



Determining quantitative road safety targets by applying statistical prediction techniques and a multi-stage adjustment procedure

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ABSTRACT

Due to substantial progress made in road safety in the last ten years, the European Union (EU) renewed the ambitious agreement of halving the number of persons killed on the roads within the next decade. In this paper we develop a method that aims at finding an optimal target for each nation, in terms of being as achievable as possible, and with the cumulative EU target being reached. Targets as an important component in road safety policy are given as reduction rate or as absolute number of road traffic deaths. Determination of these quantitative road safety targets (QRST) is done by a top-down approach, formalized in a multi-stage adjustment procedure. Different QRST are derived under consideration of recent research. The paper presents a method to break the national target further down to regional targets in case of the German Federal States. Generalized linear models are fitted to data in the period 1991–2010. Our model selection procedure chooses various models for the EU and solely log-linear models for the German Federal States. If the proposed targets for the EU Member States are attained, the sum of fatalities should not exceed the total value of 15,465 per year by 2020. Both, the mean level and the range of mortality rates within the EU could be lowered from 28–113 in 2010 to 17–41 per million inhabitants in 2020. This study provides an alternative to the determination of safety targets by political commitments only, taking the history of road fatalities trends and population into consideration.

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1. Introduction

1.1. Road safety today

Road accidents remain one of the leading causes of death worldwide. The World Health Organization (WHO) predicted that road traffic injuries will become the 5th leading cause of death in 2030, compared to 9th position in 2004, if policies stay unchanged. Approximately 1.2 million people are killed as a consequence of road traffic accidents annually (WHO, 2004).

According to ETSC (2011), the number of deaths caused by road traffic collisions in the EU in 2010 was nearly 31,000 within a population of about 500 million people.

The main reduction target proposed in the Transportation White Paper in 2001 (EC, 2001) and set by the European Union was halving road traffic deaths by 2010 compared with 2001. This was agreed on in the 3rd Road Safety Action Program (RSAP) in EC (2003).

Since the total number of people killed in road accidents in 2001 was 54,000, the 50% reduction target appeared to be too ambitious: despite of the fact that the number of road accident victims has significantly decreased, achieving the maximum permitted limit of 27,000 deaths in 2010 was too optimistic.

A few more years would be necessary to accomplish that objective, bearing in mind that 10 new EU Member States joined in 2004 and 2 more in 2007 in the process of eastern enlargement. These states need some time to become integrated into existing routines of the EU. In addition, many of them have different infrastructures and road user perceptions, that also determine different approaches to the solution of road accident problems, particularly those discussed in Elvik (2010).

The main target of halving the road traffic deaths to less than 15,500 within the next ten years, beginning from the end of 2010, was proposed by the new white paper in EC (2011). To reduce the disparities between countries, the EU Commission also proposes to establish specific national objectives, like not exceeding a given number of road deaths per million inhabitants (EC, 2010). Currently, the United Nations decided to enroll a global plan for a *Decade of Action for Road Safety*, encouraging also middle and low income countries in setting quantitative targets (UN, 2010).

Studies have shown that setting individual quantitative road safety targets (QRST) for countries and counties can be an effective strategy, see Elvik (1993), Wong et al. (2006) and Allsop et al.

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Table 1
Quantitative road safety targets set by EU Member States.

State ^a	Reference year	Target year	Reduction (%)	Ave. annual rate in %
CZ	2002	2010	–50	–8.3
DK	1998	2012	–40	–3.6
DK	2005	2012	–40	NA
DE	2010	2020	–40	–5.0
EE	2002	2015	–55	–6.0
EE	2003	2015	–55	–6.4
IE	1997	2002	–20	–4.4
EL	2000	2005	–20	–4.4
EL	2000	2010	–50	NA
EL	2000	2015	–40	–3.3
ES	2003	2008	–20	NA
FR	1997	2002	–50	–13.0
IT	1998–2000	2010	–40	NA
NL	1998	2010	–30	–2.9
NL	2003	2010	–17	–2.6
AT	1998–2000	2010	–50	NA
PL	1997–1999	2010	–43	NA
PL	2000	2010	–36	–4.4
PT	2000	2010	–50	–6.7
RO	2002	2008	–20	NA
FI	2000	2010	–37	–4.5
FI	2000	2025	–75	–5.4
SI	1995	2005	–50	–6.7
SE	1996	2007	–50	–6.1
SE	2006–2008	2020	–50	NA
UK	1994–1998	2010	–40	NA

^a Abbreviations are explained in Tables A.1 and A.2.

(2011). Now our study suggests one way of obtaining realistic and challenging QRST in terms of the absolute number of road traffic deaths.

Obviously, improving the situation in the EU is possible as long as all Member States make corresponding substantial contributions on the path to the collective objective of cutting traffic road fatalities by half. These may include new safety measures like speed limits, seatbelt law modifications, stiffening penalties for drunk driving, construction of safer roads, producing safer vehicles etc., depending on which measures are the most helpful and essential ones for the country under consideration. The impact of a wide range of road safety measures was analyzed, for instance, in Lassarre (2001), Elvik (2008), Hermans et al. (2009) and Chapelon and Lassarre (2010), for some European States.

Table 1 illustrates the current target setting situation based on individual analyses and political decisions of Member States. Self assigned quantitative road safety targets and forecasts were developed by an increasing number of Member States in the past decades as were found in the literature in Mikulik (2004), OECD/ITF (2008), Vägverket (2009) and BMVBS (2011). It can be summarized that timescale, reference year, target year and absolute reduction are varying among states. A wide spread of average annual reduction rates between 3.3% and 13% is showing the level of ambition and challenge.

1.2. Road fatalities in the last decade within EU and Germany

A final outcome target of 50% overall reduction was set. The road death numbers significantly differ throughout the EU Member States. Table 2 shows that in our considered timescale between 2000 and 2010, leading positions in fatality reduction were held by Latvia, Estonia, Portugal, Spain, Slovenia, Lithuania and France. These States probably achieve more than 50% reduction in the number of road deaths. Germany, Ireland, Italy and Slovenia were close to this leading group. Bulgaria and Romania tail the list behind Malta, which is considered as a special case because of its small population size. Constant declining trends were observed for EU-27, Austria, Germany, Spain and Portugal. In a detailed review Bosetti

et al. (2010) suggests that the 3rd RSAP had positive impact on EU road safety.

No QRST were set at national level in Germany. Though some German Federal States, i.e. North Rhine-Westphalia set their own QRST of –50% fatalities between 2005 and 2015 (MBV, 2006). By making accomplishments regarding road safety, a 51% reduction of road traffic deaths was achieved on national level in the past decade. It should be emphasized that a remarkable development in all six new Federal States was obtained (Table 3). The Federal States of Brandenburg, Berlin, Thuringia, Mecklenburg-West Pomerania, Saxony and Saxony-Anhalt made good progress in reducing their road mortality. Only Bavaria, Hesse and Schleswig-Holstein were also able to achieve this. Constant declining trends could be observed in two federal states, namely Brandenburg and North Rhine-Westphalia.

1.3. A two-stage adjustment procedure

Our aim is to propose a two-stage adjustment procedure as a top-down target setting approach for obtaining reasonable QRST values for the EU Member States on the NUTS0 level of territorial aggregation (Nomenclature of Territorial Units for Statistics) which are required to accumulate to (at most) the specified EU-wide target value of road traffic deaths for 2020. Following principles of subsidiarity, the approach allows the break down of determined QRST on NUTS0 level as a base for national target setting. A possible application of the procedure on the aggregation of NUTS1 sub level targets will be discussed later on.

A QRST is given in one of the following three equivalent forms, depending on what is most convenient: the actual QRST is the absolute number of road traffic deaths that are not to be exceeded. The reduction factor is the QRST relative to the current number of deaths in a state, i.e. the proportion to which the current number has to be reduced. Alternatively, the reduction rate (1 minus reduction factor) is the proportion by which the current number has to be reduced.

Without any additional information about the states there is only one reasonable QRST: the reduction rate/factor must be the

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