KABEWISTRA
Capacity management for the Swiss network of national trunk roads

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KABEWISTRA

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Abstract

ASTRA, the Swiss Federal Roads Authority, has set itself the objective of improving the congestion situation on the network of national trunk roads. The goals include achieving a decrease in the number of congestion incidents, along with a reduction in the duration and extent of congestion.

The aim is to achieve these goals by using measures that can be implemented within 1 to 2 years and that do not require extensive modifications to the road infrastructure. On the contrary, the aim is to manage existing infrastructure and capacity as effectively as possible, to ensure that they are used optimally.

A concept paper outlining these measures should be available in August ’03.

The starting point of the work is a comprehensive survey of congestion on the Swiss network of national trunk roads, which recorded both the causes of congestion, and the frequency and length of the congestion. It also recorded the measures that have already been planned or implemented at canton level.

Depending on the causes of congestion in the overall context of the network, it is possible to assign a congestion point to a particular category of congestion. The measures are divided into two types: those which have an effect on the entire network and those which focus on a particular congestion point.

Keywords

Xyz – Zxy – Yxz – 3rd Swiss Transport Research Conference – STRC 03 – Monte Verità

1. Starting situation and goals

ASTRA, Switzerland's Federal Roads Authority, has been keeping congestion statistics for some time now. These indicate that there has been a sharp rise in the number of traffic jams in recent years as a result of capacity bottlenecks. A further significant increase is to be expected.

ASTRA is seeking to deal with the increasingly negative effects of road traffic with a «Three-pronged zero tolerance strategy». The three elements relate to an increase in traffic safety (zero traffic fatalities), a reduction in the negative impact on the environment (zero emissions) and optimum use of existing infrastructure (zero congestion).

As part of the latter strategy, ASTRA has set itself the goal of improving the congestion situation on the Swiss network of national trunk roads[1]. It aims to reduce the number of congestion incidents, as well the duration and extent of any incident.

The aim of the KABEWISTRA project is to produce a concept paper outlining measures that can be implemented within 1 to 2 years.

[1] Road network as defined in the "Entwurf Sachplan Strasse," (draft road plan) comprising motorways and trunk roads

2. Identification of congestion points

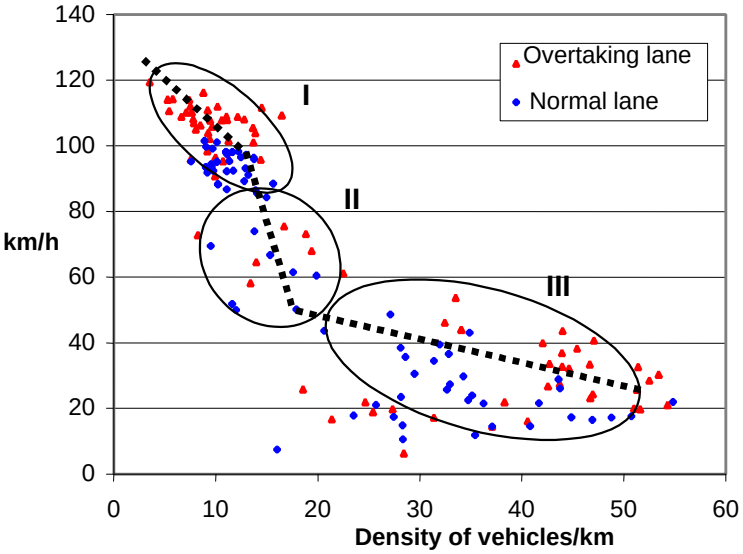
The first step involves recording the congestion points on the Swiss network of national trunk roads. Apart from the cause of the congestion, the frequency of the incident and its extent are ascertained (average length of traffic jam and average duration).

The data situation at ASTRA has enabled the cantons in question to be incorporated into the recording process. Working in conjunction with representatives of the relevant Traffic Police Forces and Departments of Public Works ensures that the required degree of completeness and accuracy is achieved.

2.1 What is congestion?

To ensure uniformity in the congestion survey, it is crucial to clarify the term “congestion”. From an objective, physical point of view, there are compelling reasons for using the levels of service defined by VSS. Here congestion is defined as the consequence of instable traffic flow in categories E and F. The exact assignment of a situation to one of the two categories is only possible if the body of data is correspondingly precise (cf. Figure 1).

Figure 1 Fundamental diagram (speed [km/h]/flow density [vehicles/km]) for a two-lane section of motorway (A1, Zurich Affoltern)



Source: Data by ASTRA

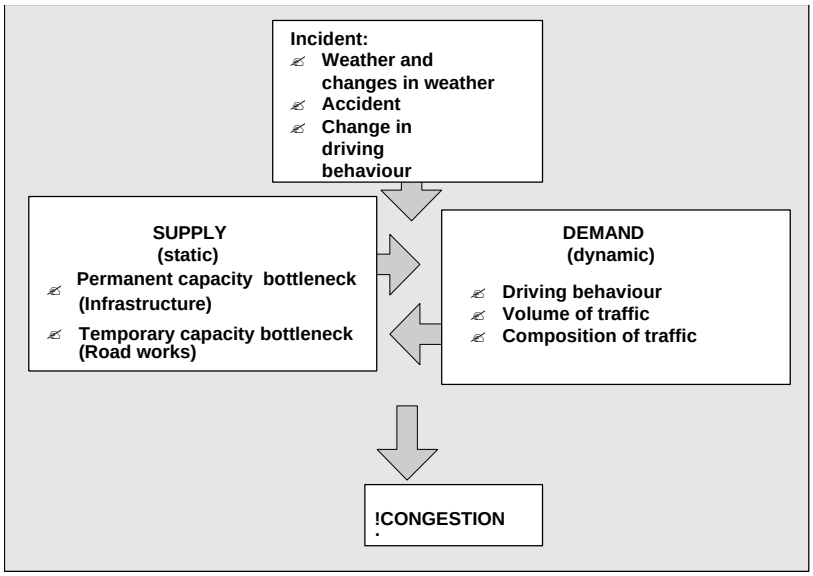
However, congestion points are frequently not equipped with adequate recording instruments, which means that data from readings alone do not allow a comprehensive and objective evaluation.

The congestion points and their characteristics, such as frequency of congestion incident, average duration and extent of the incident, are therefore recorded using estimates. The experience of specialists in the Traffic Police and Department of Public Works is taken into account here.

As well as looking at an objective definition of congestion, KABEWISTRA also intends to examine how road users perceive congestion. Different road users experience the same traffic situation very differently. For some people, congestion only exists when a queue of vehicles forms and comes to a standstill, whereas others feel a situation as congested whenever they are forced to drive more slowly than the speed limit.

2.2 Causes of congestion

Figure 2 Degree of influence of the causes of congestion



Congestion can occur randomly whenever the balance between supply (capacity of the infrastructure) and demand (current volume and composition of traffic) is disturbed by an external cause. This can be a change in the weather, such as fog or snow on the carriageway, or a sudden change in the driving behaviour of individual road users. Due to the arbitrary way in which congestion can occur, it is not possible to carry out a widespread systematic survey without using automatic measuring stations.

Congestion can also occur periodically at a permanent location, if, at a given time of day, year and/or season, demand exceeds local supply (capacity). It obviously makes sense to survey this type of congestion and look at what measures might be implemented.

2.3 Congestion points resulting from permanent capacity bottlenecks

The total of 98 congestion points recorded in 16 cantons, at which congestion occurs at the same place periodically, are caused by a permanent capacity bottleneck. They suffer traffic jams over approximately 34,700 hours per year. The majority of these traffic jams are caused by the transition between motorways (MWS) and trunk roads (TRS) and in particular

motorway exits where there is a trunk-road junction after the slip road limiting the flow of traffic leaving the motorway. Table 1 gives an overview of the how the hours of congestion per annum on the MWS/TRS networks is distributed across different times.

In terms of hours, most congestion, in fact 86%, occurs on weekdays. Seasonal holiday congestion, along with congestion on the remaining weekends, thus accounts for 14%.

Table 1 Permanent capacity bottlenecks on the Swiss network of national trunk roads[2]

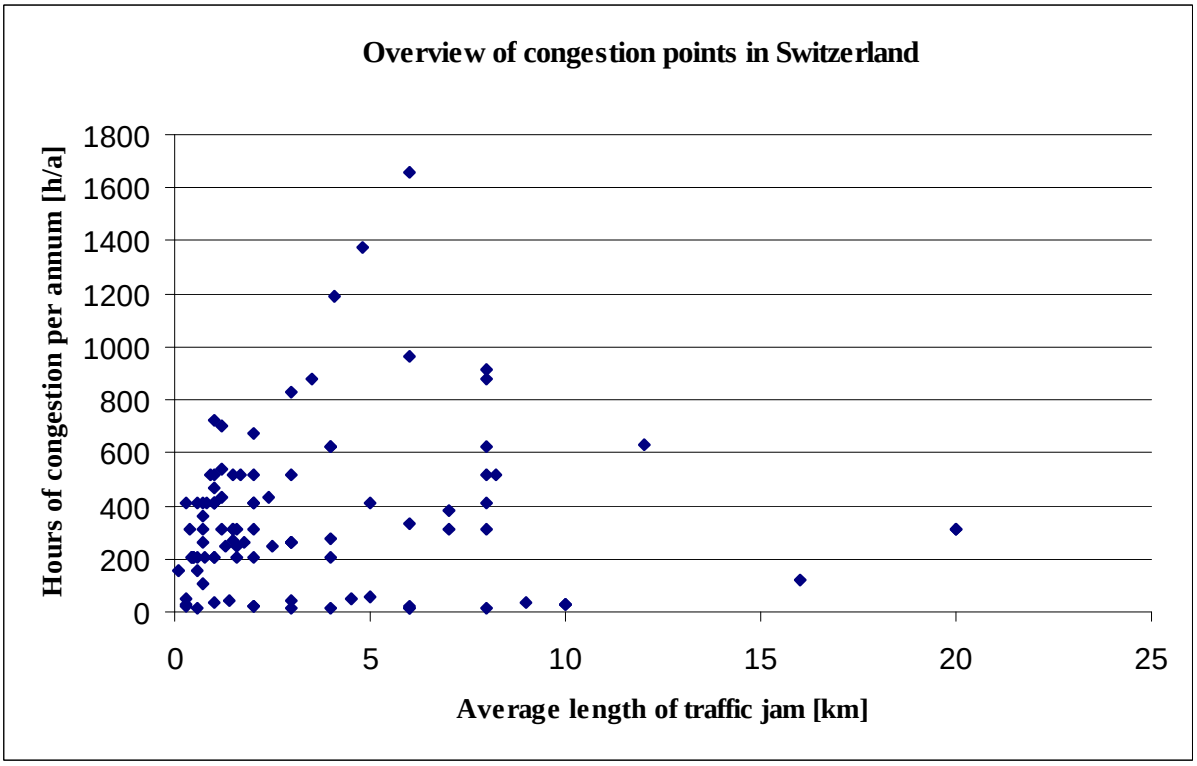
Number of congestion points	**98**	**Proportion**
MWS	34	34.7%
Transition between MWS/TRS	46	46.9%
TRS	18	18.4%

Hours of congestion per annum [h/a]		
	34'716	**100%**
MWS	13'341	38.4%
Transition between MWS/TRS	14'564	42.0%
TRS	6'812	19.6%
	34'716	**100%**
Weekdays	30'023	86.5%
Weekend	1'118	3.2%
Saisonal	3'576	10.3%

Figure 3 shows the average length of traffic jam and hours of congestion per annum for all congestion points. The pronounced differences in the annual duration of congestion and the average length of a traffic jam at a particular congestion point are striking. This pair of values reflects the pressure at a given congestion point.

[2] not counting additional trunk road networks in conurbations

Figure 3 Permanent capacity bottlenecks, showing average length of traffic jam per incident and the annual total of hours



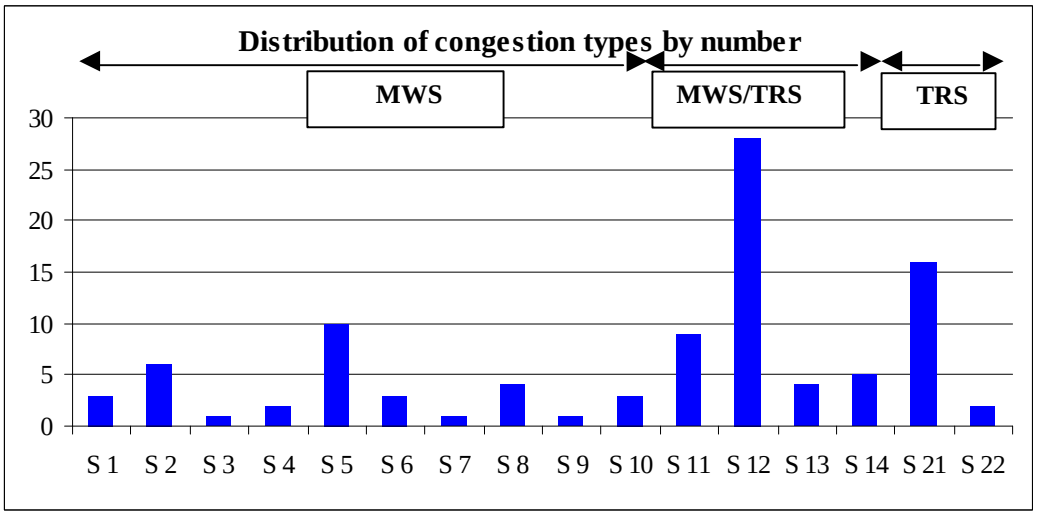
3. From congestion point to congestion type

The individual congestion points can be amalgamated into specified congestion types and categorised, based on the cause of congestion in the context of the road network.

The following types can be distinguished:

- Motorway network:
  - Reduction in number of lanes from 3 to 2 or from 2 to 1
  - Merging of two traffic flows
  - Unrestricted stretch
  - Incline or decline
  - Visual bottleneck
- Transition between motorway and trunk-road network
  - Motorway slip road (access)
  - Motorway exit
  - End of motorway (within towns/outside towns)
- Trunk-road network
  - Through roads in towns with a succession of junctions

Figure 4 Distribution of congestion points by congestion type



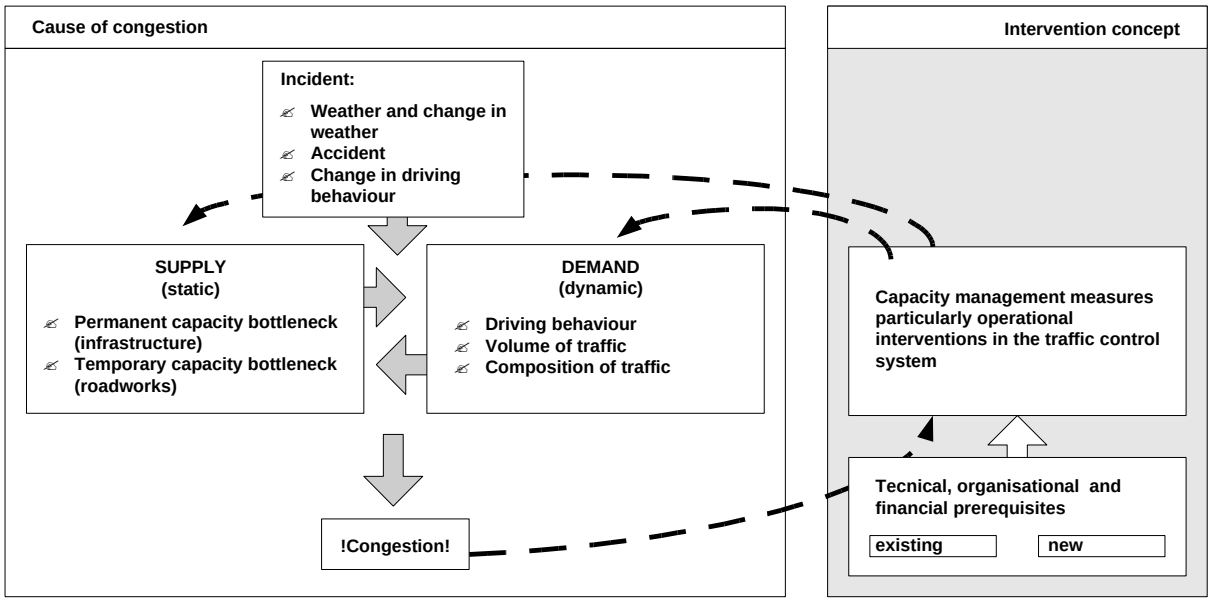
The congestion type labelled “exit from motorways with a succession of trunk-road junctions (S12)” is the one that occurs most frequently and clearly reflects the problems connected with areas of transition between motorways and trunk roads.

4. Measures

4.1 Range of measures indicated by KABEWISTRA

The range of measures for KABEWISTRA intervenes in the supply and demand system. (Cf. Figure 5).

Figure 5 Measures to influence the congestion situation



The range of measures comprises 3 distinct areas (cf. Figure 8 in Annex A):

- Operational and planning measures:
  e.g. Traffic information (local or regional), traffic routing, traffic control, traffic management, as well as strategic planning measures (VESIPO, UplaNS). These measures primarily affect the supply, although in individual cases they also affect demand.

- Structural measures affecting road infrastructure:
  Local modifications, such as extending the deceleration and acceleration lanes, increasing the size of the area available to absorb congestion at motorway exits by extending the number of lanes used for exiting traffic.

- Parallel measures to affect drivers' awareness and behaviour:
  Measures to change driving behaviour, measures to promote awareness of the effect of measures and measures to reduce demand.

Possible measures or packages of measures (combinations of individual measures) for the individual congestion points and types of congestion are being explored. It is important to take into account here the fact that measures concerned with promoting awareness and influencing behaviour have an effect on the entire network, whereas operational and planning measures or structural measures affecting road infrastructure mainly have a local effect, impacting on a particular congestion point. Particular consideration will be given in the evaluation to those measures that the cantons are already planning.

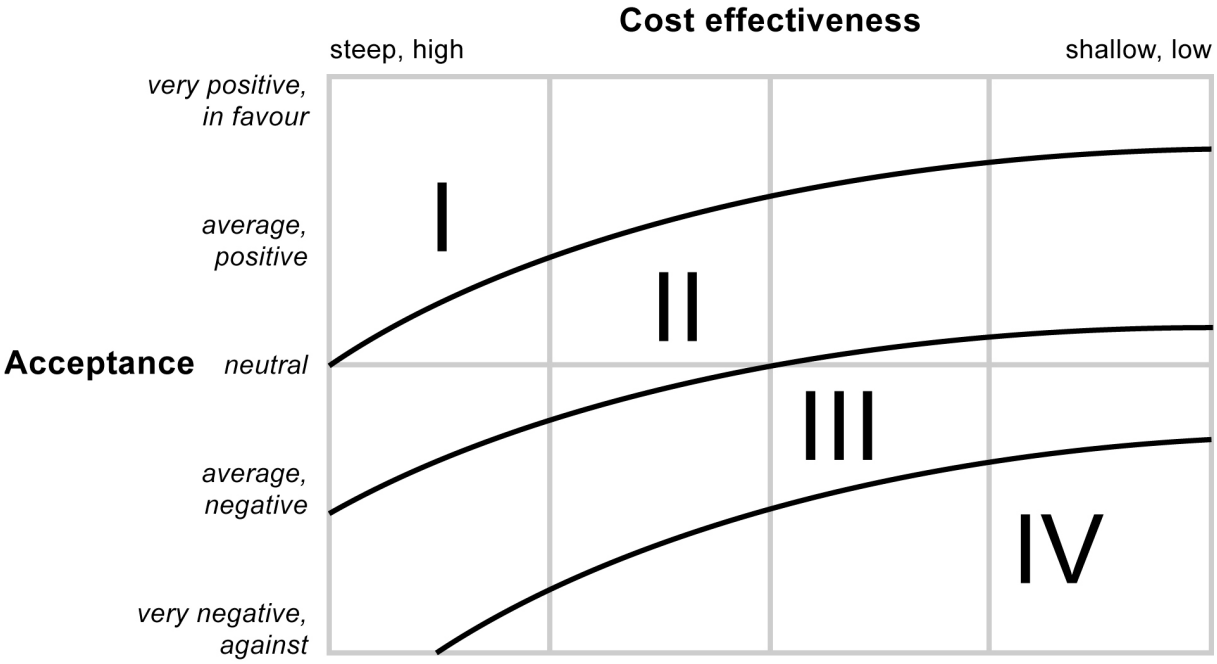
4.2 Evaluation of measures

The measures for the different congestion points will be reviewed in the light of their cost-benefit ratio, taking into account overall costs incurred annually. The benefit is achieved by reducing the number of congestion incidents as well as the duration and extent of the congestion, which corresponds to reducing pressure. The impact of the measures on safety is an additional benefit.

As well as the cost/benefit analysis, the social acceptance of the measures is also evaluated. For example, the introduction of enforcement measures is significantly more difficult to implement than lengthening a deceleration lane at a motorway exit.

Figure 6 shows that four groups of priorities relating to the implementation of measures can be established.

Figure 6 Prioritisation of (packages of) measures for dealing with individual congestion areas within an implementation programme.



The groups of priorities can be characterised as follows:

I Top implementation priority. Implement as quickly as possible.

II High implementation priority. Measures where negative acceptance is expected need to be accompanied by special public relations campaigns.

III Medium implementation priority. Implementation is advisable, in particular of measures that are highly cost effective, provided they are accompanied by intensive public relations campaigns.

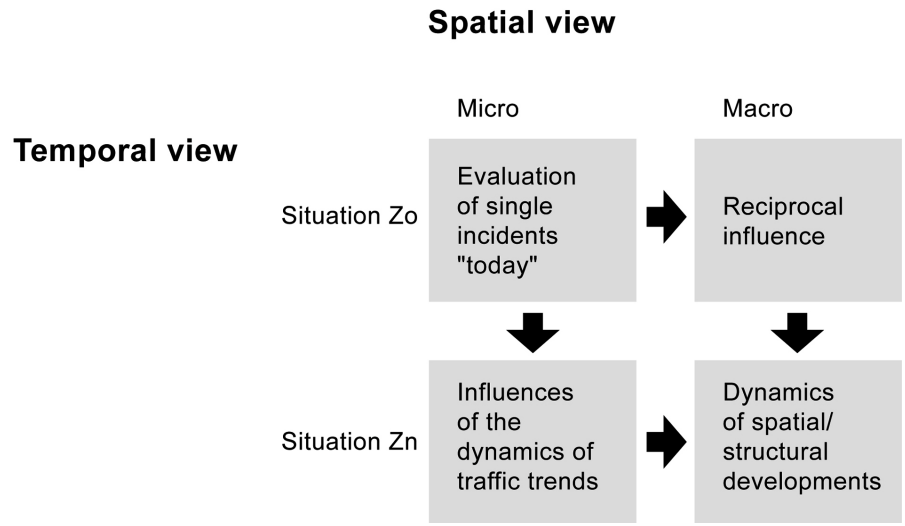
IV Low implementation priority. Implementation is questionable, or chances of success are few, even if a great deal of money is spent on public relations efforts.

5. Overall evaluation

It is crucial to move away from the isolated consideration of individual congestion areas at the present time, towards a macro-view that takes account of the interdependency of the 98 different congestion areas.

Similarly, the consideration of the present time must be extended to include the future situation Zn, taking into account the dynamics of traffic trends. Finally, the overall evaluation combines and appraises the spatial and temporal extent (cf. Figure 7).

Figure 7 Overall evaluation. Move away from the individual consideration of a single congestion area at the present time to a comprehensive evaluation of the state of the network as a whole in the future situation Z_n.



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Leistungsfähigkeit, Verkehrsqualität, Belastbarkeit – Freie Strecken auf Autobahnen

VSS Vereinigung Schweizerischer Strassenfachleute/Schweizer Norm SN 640 019:

Appendix A: Detailed range of measures for KABEWISTRA

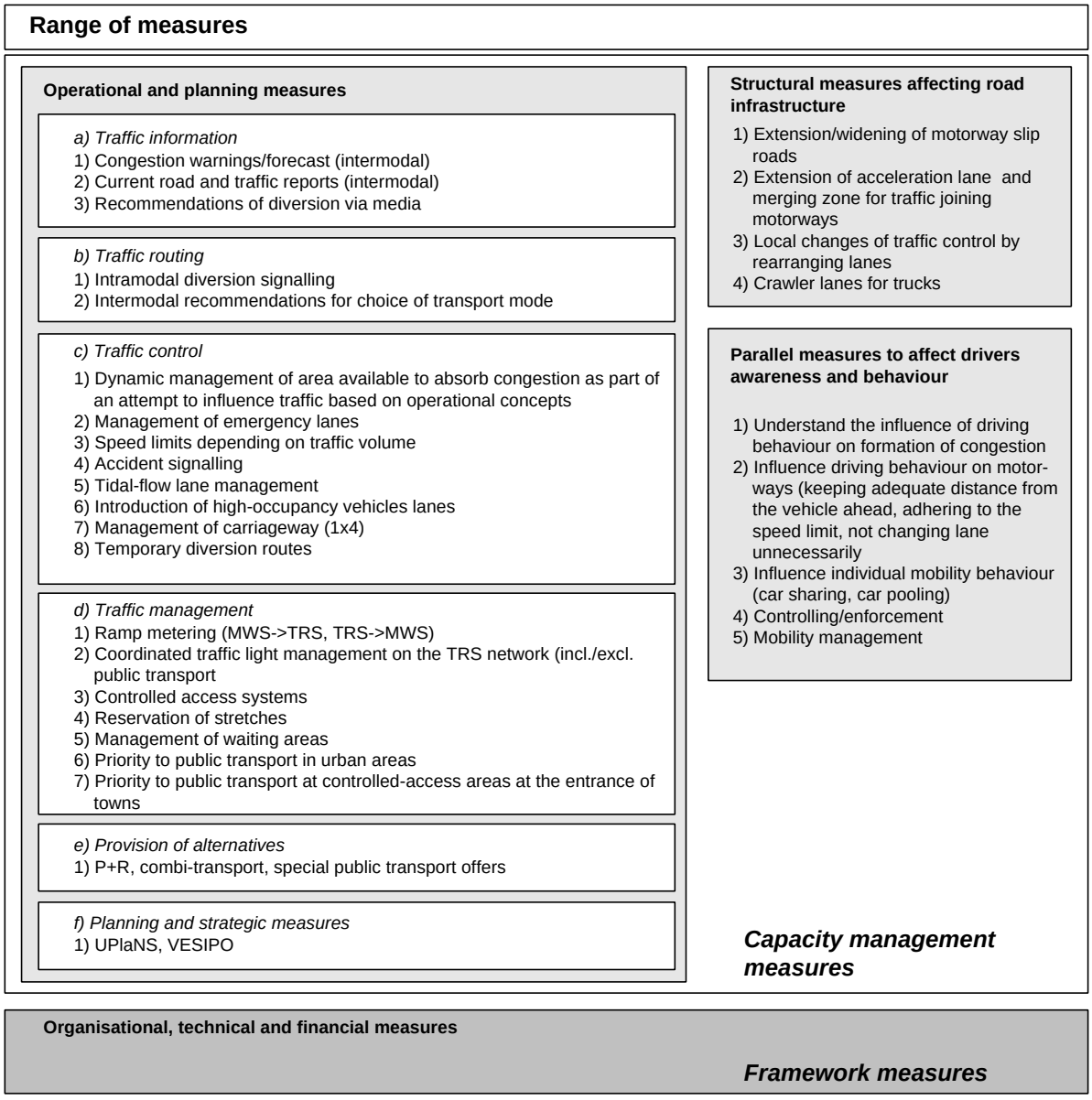

Figure 8 Range of measures within KABEWISTRA