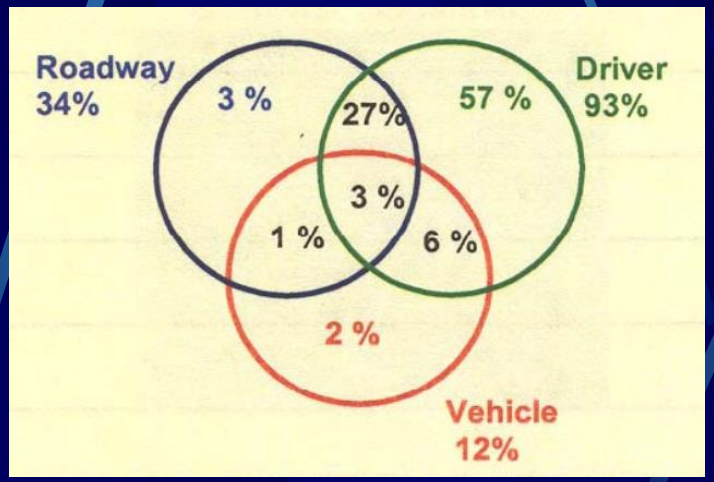
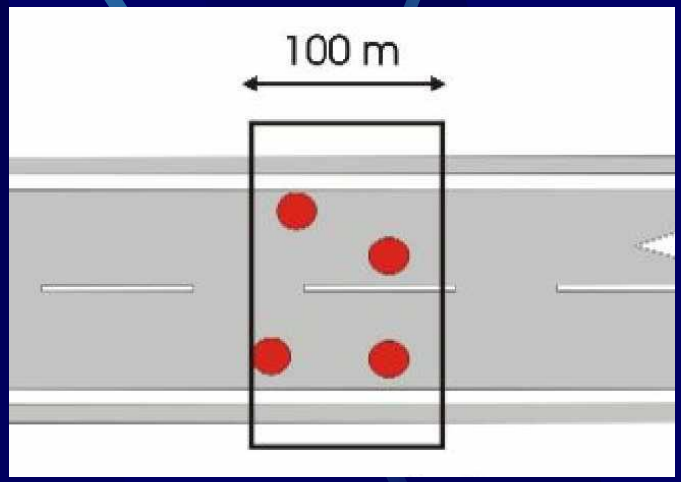
Traffic safety, accident analysis





Urban Transport 14.
András Gulyás PhD habil
associate professor

Content

- Principles of traffic safety
- Definitions concerning accidents
- Accident situation in Europe
- Safe roads and roadside environment
- Identification of black spots
- Activities to improve traffic safety
- Road safety impact assessment
- Road safety audit
- Management of road network safety
- Safety inspection

Definitions concerning accidents

In the road – vehicle – human interaction the safety is indispensable in any elements.

The road possibly should help to correct the mistakes of the vehicle or the driver to avoid conflicts and accidents.

The traffic engineering rules and control serves the same aim.

Improving safety requires resources therefore it is not possible to improve it beyond all limits.

Definitions concerning accidents

Road traffic accident with personal injury:

A traffic event that occurred on a public road or started from a public road involving at least one moving vehicle or beast of burden resulting the injury or death of at least one person.

Dead by traffic accident:

A person who died because of a traffic accident on the spot or within 30 days after the accident.

Definitions concerning accidents

Seriously injured person:

Whose injury is healed within more than 8 days after the accident (fractures, bruises, inside injuries, cuts and destruction, shock requiring medical treatment, altogether any injury that requires hospitalisation).

Lightly injured person :

Getting bruises or wrenches but healed within 8 days.

The outcome of the accident is determined by the most serious type of injury or death involved.

Definitions concerning accidents

Accident cost rates in Hungary in 2008

Outcome of the accident	Cost rate
Fatal	266,9 million HUF/victim
Serious injury	35,8 million HUF/injured
Light injury	2,6 million HUF/injured

Definitions concerning accidents

Weighing proportions for accidents:

Outcome of the accident	Weighing proportions
Fatal	103
Serious injury	14
Light injury	1

Definitions concerning accidents

Traffic performance of a road section is given by:

$$TP = N * AADT * 365 * L$$

where

N = time period analysed (years),

AADT = annual average daily traffic in the time period analysed, average of AADTs in the analysed years (veh/d),

L = length of section (km).

Definitions concerning accidents

Accident rates for a road section:

Number of dead (D), seriously injured (S) and lightly injured (L) persons referred to the traffic performance of the section (in 10 million veh-km)

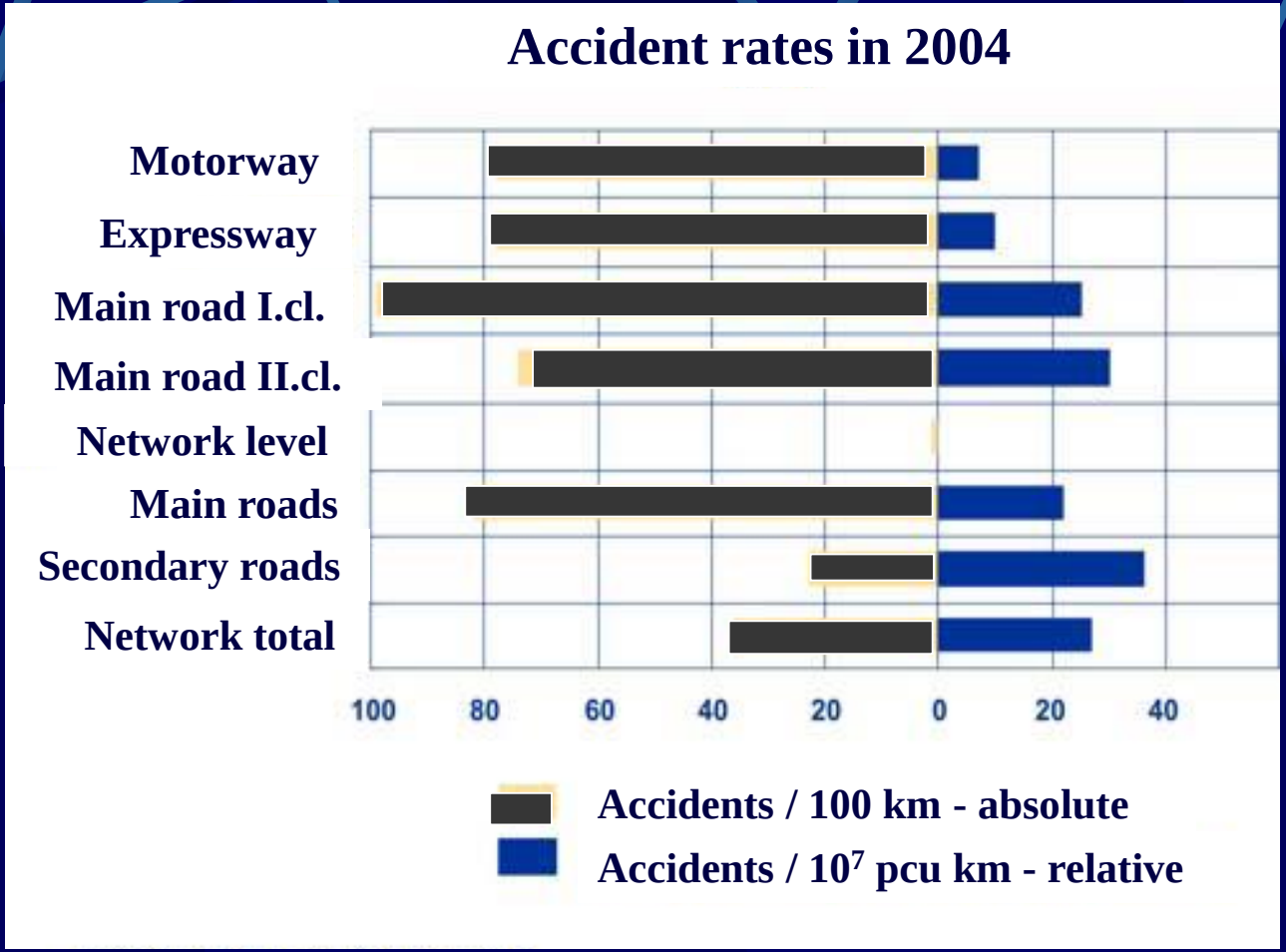
Cumulated relative accident rate:

$$CRAR = (D+S+L) * 10^7 / TP$$

Weighted Cumulated relative accident rate:

$$WCRAR = (103*D+14*S+L) * 10^7 / TP$$

Definitions concerning accidents



Road safety situation in Europe

DIRECTIVE 2008/96/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 19 November 2008 on road infrastructure safety management

Establishment and implementation of procedures relating to road safety impact assessments, road safety audits, the management of road network safety and safety inspections.

Apply to roads which are part of the trans-European road network (TEN), whether they are at the design stage, under construction or in operation.

Road safety situation in Europe

Main goals of the EU Road Safety Directive:

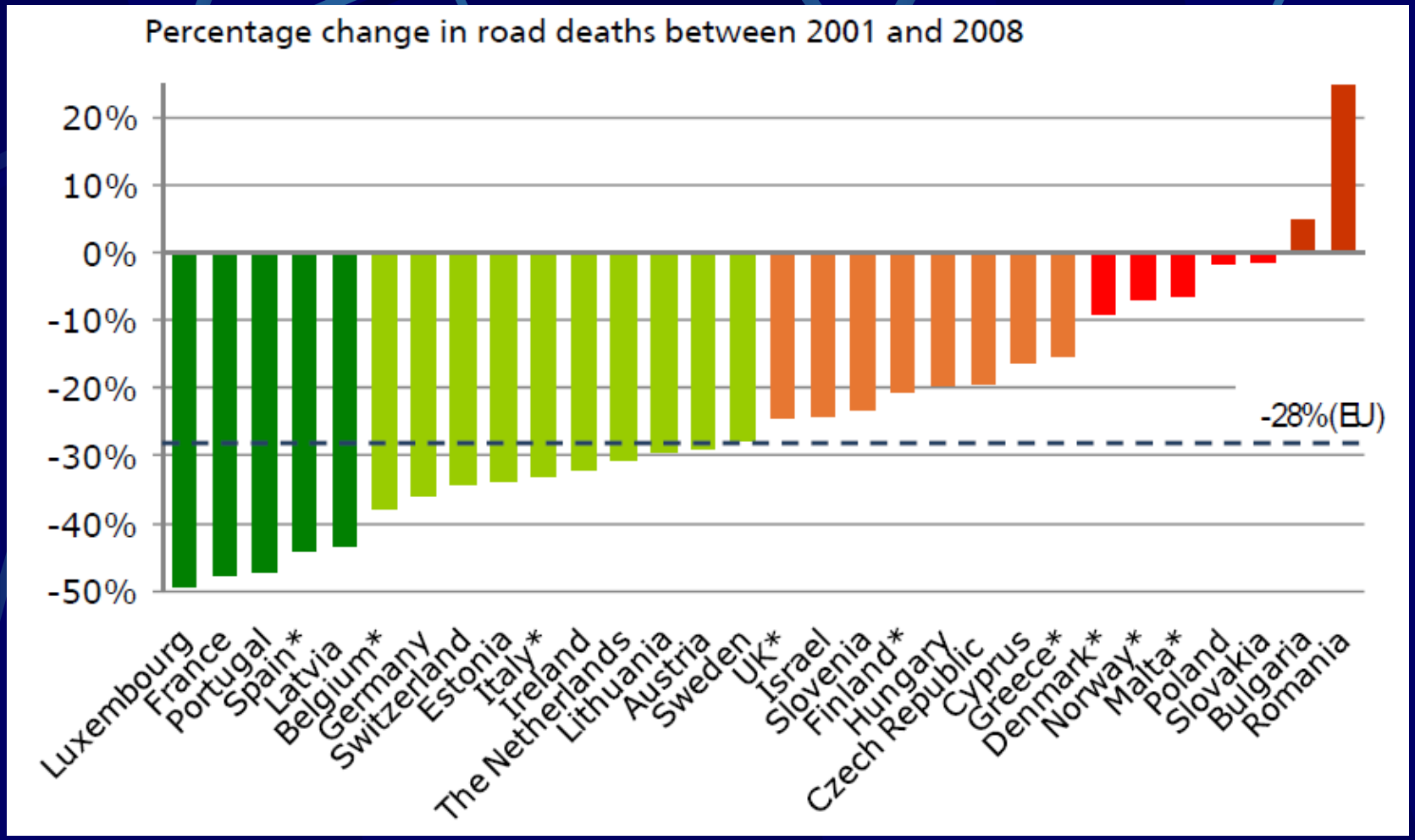
- **Improvement of road safety in all Member States**
- **New road sections be safe and up-to-date**
- **Existing road sections be safe and up-to-date**
- **Safety concerns in design**
- **Transparency of safety requirements and decisions**
- **Better utilisation of research results**
- **Better utilisation of resources**
- **Better utilisation of safety related information**

Road safety situation in Europe

Type of safety measures in the EU Directive

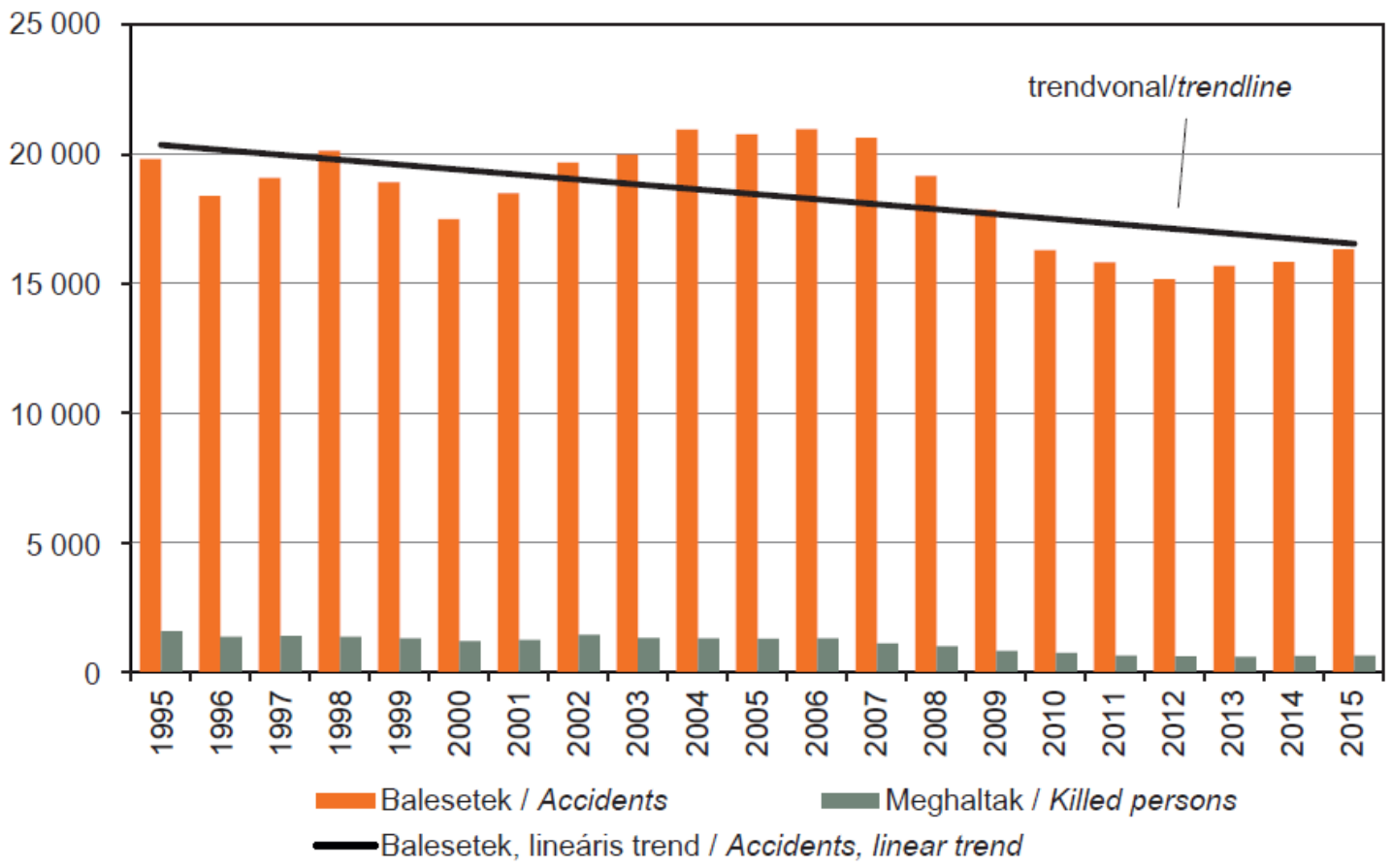
Phase	Type of safety measure
Planning	Road safety impact assessment
Design, construction	Road safety audit
Operation	Management of network safety
Operation	Safety inspection

Road safety situation in Europe



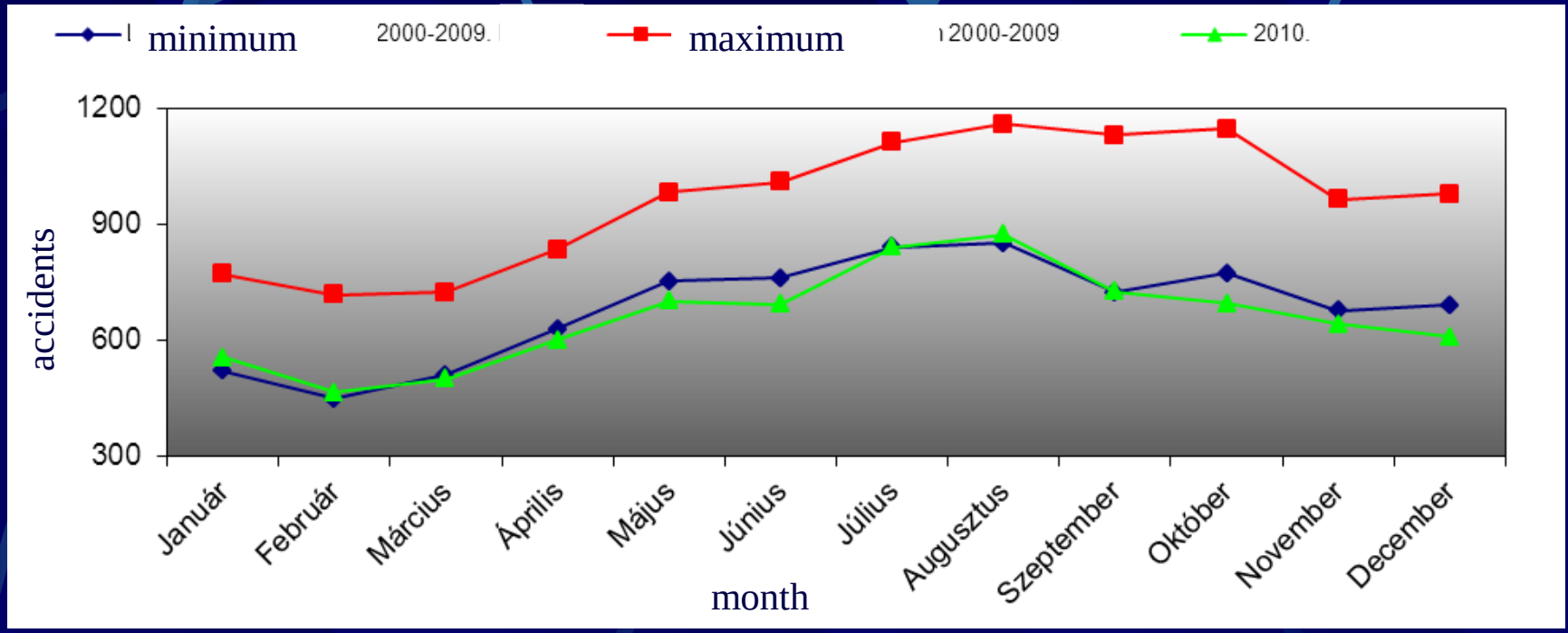
Road safety situation in Hungary

Number of accidents involving personal injury and the number of persons killed



Source: Hungarian Central Statistical Office

Road safety situation in Hungary



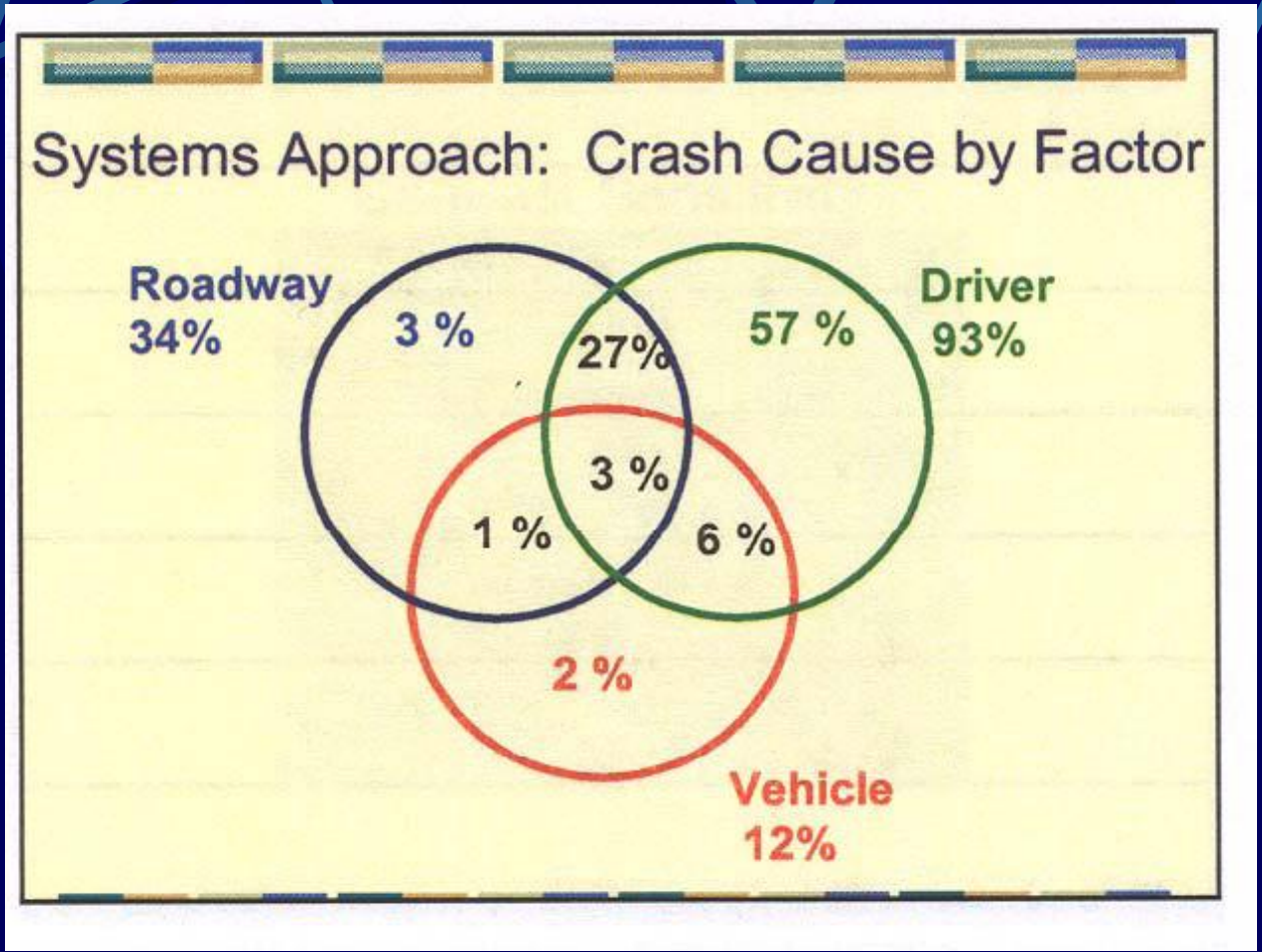
Accidents by month 2000 - 2010

Safe roads and roadside environment

Majority of accidents (more than 50%) is caused by driver's fault. To decrease this:

- **Increase safety considerations in road and roadside development, create a forgiving environment.**
- **Identify and eliminate black spots, accident groups.**
- **Traffic engineering activities may provide help at low cost.**

Safe roads and roadside environment



Safe roads and roadside environment

The safe road and roadside environment:

- **gives warning to road users on unusual condition and circumstances,**
- **provides information on expected condition issues,**
- **helps to drive through at unusual sections,**
- **helps to drive through at possible conflict points or areas,**
- **forgives to road users their occasional faults and inadequate behaviour.**

Safe roads and roadside environment

The safe road and roadside environment:

- **does not show surprises in the road alignment or in traffic engineering solutions, answers the expectations of road users,**
- **provides controlled and substantial information but not too many at a given time,**
- **where necessary, repeats important information in order to highlight dangerous situations.**

Safe roads and roadside environment

- Activities of the forgiving roadside environment program in Hungary
- Passive defence solutions
  - Defence at solid obstacles (road direction tables, public lighting poles, tree alleys) using guardrails
  - Deployment of energy adsorbing devices
- Where necessary cutting the trees at roadside
- Paving of the inside shoulder in dangerous curves

Safe roads and roadside environment

The self-explaining road is a road designed and constructed for safety purposes, it motivates drivers to adequate behaviour in order to avoid driving faults.

In theory on a perfectly designed self-explaining road there is no need for speed limit signs or danger warning signs.

This is not the case in the practice since drivers are different and their reactions are various.

Safe roads and roadside environment

To achieve safe road and roadside environment it is recommended:

- **Use of standardised road types with only a few well distinguishable categories that can be recognised unambiguously.**
- **The driver must recognise the road category to behave adequately.**
- **Application of junctions of the same type.**

Identification of black spots

There are always places where the number of accidents is bigger than expected or calculated, and there is always a reason for this phenomena.

The task of the road operator is to identify this places, to find the possible causes and eliminate them or at least decrease their harmful effects in order to expect less accidents in the future.

A short road section (usually 100 m) or a junctions is called a „black spot” if there occur more accidents than expected.

Identification of black spots

The road operator must define spots of potential safety problems.

Even if there have been not too many accidents, a spot may be potentially unsafe because of various reasons, possible conflicts.

Road operators use traffic engineering thinking to filter out these spots.

Identification of black spots

The identification of real black spots is based on accident data analysis.

To find the most dangerous spots with the largest safety risk is the responsibility of road safety experts.

The proper identification real black spots is only possible by performing a careful multi-criteria assessment.

Identification of black spots

The definition of a black spot is:

- **where the number of accident is more than expected,**
- **where the accidents are more serious,**
- **where the relative accident rate is higher than the average.**

A black spot can be point-like or section-like.

Identification of black spots

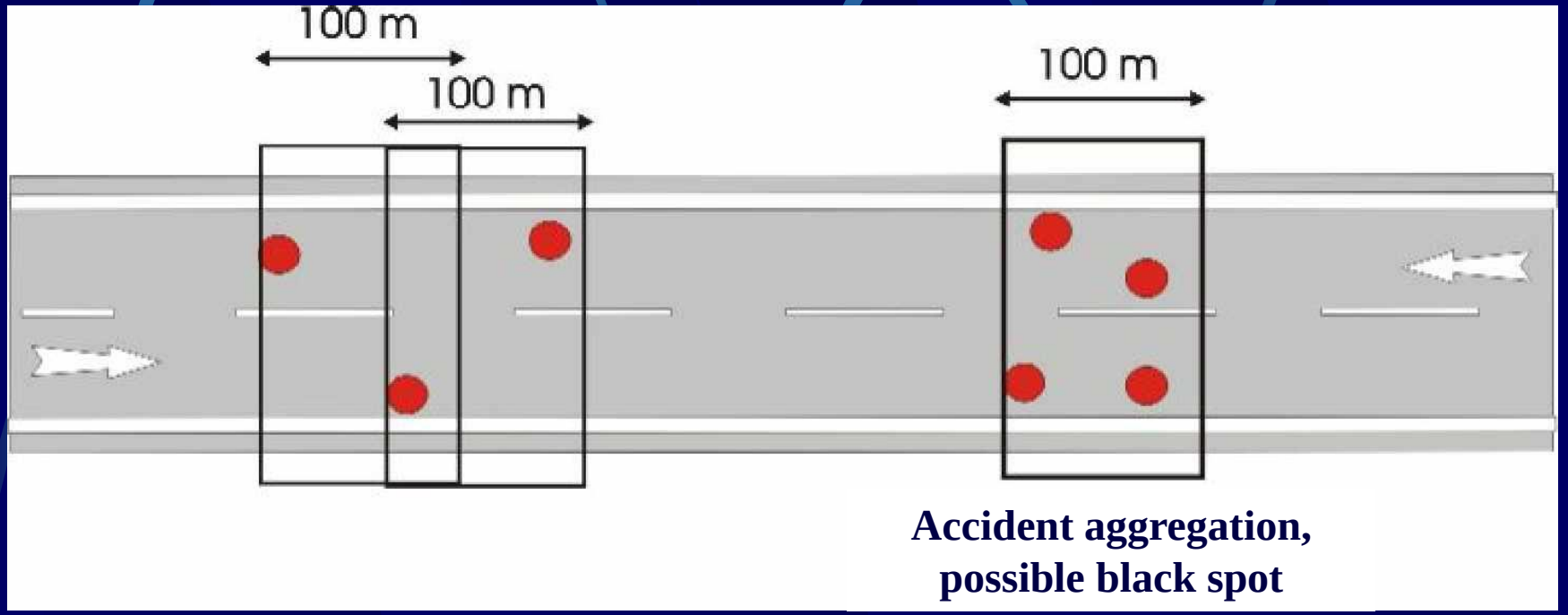
At built-up areas a junction or a road section of 100 m length is a potential black spot if there occurred at least four accidents with injuries during three years.

To find such spots an accident point map or a data list can be used applying the window technique.

Smaller section of a road can be identified this way.

Identification of black spots

Analysis of accidents occurred during the last 3 years at a built-up area applying the window technique



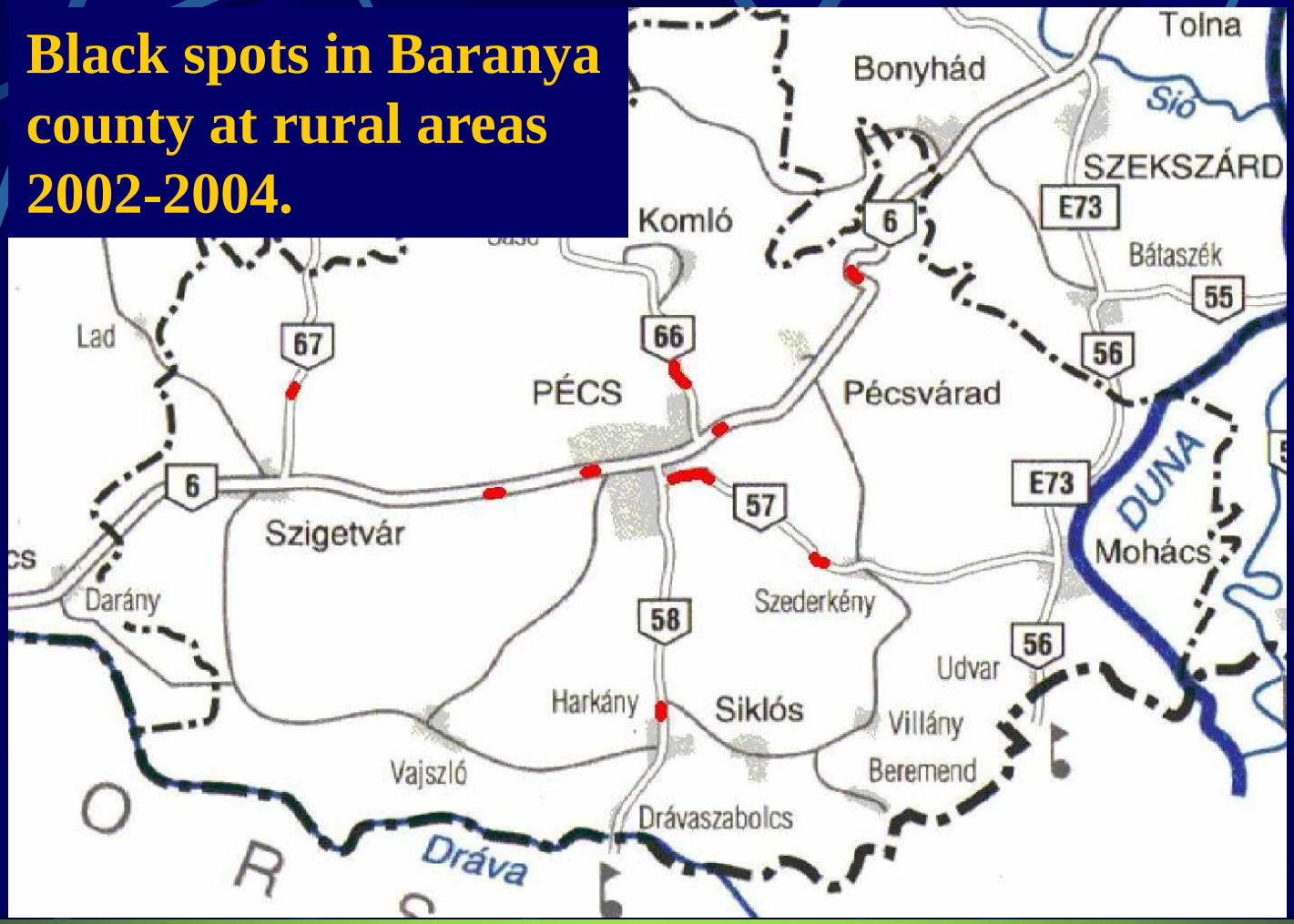
Identification of black spots

The method for identification of black spots has three parts: ranking by different points of view and putting together a combined ranking as a final one.

- **ranking based on the absolute number of accidents,**
- **ranking taking into account the seriousness,**
- **ranking based on the relative accident rate (projected to the traffic performance).**

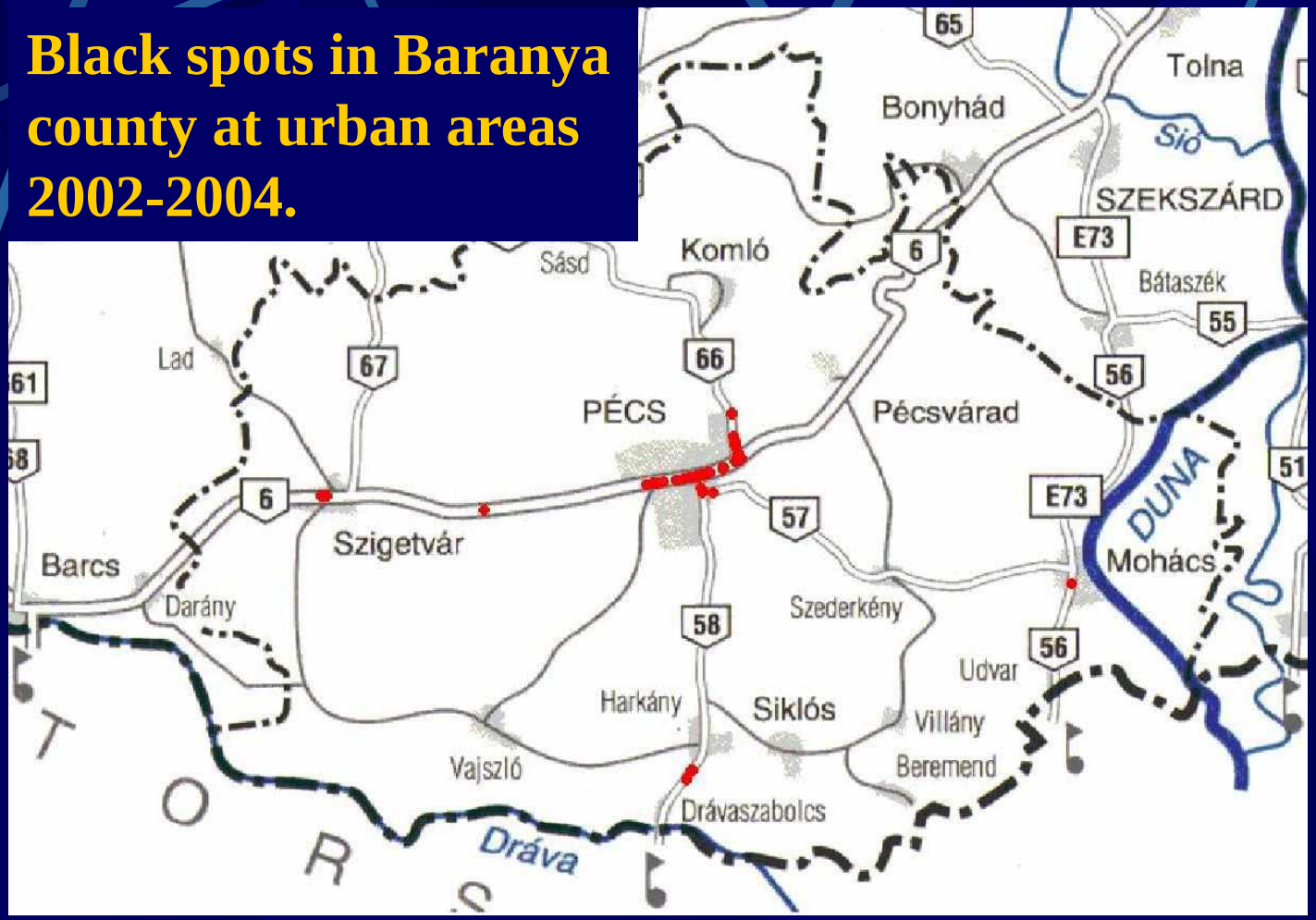
Identification of black spots

Black spots in Baranya county at rural areas 2002-2004.



Identification of black spots

Black spots in Baranya county at urban areas 2002-2004.



Activities to improve traffic safety

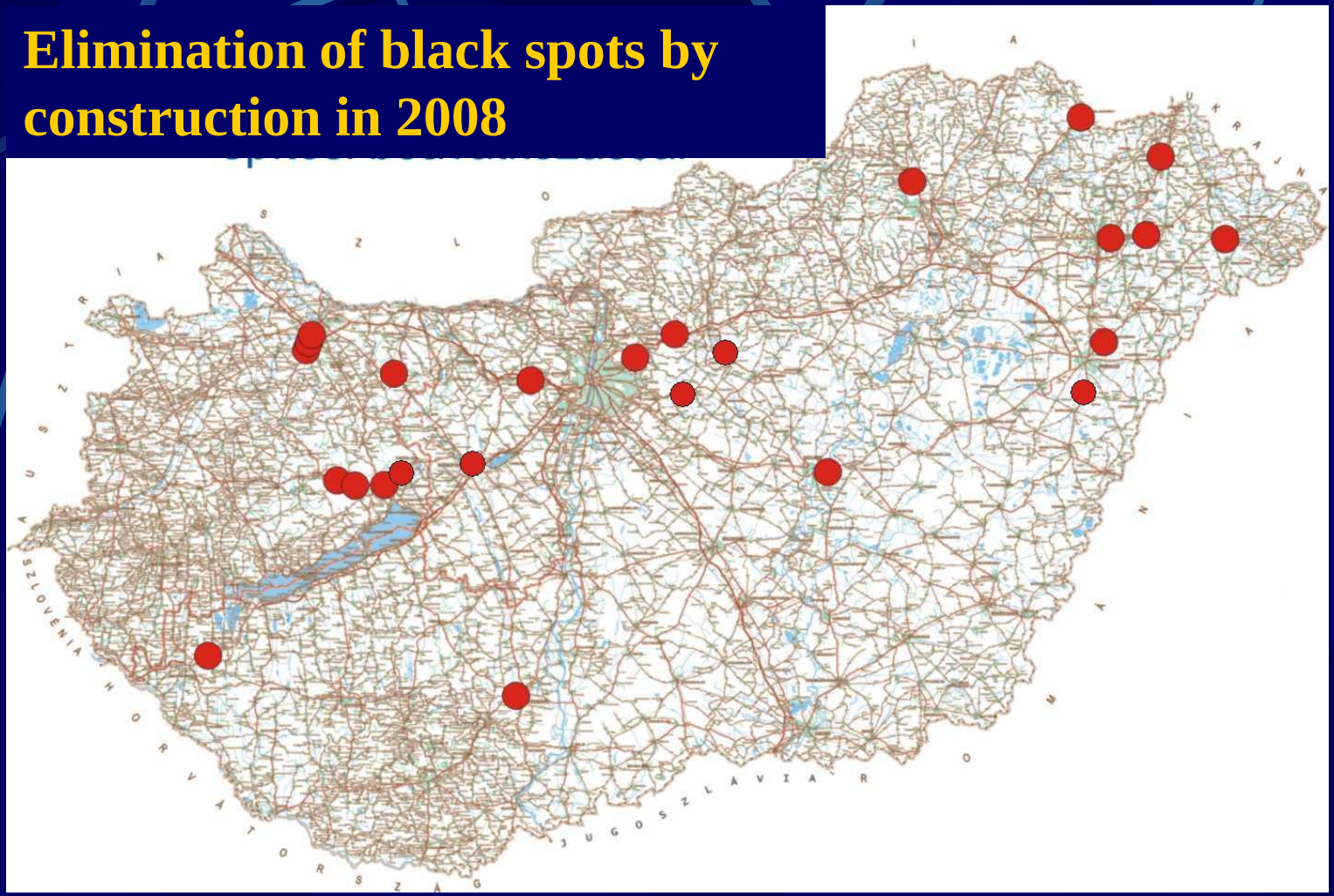
After the identification of a black spot the next task is to find the main causes of accidents and to determine the possible developments as well as to construct or deploy them.

The recommended activities for a certain black spot are based on the specified causes and the financial resources and the technical possibilities.

After the construction or deployment the last step is the assessment of the results achieved and the calculation of its effectiveness.

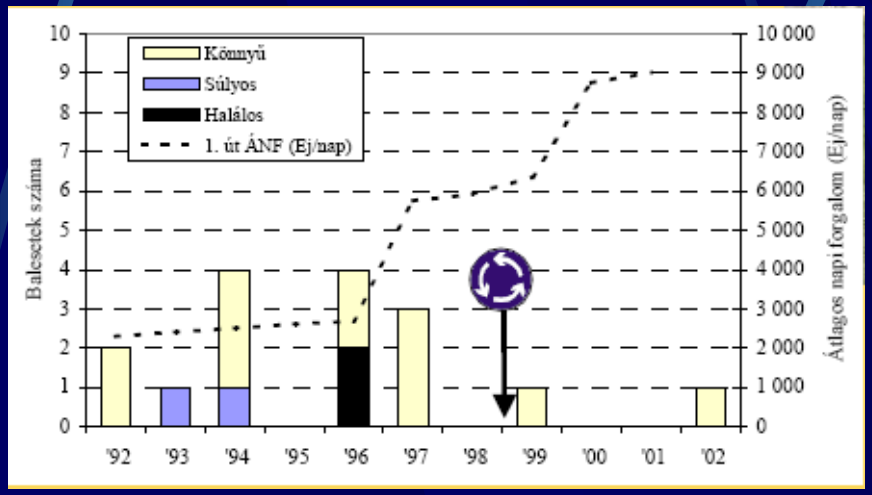
Activities to improve traffic safety

Elimination of black spots by construction in 2008

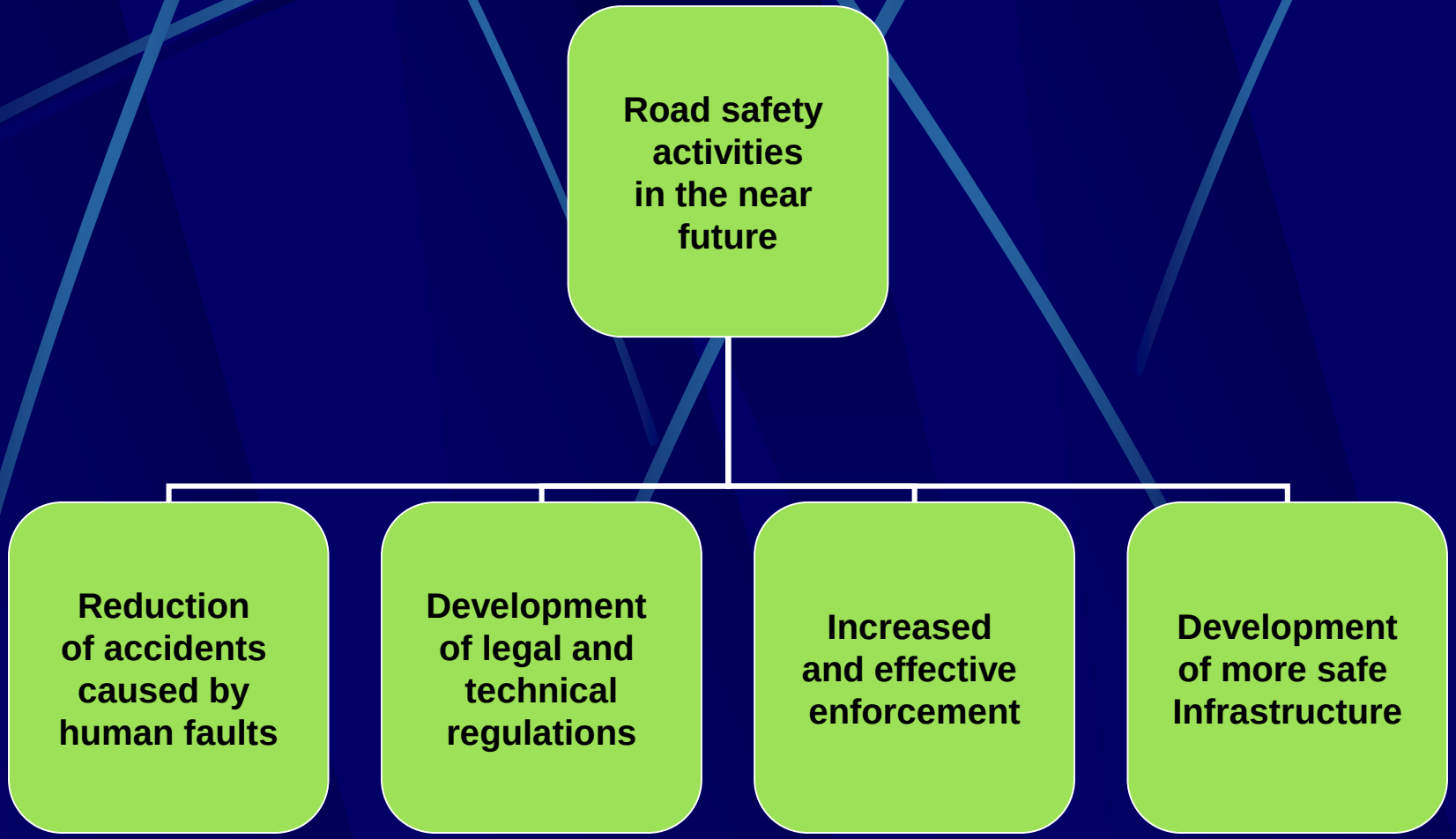


Activities to improve traffic safety

Replacement of a black spot junction by a roundabout has good safety results.



Activities to improve traffic safety



Road safety impact assessment

Road safety impact assessment means a strategic comparative analysis of the impact of a new road or a substantial modification to the existing network on the safety performance of the road network.

Road safety impact assessment

The road safety impact assessment shall be carried out at the initial planning stage before the infrastructure project is approved.

The road safety impact assessment shall indicate the road safety considerations which contribute to the choice of the proposed solution.

It shall further provide all relevant information necessary for a cost-benefit analysis of the different options assessed.

Road safety impact assessment

Elements of a road safety impact assessment:

a) problem definition;

b) current situation and ‘do nothing’ scenario;

c) road safety objectives;

d) analysis of impacts on road safety of the proposed alternatives;

e) comparison of the alternatives, including cost-benefit analysis;

f) presentation of the range of possible solution.

Road safety audit

Road safety audit means an independent detailed systematic and technical safety check relating to the design characteristics of a road infrastructure project and covering all stages from planning to early operation.

Road safety audits shall form an integral part of the design process of the infrastructure project at the stage of draft design, detailed design, pre-opening and early operation.

Road safety audit

The main goal of the road safety audit is the safe operation of the road increasing the safety level of all road users.

A further goal is the identification of potential traffic safety problems from the user's point of view moreover to make recomemndations for solving these problems absed on the priciples in traffic safety gudelines.

Road safety audit

Member States shall ensure that the auditor sets out safety critical design elements in an audit report for each stage of the infrastructure project.

The safety audit report shall result in relevant recommendations from a safety point of view.

Where unsafe features are identified in the course of the audit but the design is not rectified before the end of the appropriate stage, the reasons shall be stated by the competent entity in an Annex to that report.

Road safety audit

The auditor shall have the necessary competence and certified training. Member States shall ensure that auditors are appointed in compliance with the following requirements:

- **they have relevant experience or training in road design, road safety engineering and accident analysis;**
- **for the purpose of the infrastructure project audited, the auditor shall not at the time of the audit be involved in the conception or operation of the relevant infrastructure project.**

Road safety audit

General audit questions:

- **Is the analysed item safe for all road users?**
- **Within the frame of technical guidelines the most safe solution has been chosen?**
- **Is there a recommendation to amend the design?**
- **Is any mistakable thing in the design for road users?**
- **Is there any trouble or equivocality?**
- **The information provided is too little or too many?**
- **Is the proper visibility ensured?**
- **Are there any obstacles or „traps”?**

Road safety audit

The auditor is mainly independent therefore:

- **the auditor shall not take part in the design,**
- **the auditor does not represent the contractor,**
- **to confront the safety and economic aspects is not the task of the auditor**
- **the auditor cannot be ordered.**

Main tasks of the contractor:

- **proper definition of what to be audited,**
- **putting together all necessary conditions.**

Road safety audit

The tasks of the auditor:

- **to choose the adequate checklists,**
- **to analyse the project,**
- **to perform site investigation, if necessary by night as well,**
- **to list the problems, the remarks and their justification,**
- **to make recommendations for problem solving,**
- **to summarise and make an audit report.**

Road safety audit

The tasks of the consultant:

- **to read the audit report,**
- **to agree or not agree with the report,**
- **to formulate an opinion and give this to the auditor.**

The common tasks of the consultant, auditor and contractor:

- **to read the audit report, in case of disagreement asking for the decision of the contractor in written form.**

Road safety audit

The goal of the road safety audit is to identify the possible safety problems and to provide an independent recommendation for solving these.

The auditor does not consider other (i.e. economic) aspects.

The contractor decides on accepting or rejecting the recommendations.

The responsible is the contractor and in case of rejection a written justification must be made.

Management of road network safety

Network safety ranking means a method for identifying, analysing and classifying parts of the existing road network according to their potential for safety development and accident cost savings.

The number of accidents per unit length or per junction within the previous years and the accident rate referred to the traffic performance are taken into account.

Management of road network safety

The goal is to rank the road sections from a safety point of view to provide a traffic safety ranking.

The possible savings in accident cost is taken into account.

The road sections are analysed in all road categories and the rankings are made for these categories.

The road sections at the top of the ranging list are those where the infrastructure development will result in high efficiency.

Management of road network safety

The black spot analysis:

- **focuses to the spot, based on accidents.**

The analysis of sections with high accident risk:

- **focuses to the section, based on accidents.**

The management of road network safety:

- **focuses to the network, based on accidents and traffic.**

Management of road network safety

Risk indicator:

$$A_r = \frac{A * 10^7}{AADT * L * T * 365}$$

where

- A_r – relative accident rate or risk indicator
- A – number of accidents occurred in T time interval
- AADT – average daily traffic
- L – section length (km)
- T – time (years)

Management of road network safety

Example	M5 13-17,4 km motorway 2*2 lanes	M15 0-13,7 km expressway 2*1 lanes
Length km	4,4	13,7
Traffic vehicle/day	55616	6604
Accidents per 100 km	181,82 Absolutely more dangerous	29,20
Risk indicator accident / 10^7 vehiclekm	0,90	1,21 Relatively more dangerous

Safety inspection

Safety inspection means an ordinary periodical verification of the characteristics and defects that require maintenance work for reasons of safety.

Member States shall ensure that safety inspections are undertaken in respect of the roads in operation in order to identify the road safety related features and prevent accidents.

Member States shall ensure that periodic inspections are undertaken by the competent entities (in Hungary the Road Management Co., the Police and the Transport Authority).

Safety inspection

POGSE approach in safety inspection

- **Problem:**
- **frequent accidents, complaints of inhabitants**
- **Origin:**
- **function of road, type of environment, signing**
- **Goal:**
- **To reduce the number of accidents and speed**
- **Solution:**
- **Traffic engineering activities, geometric corrections**
- **Evaluation:**
- **After survey, traffic order, speed measurement**

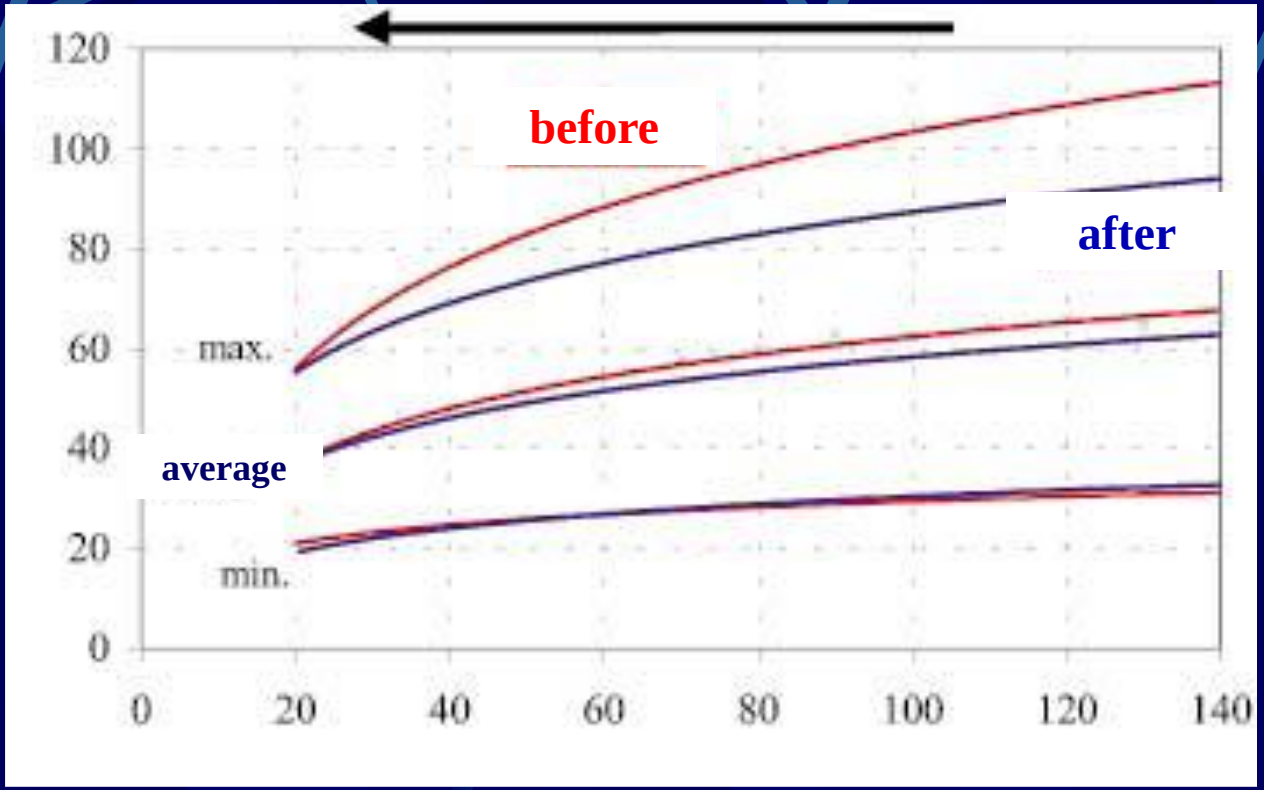
Safety inspection

before

after

Road 6219 at 17+500 –17+800 kms
hump and curve reconstruction

Safety inspection



Speed profiles before and after the reconstruction

Safety inspection

Urban problem:
The stop length is not enough for buses

Urban problem:
No island at the right side of the pedestrian crossing

Summary

Majority of accidents is caused by driver's fault. To decrease this: always consider safety in road and roadside development, create a forgiving environment.

There are always places where the number of accidents is bigger than expected or calculated, and there is always a reason for this phenomena.

The road safety audit is an independent, detailed, methodical and technical safety check of a road infrastructure development project from the design to the construction and the beginning of the operation.

Thank you for your attention!

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