Tunnel administration decision support

Presentation of the solution

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Problem noticed

What was the reason for the solution??

- Road safety management comes down to:

  - minimizing the number of events

  - mitigation of the effects of events that occur

- In the case of tunnels, the number of incidents or casualties lower than on an alternative road section makes the tunnel safer

- A tunnel can replace a long stretch of road and thus the initial number of events may be disproportionately greater

- **In the event of traffic in a tunnel, even the same number of incidents as on an alternative route may have disproportionate effects**

Problem noticed

Social expectations

- The death toll in tunnels is not expected to exceed 1 person per 10 years of use, and a tenfold reduction (to 1 per 100 years) is desirable.

- Events in the tunnel are the result of a combination of many factors, including the behavior of people who will behave in an irrational but predictable manner in the event of an event.

- In most tunnels, stationary solutions are used to limit the extent of damage (e.g. emergency exits, ventilation, fire protection systems)

- **It is possible to have a preventive impact on the effects and frequency of events by modifying traffic parameters in real time**
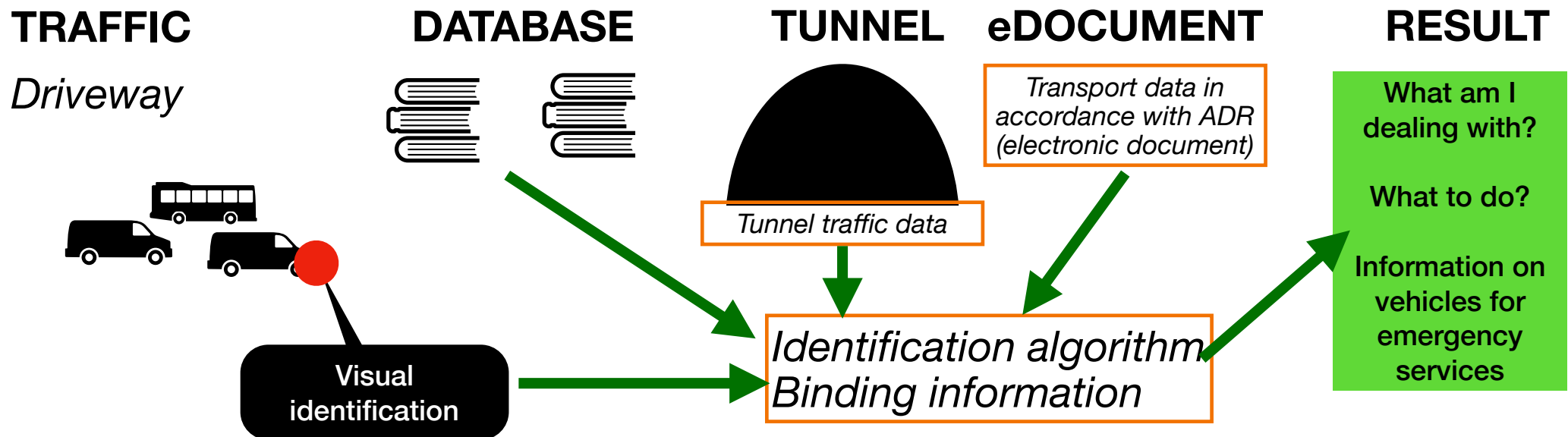
Application

Capabilities

- Regardless of the level of advancement of the tunnel equipment, there is a possibility of preventive impact on:

  - motion system and its slowing down,

  - its flow,

  - number of people in the tunnel

- In the most extreme cases, it is possible to allow the passage or exit from the tunnel of vehicles that threaten others (with dangerous goods or even with a fire in the initial phase), as long as the traffic organization will minimize the remaining risks.

- **The developed solution is to enable traffic flow management in such a way as to prevent the risk potential from revealing itself**

SOLUTION

Decision support for the tunnel manager

- The solution is based on the use of databases, machine learning and indicating to managers possible decisions with the determination of their effects.

TRAFFIC

Driveway

DATABASE

TUNNEL

Tunnel traffic data

eDOCUMENT

Transport data in accordance with ADR (electronic document)

RESULT

What am I dealing with?

What to do?

Information on vehicles for emergency services

Visual identification

Identification algorithm Binding information

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What do we get?

The result of the operation of the solution

- Vehicles are identified by their shape (characteristics), appearance, markings (ADR plates, stickers)

- The read information is associated with the ERG rescue procedures

- The procedures were adapted to the traffic in the tunnel

- The traffic in the tunnel is analyzed in terms of traffic load, the number of people, and the number of vehicles

- It is possible to calculate the possible risk

- We obtain management recommendations
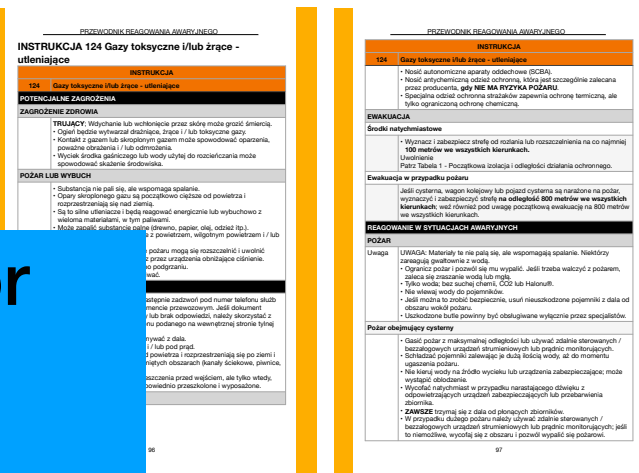
What do we get?

Example

- The system detects a vehicle labeled as a chlorine tanker (UN 1017)

- We identify that 15 city buses + 2 tourist buses, 10 trucks and 160 passenger cars have been slowed down in the tunnel

- Scenario identification (hazard identification)

- Indications of the event

- Calculation of people at risk and possible conseque

RECOMMENDATION (example)
- steer the vehicle on a detour thin out movement
– change speed
– change the assumptions of ventilation

The operator makes the decisions

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What do we get?

Emergency operation

- In the event of an event (collision, accident), it is possible to:

  - determination of the risk (what goods, what zones of influence)

  - identification of possible secondary events (distance from other vehicles, electric vehicles, vehicles with dangerous goods)

RECOMMENDATION (example)
- ventilation indications
- indications for evacuation
- indications regarding the preparation of facilities for possible victims
- indications of possible effects taking into account weather conditions, time of day and traffic
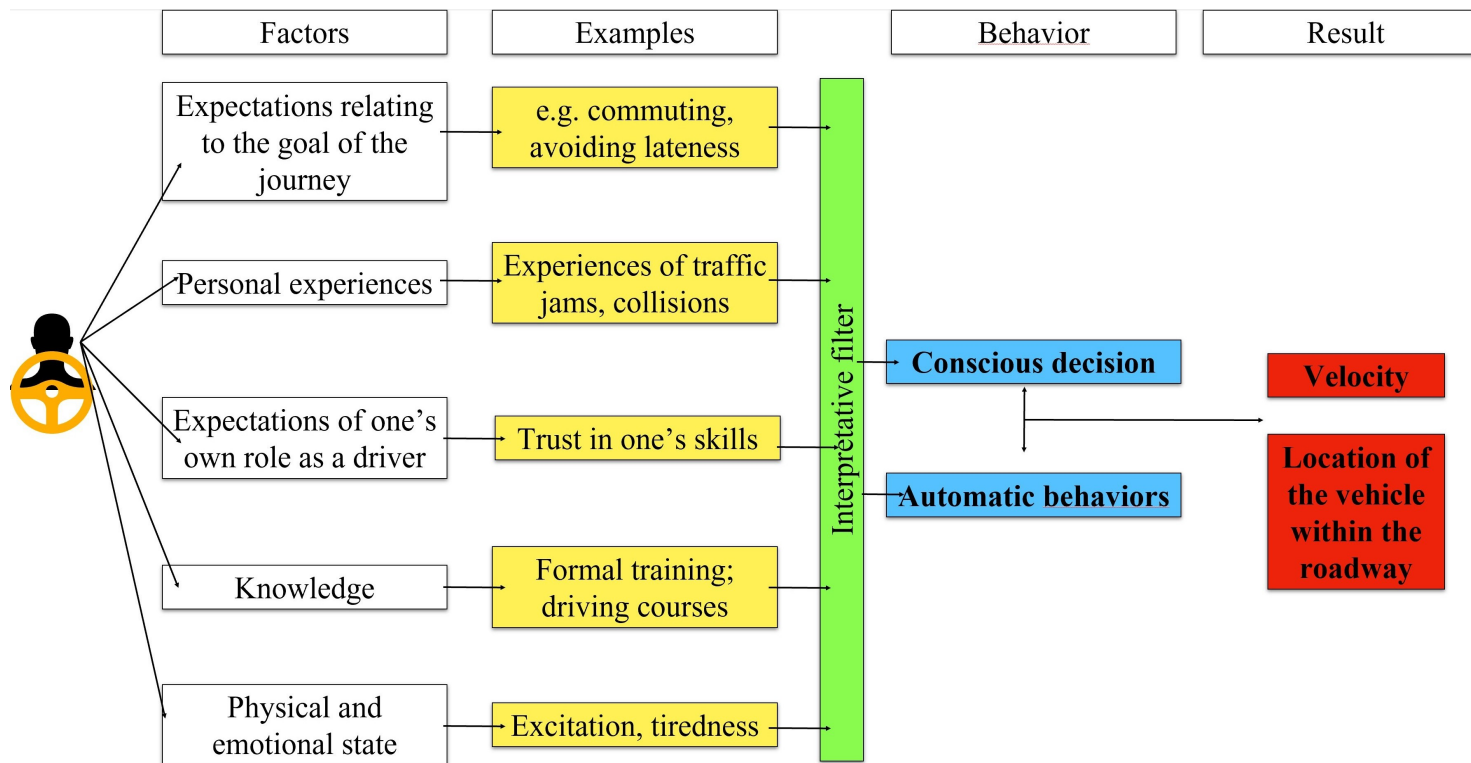
Assumptions

Practical observations

- The number of incidents in the tunnel results from the traffic characteristics

- Their frequency is influenced by the equipment and marking used

- It has been observed that it is possible to determine the impact of infrastructure elements on the driver's driving style - seeing the infrastructure elements, the driver can:

- change speed (in plus or in minus)

- change the position in relation to the road axis

- The change is measurable and reflects the change in speed (m / s) and vehicle position relative to the center of the road (m) over time (s).
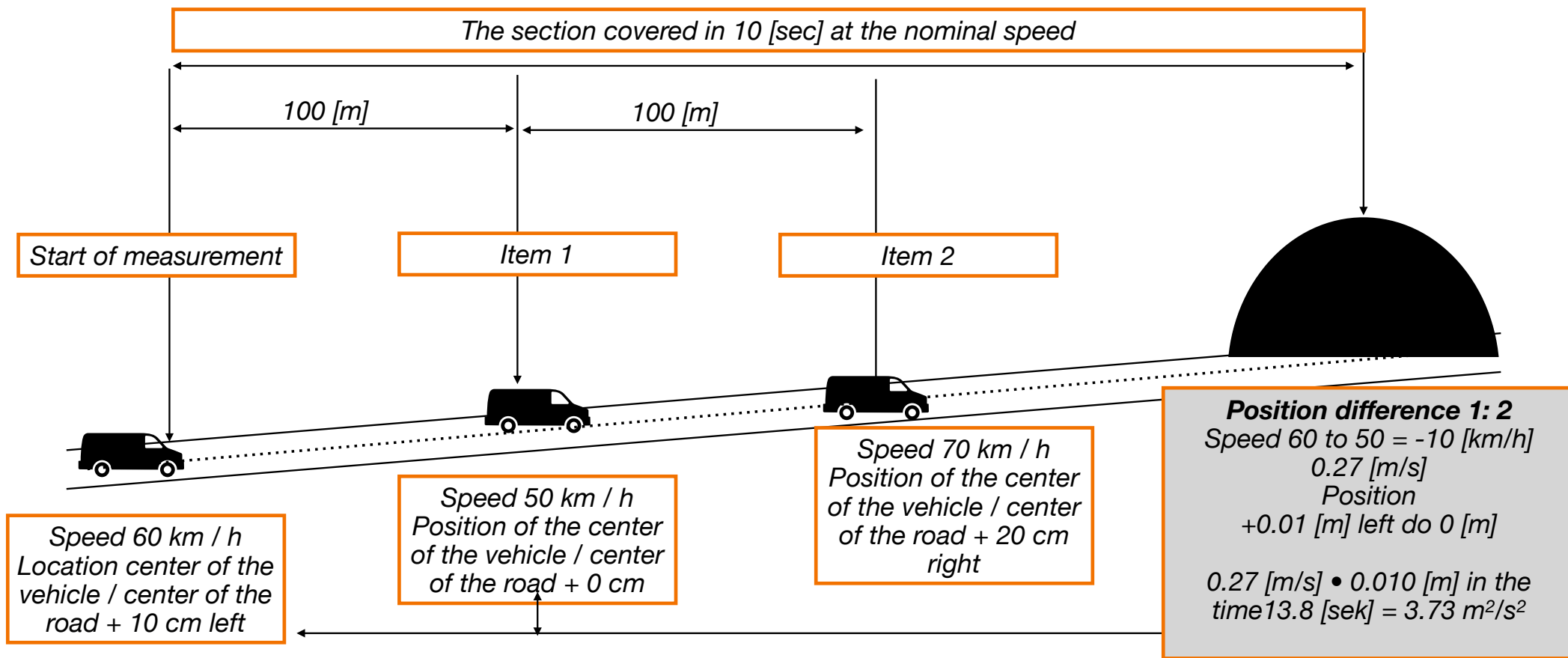
Possibilities of measuring behavior

Factors influencing the "discomfort index"

Factors	Examples	Behavior	Result

Expectations relating to the goal of the journey → e.g. commuting, avoiding lateness

Personal experiences → Experiences of traffic jams, collisions

Expectations of one's own role as a driver → Trust in one's skills

Knowledge → Formal training; driving courses

Physical and emotional state → Excitation, tiredness

Interpretative filter

Conscious decision

Automatic behaviors

Velocity

Location of the vehicle within the roadway

Discomfort index

How does this work?

The section covered in 10 [sec] at the nominal speed

100 [m]   100 [m]

Start of measurement

Item 1

Item 2

Speed 60 km / h
Location center of the
vehicle / center of the
road + 10 cm left

Speed 50 km / h
Position of the center
of the vehicle / center
of the road + 0 cm

Speed 70 km / h
Position of the center
of the vehicle / center
of the road + 20 cm
right

Position difference 1: 2
Speed 60 to 50 = -10 [km/h]
0.27 [m/s]
Position
+0.01 [m] left do 0 [m]

0.27 [m/s] • 0.010 [m] in the
time13.8 [sek] = 3.73 m²/s²

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Assumptions

Practical observations

- The measure of change is the "discomfort index"

- It can be specified in the unit m^2/s^2

- Measurement of changes in distance and changes in speed over a distance equal to the distance traveled in 10 seconds allows to determine the impact of individual solutions on traffic

- It is possible to influence traffic in a predictable manner

- It is possible to compare the influence of individual factors

- discomfort is measured as the SUM of individual deviations

Observation

Mode of operation

- It has been observed that it is much easier to reduce events by much (active risk) than by one (passive risk)

- In order to reduce the events by one, it is necessary to increase the scope and frequency of data collection

- We manage in the scope defined as "passive risk"

- By measuring the reaction of drivers to conditions, the desired reduction of incidents can be achieved

D - expected number of events
V_0, V_1 - most likely distribution of events (50% probability)
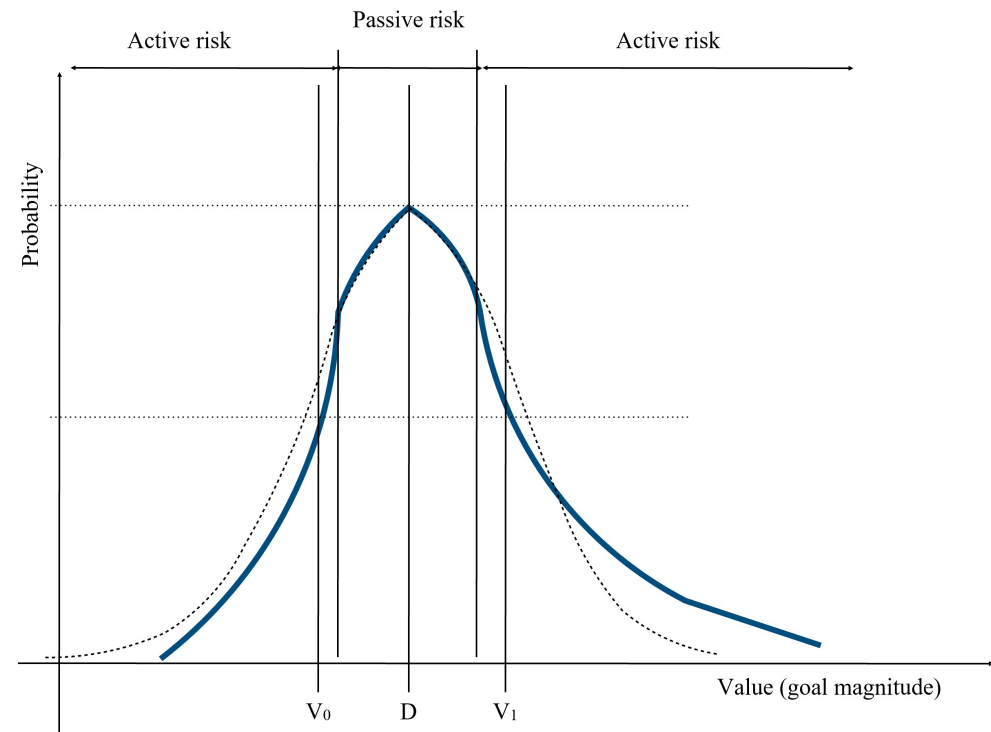
Assumptions

Application of solutions

- By identifying the traffic composition (dangerous goods) and the type of vehicle, as well as measuring the changes in the "discomfort index" in real time, you can manage traffic to minimize collisions and adverse events

Possibilities

Mode of operation

- The solution can be implemented as an element (module) of traffic management programs

- The solution can be used in a tunnel simulator for training purposes (modeling the operator's behavior in relation to traffic)

- The solution is constantly updated (machine learning algorithms allow you to take into account the specificity of the traffic and omit any erroneous or redundant indications)

- It is possible to automate the response of the tunnel equipment (linking the identification with the control), which facilitates the operator's work

Trainer

Sample screens - visualization

Partners

The initiative was created as part of cooperation

- contractor of the solution

- data integrator

- author and developer of IT solutions for traffic management

- tunnel automation contractor

- the originator and developer of the tunnel simulator

- concept author

- database provider including EGR translations

- machine learning verifier