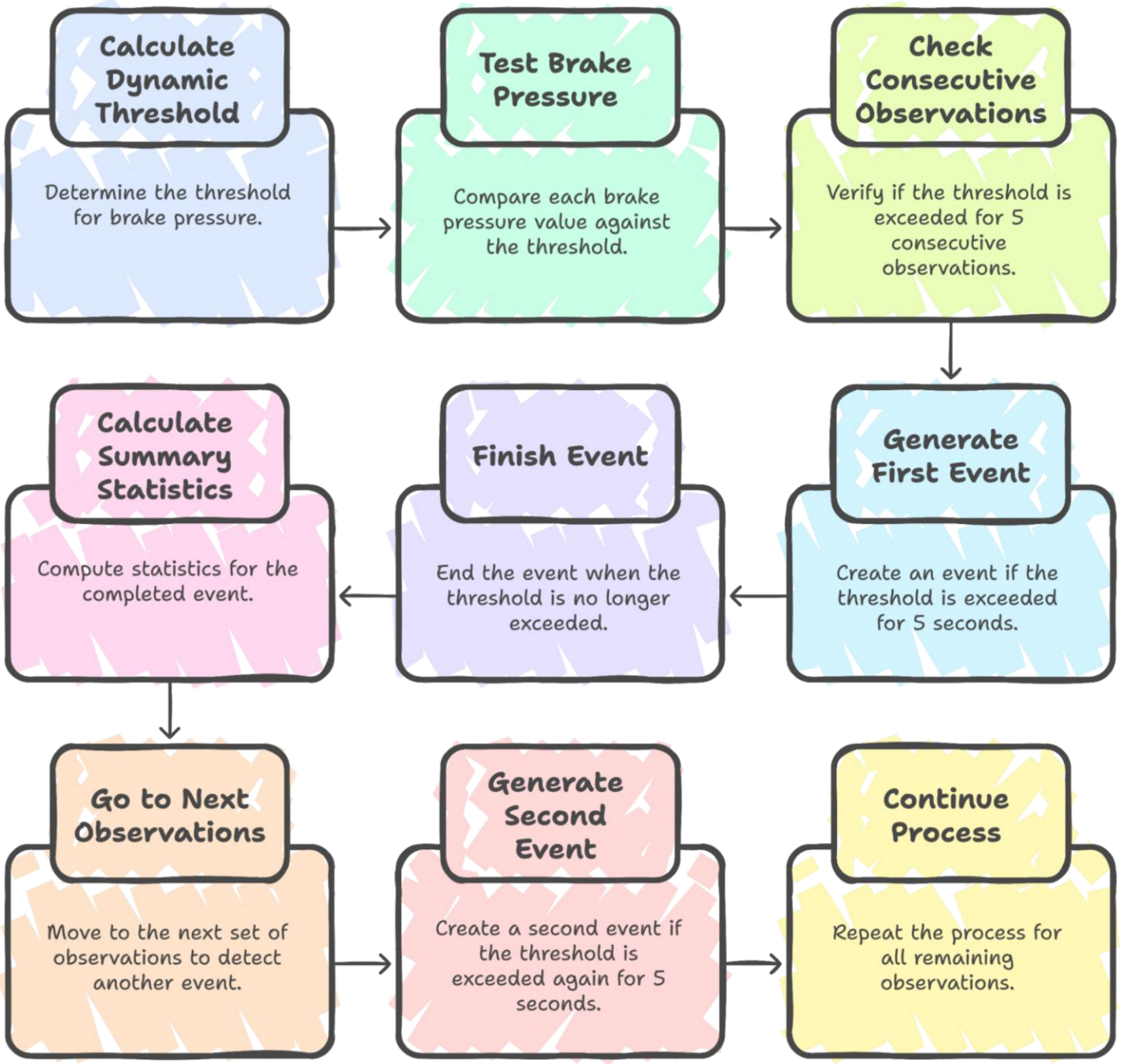
Indicator	Functional forms	Goodness-of-fit (R^2)
Brake pressure(bar):	$BP_{th} = -0.08Speed^2 - 4.87\ \mathrm{Speed} + 198$	0.69
Accelerator pedal change (%):	$Acc_{th} = -0.004Speed^2 - 0.06\mathrm{Speed} + 39.2$	0.77
Steering wheel angle change rate (°/sec):	$SWA_{th} = -0.09Speed^2 - 0.045\ \mathrm{Speed} + 17.92$	0.88

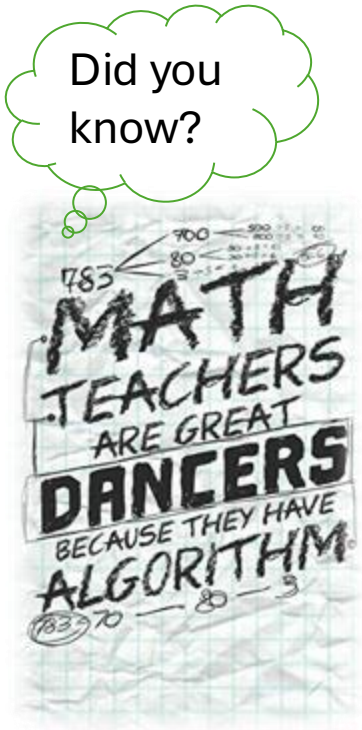
indicator based on speed.



Algorithm for event extraction

(Papazikou et al., 2021)





Event Detection Process

Optimisation of detection process
Refine the algorithm for better accuracy

Analysis & evaluation of events
Examine frequency, patterns & location of events

Extraction of classified harsh Events
Analysis of a ten-day data sample

Application of the event detection algorithm
Identify data points exceeding dynamic thresholds

Development of dynamic thresholds equations
For the three indicators

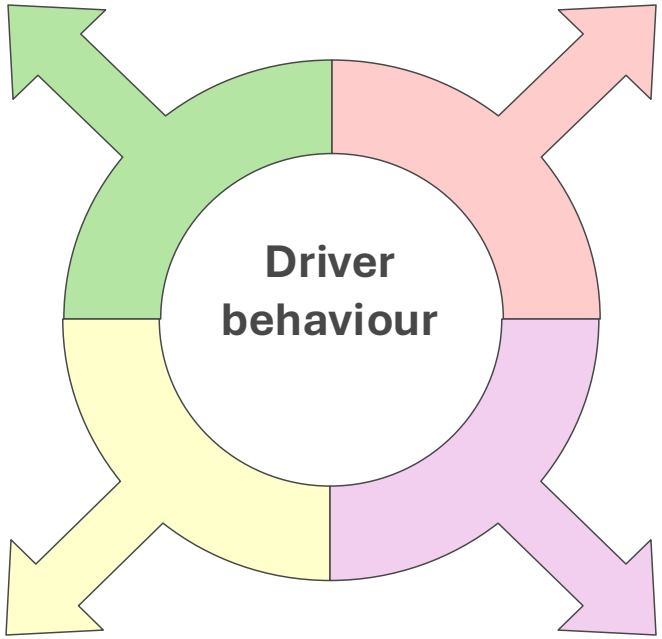
Steering events occur more frequently than braking or acceleration events

adjustments to the dynamic thresholds… adjusting the **sensitivity** of the detection system for typical driving manoeuvres.

Understanding DB Improves overall Road Safety

Traffic Management

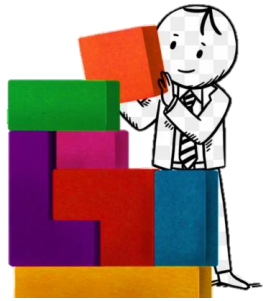
Infrastructure Planning

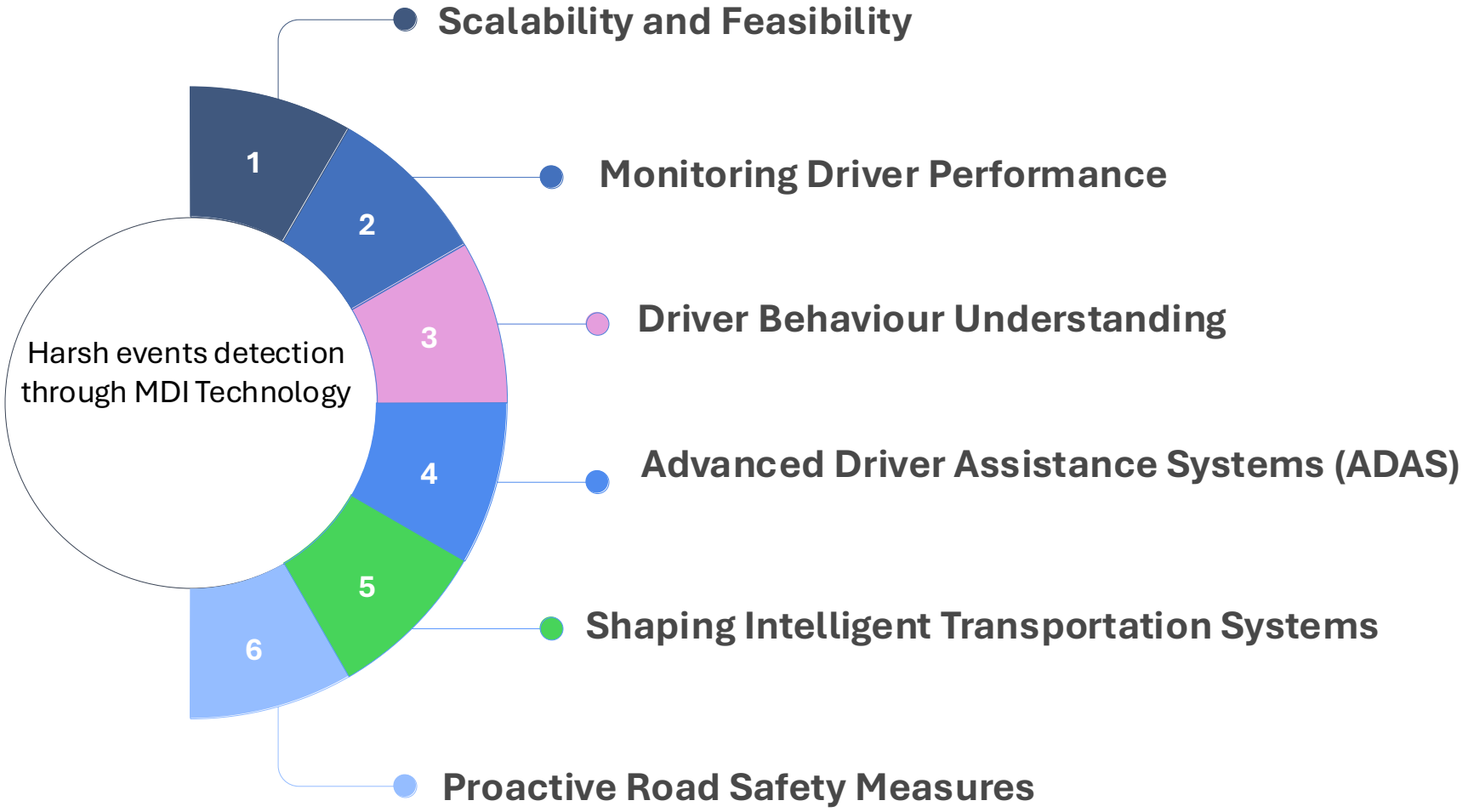


Fuel consumption management

Automotive Industry & Insurance Industry

This study...




Harsh events detection through MDI Technology
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2
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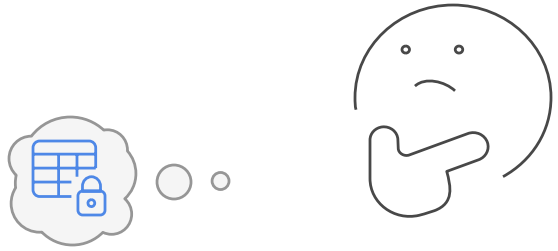
Scalability and Feasibility
Monitoring Driver Performance
Driver Behaviour Understanding
Advanced Driver Assistance Systems (ADAS)
Shaping Intelligent Transportation Systems
Proactive Road Safety Measures

Governance, Ethics & Broader Implications

How do we balance data-driven safety with ethical governance?”

Data Ownership & Control

Determine who owns and controls the driving data to ensure accountability & prevent misuse.

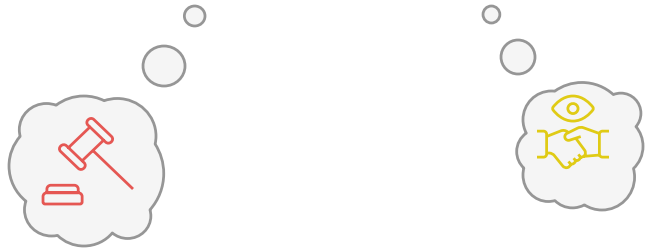


Transparency & Explainability

Ensure surveillance is transparent & explainable (driver awareness, & consent), to build trust & avoid privacy concerns.

Policy Governance

Establish clear policies for data use in enforcement, insurance, and planning to prevent unfair practices.



Equity & Inclusion Considerations

Address ethical concerns such as potential targeting of specific groups.

References

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Thank you!

Dr Evita Papazikou
Lecturer in Transport Engineering
Email: Evita.Papazikou@uwe.ac.uk
School of Engineering
College of Arts, Technology & Environment
UWE, Bristol.