49th ASECAP DAYS

Decarbonizing Road Infrastructure : Challenges, Perspectives and Actions in Tough Economy

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Accident Prediction Models Applied To Ascendi's Highways Network

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ascendi

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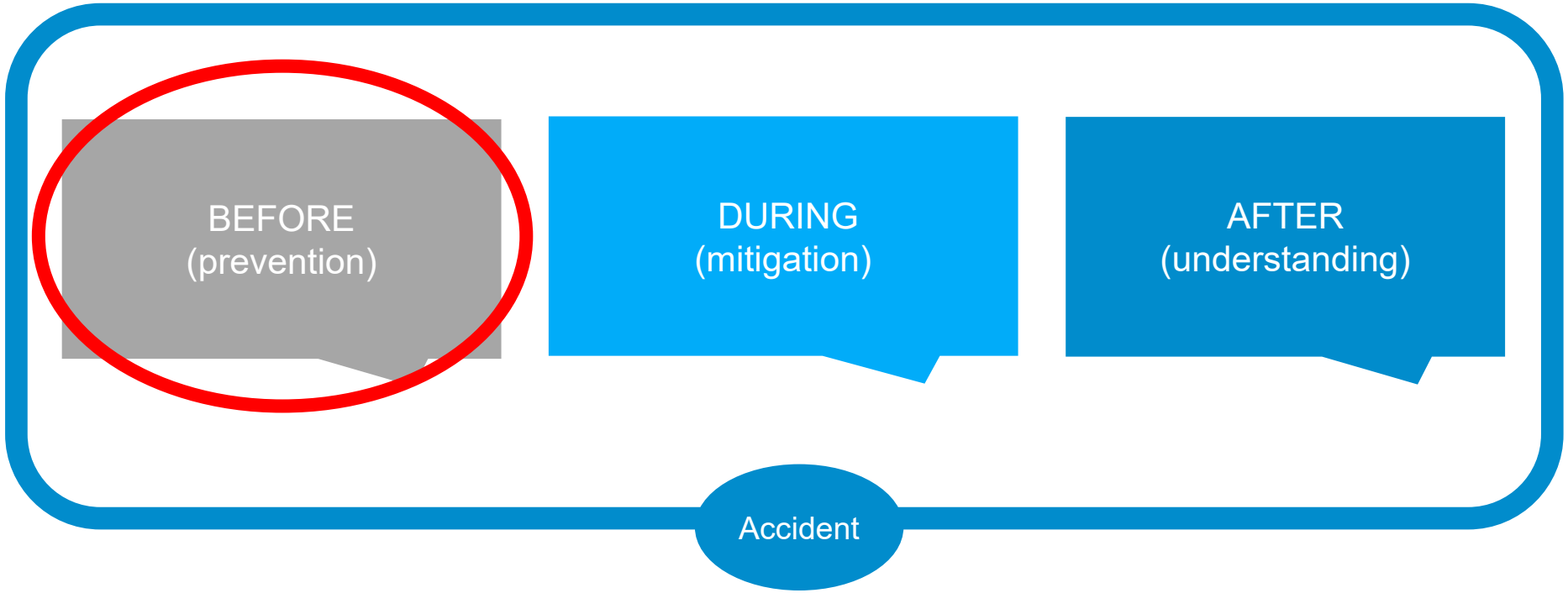
/01 Ascendi Network

- ASCENDI is a transport infrastructure operator responsible for a 626 km motorway network, that provides toll collection and operation & maintenance services.
- Its Road Safety Action Plan (RSAP 2020-2023) is currently under implementation and sets the target to annually reduce 5% the number of victims.
- The Road Safety Unit supports accidents risk mitigation, with studies and reports.
- The main source of information for the assessment and analysis carried out are data on:
  - Accidents;
  - Traffic;
  - Speed;
  - Infrastructure (road design).

/02 Ascendi's Road Safety Action Plan (RSAP 2020-2023)

- RSAP sets strategic (goals) and operational actions to improve Road Safety;

- "Action A6": Develop Accident Prediction Models.



/03 Accident Prediction Models (APM's)

Traditional Approaches *vs* New Approaches

Traditional approaches

REACTIVE: Treatment should only be implemented after accidents happen.

- Relies on historical crash data;
- Does not consider the random nature of accidents.

New approaches

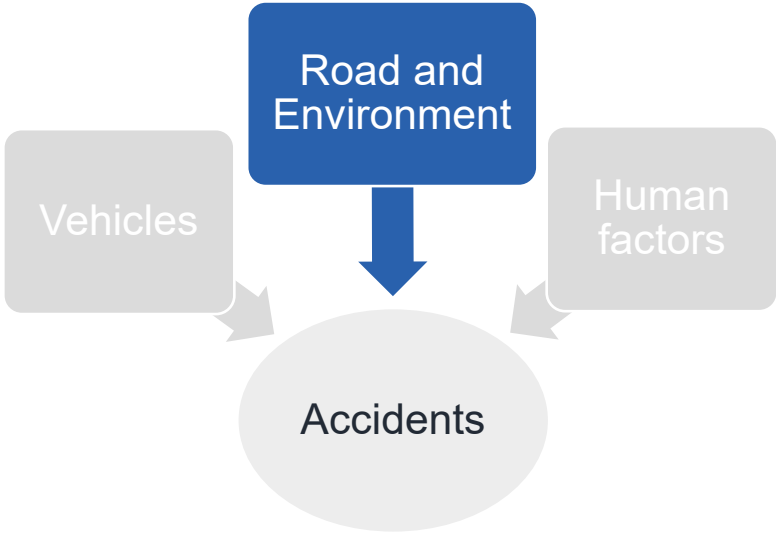
PROACTIVE: Treatment can be done before an accident occurs.

- New tools and methods;
- Based on risk factors;
- Combine reactive with proactive measures in order to prevent accidents and reduce their severity.

Accident Prediction Models

/03 Accident Prediction Models (APM's)

Statistical models that allow the prediction of accidents at a given location as well as the identification of factors that contribute to their occurrence. It is a **decision supporting tool for the selection of strategic measures and the Road Safety management.**



Applications

- Network Screening: predictive identification of sections that need treatment;
- Decision tool: predict the impact of changes in the motorway characteristics on the the number of accidents;
- Before-after study: evaluate the effect of safety improvements.

/04 Ascendi's Experience

- Steps on the creation of the APM's

Data treatment and Collection → Network Segmentation → Statistical Modelling → Validation and Application

- Road Infrastructure/Geometry

- Traffic Volumes

- Speed Limits

- Accidents (total accidents and injury accidents)

/04 Ascendi's Experience

- Steps on the creation of the APM's

Data treatment and Collection → Network Segmentation → Statistical Modelling → Validation and Application

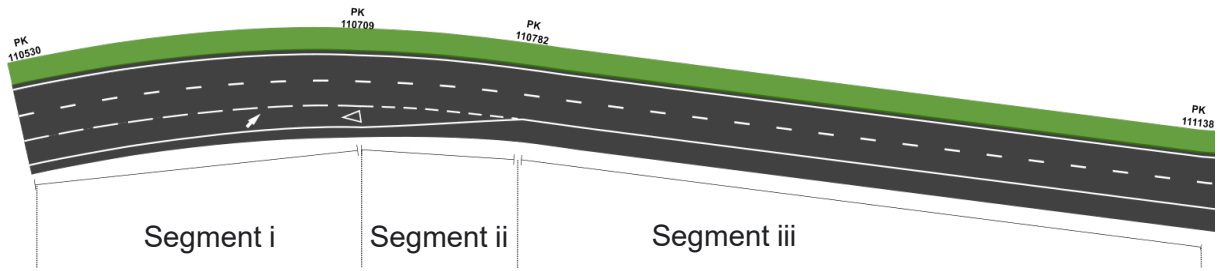
Important step in the creation of the database for the model.

Motorway divided into homogeneous segments (geometry) with **varying length.**

1st – Create a segment every time there was a change in one or more of the road characteristics (Horizontal Alignment and Cross Section).

2nd - Assignment of the variables to their respective segment.

- Accidents
- AADT
- % of Heavy Vehicles
- Speed limit
- Speeding Radar



/04 Ascendi's Experience

- Steps on the creation of the APM's

Data treatment and Collection → Network Segmentation → Statistical Modelling → Validation and Application

Functional Formula and Calibration

- Generalized Linear Models

$$E[y] = \alpha Q^{\beta} e^{\sum_j^p \beta_j x_{ij}}$$

E[Y] – expected number of accidents in a segment, per year

β – regression parameters

Q – exposure variables (AADT and Length)

xij – risk factors

- Poisson or Negative Binomial distribution

/04 Ascendi's Experience

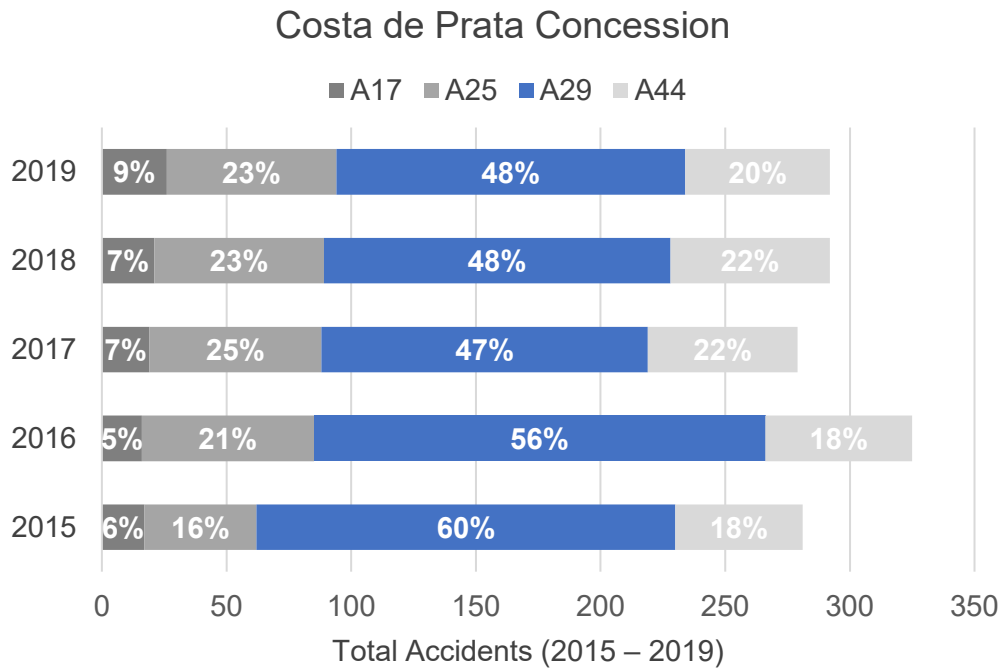
- Steps on the creation of the APM's

Data treatment and Collection → Network Segmentation → Statistical Modelling → Validation and Application

- **Evaluation the models' goodness-of-fit:** How well the model replicates reality. ✓
- **Evaluation the models' predictability:** How well the model predicts accidents. ✓

/04 Ascendi's Experience – Case Study I (A29)

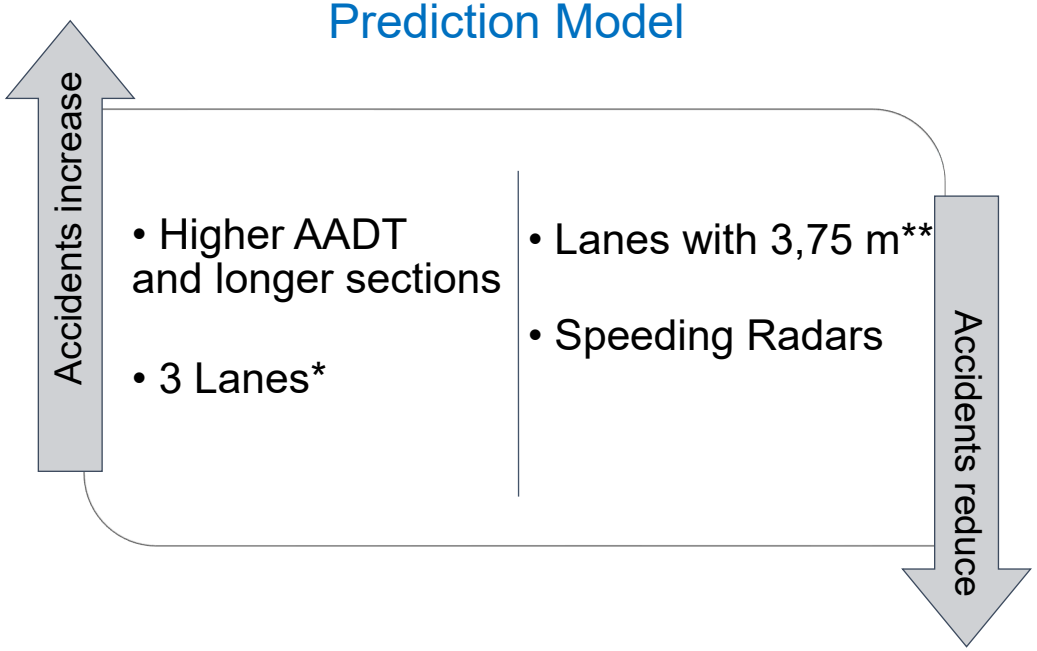
- Motorway A29 (53,3 km) – Motorway section with the biggest road traffic injury rate in the "Costa de Prata" concession.
- Average accident occurrence over 50% of all crashes of the concession for the period under evaluation.
- Database: accidents between 2015-2019.



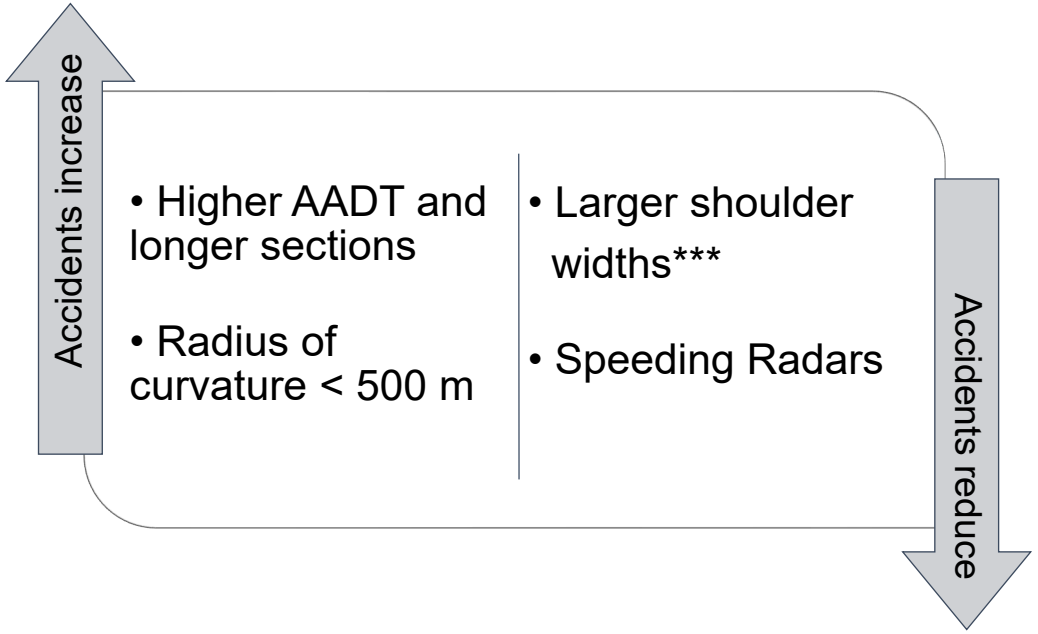
/04 Ascendi's Experience – Case Study I (A29)

Relevant factors identified

Total Accidents Prediction Model



Injury Accidents Prediction Model



**In relation to sections with two-way lanes.*

***Compared to lanes with smaller widths.*

****3.75 m and 3.5 m, in relation to smaller shoulder widths.*

/04 Ascendi's Experience – Case Study I (A29)

Practical Application – Identification of risk sites for treatment

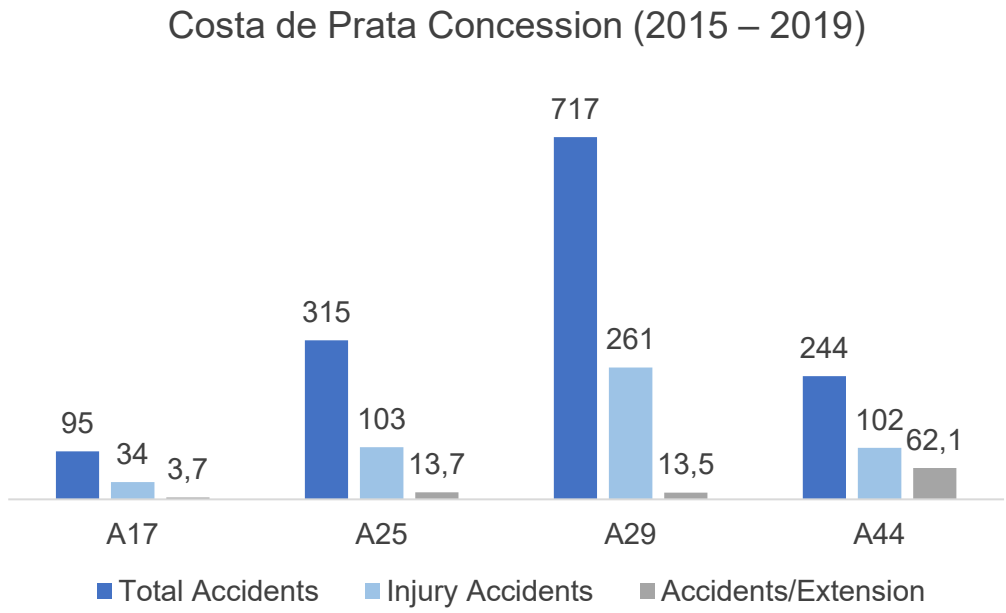
2º 1º

Ranking of segments by accident excess.

Ranking	Observed Average Ranking	Subl_ID	Location/Segment	Direction	PK_Inicial	PK_Final	Excess of Accidents
1	▲ 2	289	Gulpilhares - A29/A44	SC	46946	47026	1,8
2	▲ 4	304	A29/A44 - Canelas	SD	48379	48542	1,7
3	▬ 3	289	Gulpilhares - A29/A44	SD	46946	47035	1,7
4	▼ 1	200	Espinho - São Félix	SC	38786	39055	1,4
5	▲ 9	201	Espinho - São Félix	SD	38992	39074	1,3
6	▲ 8	85	Ovar Sul - Arada (Ovar Norte)	SD	20818	20941	1,3
7	▬ 7	280	Miramar - Gulpilhares	SC	46223	46371	1,2
8	▼ 6	274	Miramar - Gulpilhares	SC	45563	45681	1,2
9	▲ 11	276	Miramar - Gulpilhares	SD	45896	46048	1,1
10	▲ 24	196	Espinho - São Félix	SC	38582	38607	0,9

/04 Ascendi's Experience – Case Study II (A44)

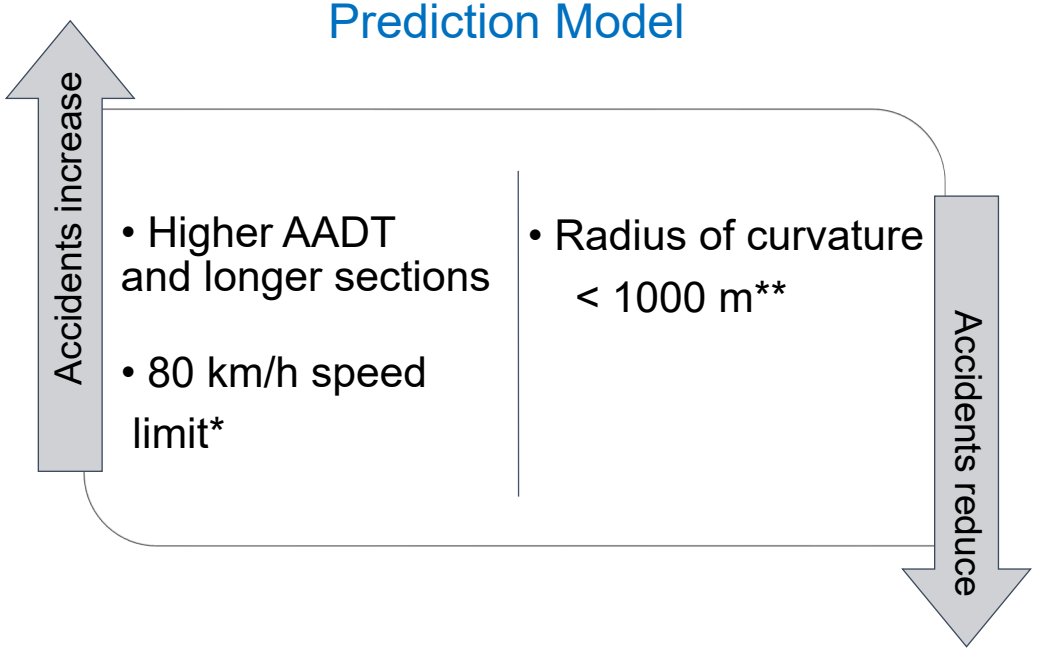
- Motorway A44 (3,7 km) – has several connections to the urban environment and has the highest AADT and accident rate per length of the "Costa de Prata" Concession.
- Database: accidents between 2015-2019.



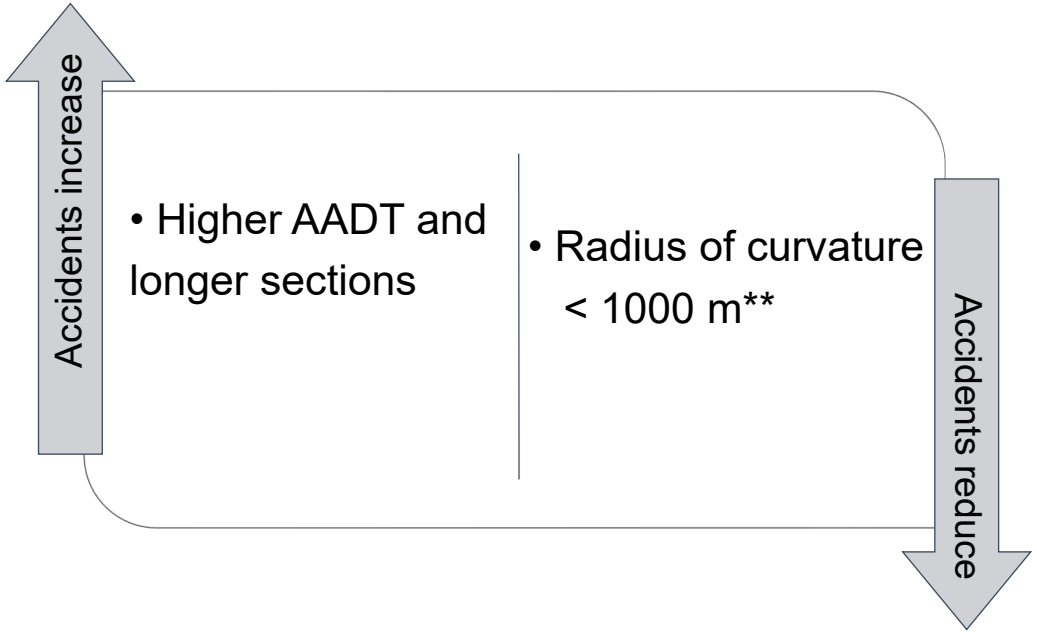
/04 Ascendi's Experience – Case Study II (A44)

Relevant factors identified

Total Accidents Prediction Model



Injury Accidents Prediction Model

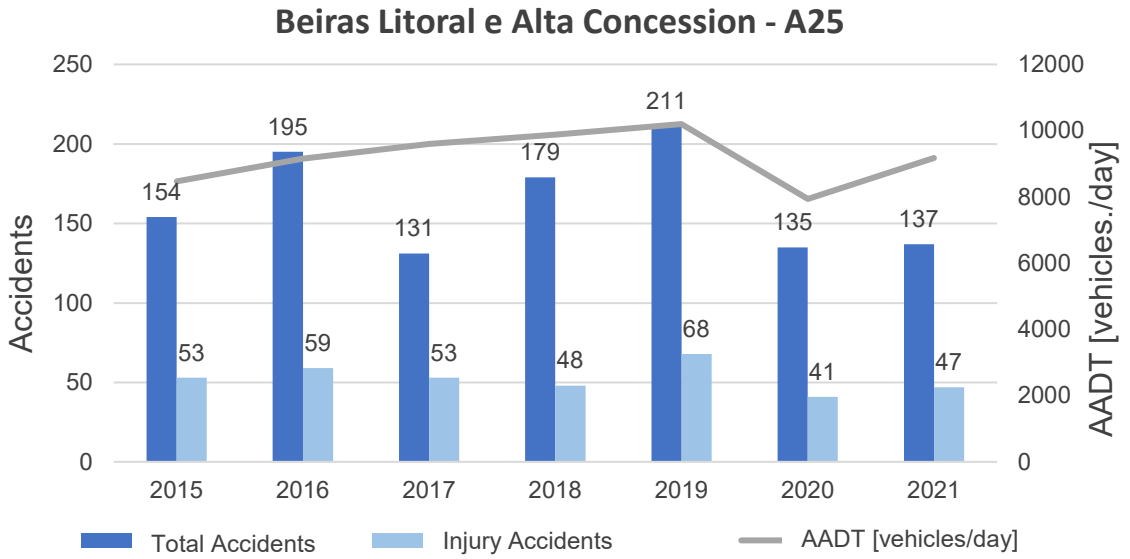


**Compared to speed limit of 100km/h.*

***Compared to straight horizontal alignment.*

/04 Ascendi's Experience – Case Study III (A25)

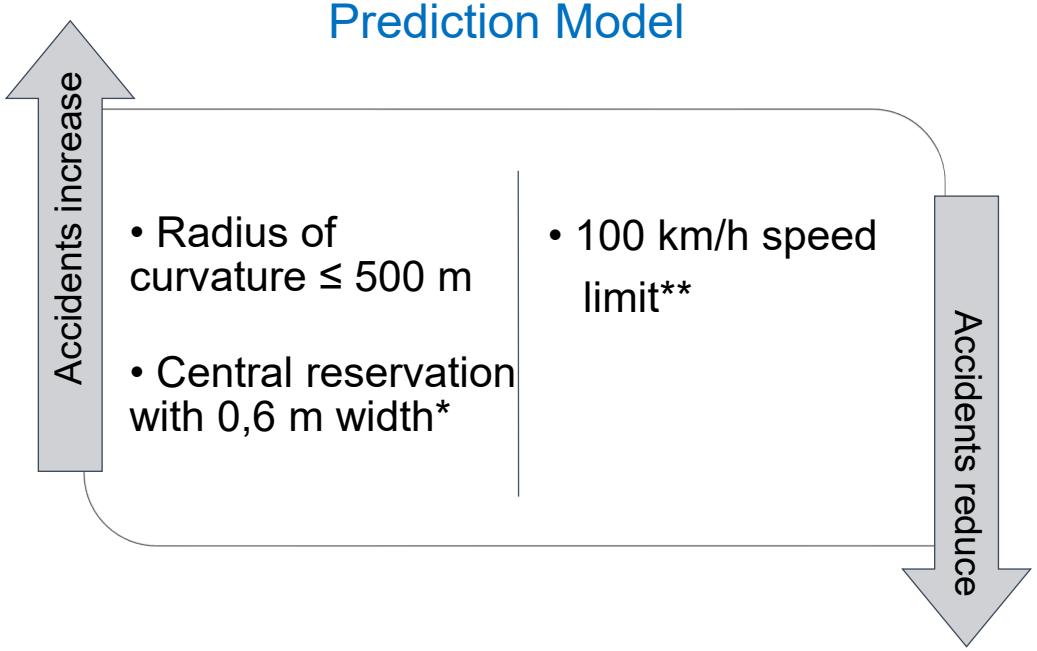
- Motorway A25 (172 km) - Part of the Trans-European Transport Network.
- High % of heavy vehicles.
- Database: accidents between 2015-2021.



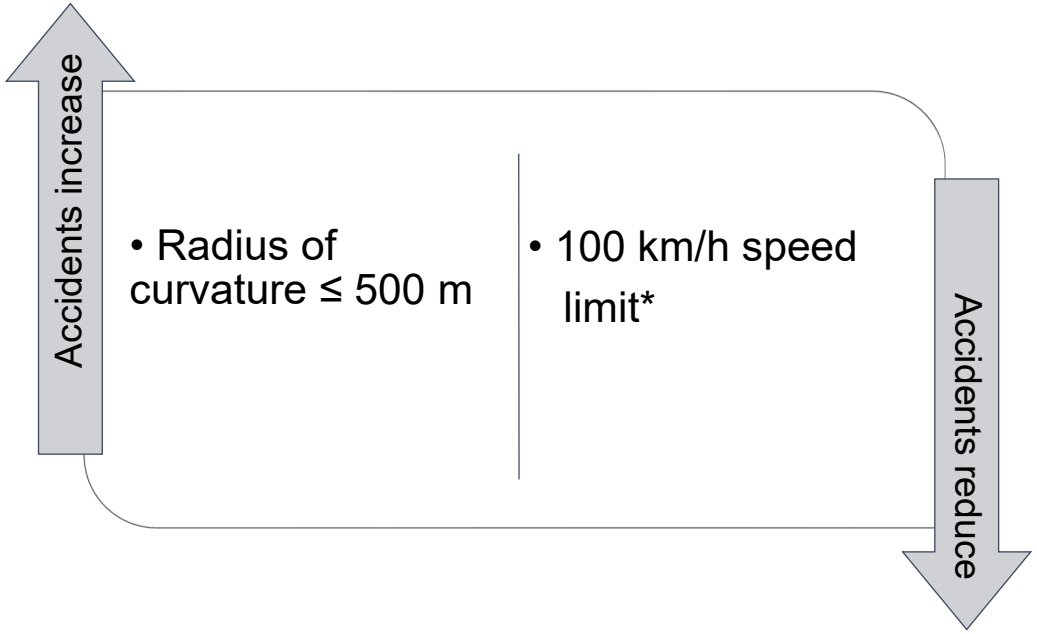
/04 Ascendi's Experience – Case Study III (A25)

Relevant factors identified

Total Accidents Prediction Model



Injury Accidents Prediction Model



**Compared to central reservation with ≥ 4 m width.*

***Compared to speed limit of 120km/h.*

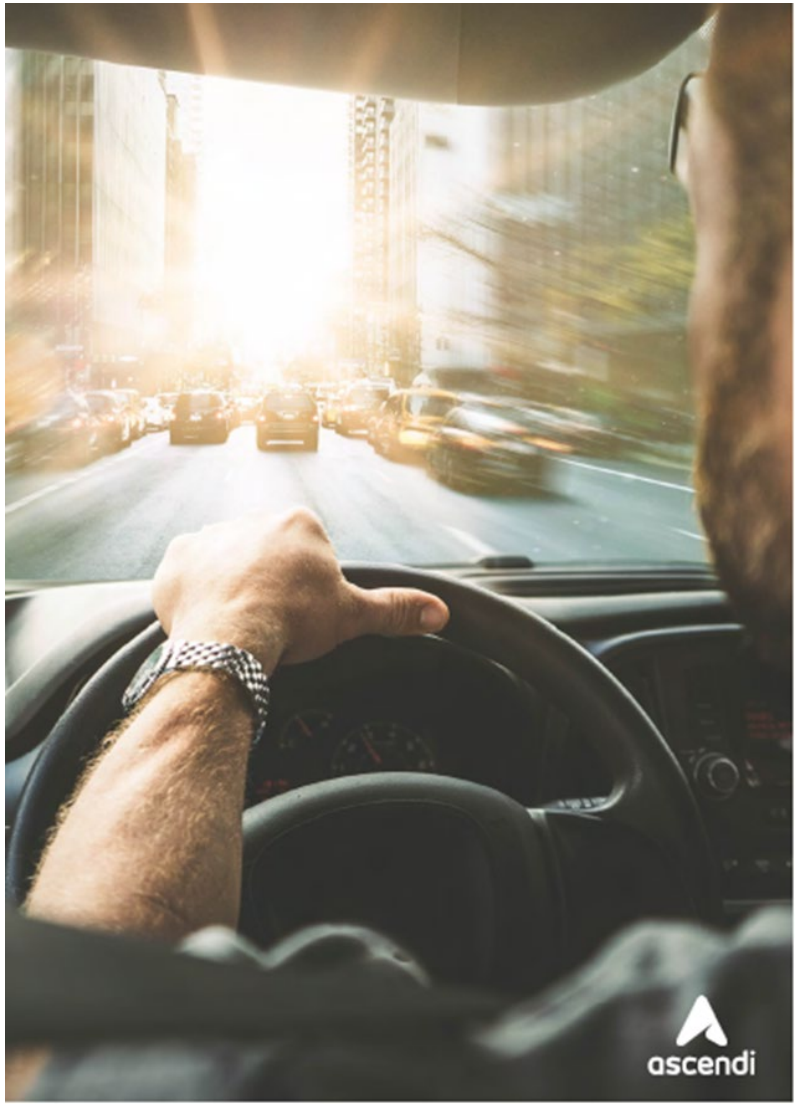
/04 Ascendi's Experience – Case Study III (A25)

Practical Application – AADT projection for 2023 (Hypothetical scenario)

Ranking	Location/Section	Direction	APM (Total Accidents) 2023	Observed Average Total Accidents (2015-2021)	Observed Average Ranking Total Accidents (2015-2021)
1º	Carvoeiro - Talhadas	SC	10,3	6,3	3º
2º	Talhadas - Reigoso	SD	9,1	5,3	7º
3º	Carvoeiro - Talhadas	SD	8,9	14,0	1º
4º	Talhadas - Reigoso	SC	7,6	2,9	18º
5º	Caçador - Fagilde	SC	6,8	6,9	2º
6º	Caçador - Fagilde	SD	6,5	5,6	6º
7º	Fornos de Algodres - Celorico	SC	6,0	5,9	5º
8º	IP2/A25 - Guarda	SD	5,9	3,4	15º
9º	IP2/A25 - Guarda	SC	5,9	2,3	23º
10º	Mangualde - Chãs de Tavares	SC	5,8	2,0	29º

/05 Next Steps

- Develop models for all motorways;
- Upgrade and update the developed models (calibrate models introducing accident data for the following years in the database);
- Automation of data treatment process;
- Develop of internal know-how and friendly tools to expand the use of the models in Road Safety analysis;
- Disseminate the results of the applications to promote the continuous improvement of the models and the adoption of the methodology by Portuguese and European stakeholders in the road sector;
- Use APM to support the selection and implementation of effective road safety measures;
- Explore other practical applications of the models.



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THANK YOU FOR YOUR ATTENTION

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