

**Summary:**

# **Major accidents in transport: frequency, long-term trends and preventability**

This report presents estimates of the expected long-term frequency of major accidents in transport in Norway. It has been prepared as part of the RISIT research programme of the Research Council of Norway (RISIT = Risk and safety in transport).

## **Historical data for Norway 1970-2001**

Data have been collected on the occurrence of major accidents in transport in Norway from 1970 to 2001 (32 years). Major accidents are defined as accidents in which at least five people are killed. There were 63 major accidents in transport in Norway between 1970 and 2001, giving an annual frequency of close to 2 per year. The largest number of major accidents occurred in maritime transport (25), followed by aviation (21), road transport (13) and rail transport (4).

By examining the distribution of major accidents by year for each transport mode, it can be determined that the accidents occur completely at random. There is no evidence that major accidents were more likely to occur in any specific year during the period 1970-2001 than in other years, nor can any long-term trend in the frequency of major accidents be discerned. Furthermore, there is no evidence that the mean number of victims per accident has changed over time. It should be recognised, however, that the Norwegian historical data are too sparse to serve as the basis for any advanced statistical analyses.

## **European experience 1991-2003 and British experience 1967-2003**

To provide a better basis for estimating the long term frequency of major accidents in transport in Norway than that provided by Norwegian data alone, use was made of data found in other reports regarding major accidents in transport in Europe from 1991 to 2003 and in Great Britain between 1967 and 2003. Both the European and British data sets indicated that the number of major accidents is declining. Both data sets allowed the estimation of FN-curves for all modes of transport. An FN-curve is a curve fitted to a diagram that plots the frequency of accidents (denoted F) with at least N fatalities against the number of fatalities per accident (denoted N). These curves are usually plotted on logarithmic scales and

tend to slope downwards. The steeper the slope, the more rare are accidents with at least N fatalities.

The European and British data were combined with Norwegian data in order to estimate the long-term frequency of major accidents in transport in Norway.

## The long-term frequency of major accidents in Norway

Table S.1 shows the estimated long-term frequency of major accidents in Norway and the uncertainty of these estimates. Uncertainty was estimated by assuming that the occurrence of accidents follows the Poisson probability law, and that the expected long-term frequency will remain constant.

*Table S1: Estimated long-term frequency of major accidents in Norway and 95% confidence intervals for the estimates*

Fatalities/accident	Expected annual number of accidents with at least 5 fatalities – 95% confidence intervals in parentheses				
	Road	Air	Sea	Rail	All
5 or more	0.50 (0.29 – 0.86)	0.50 (0.33 – 0.76)	0.70 (0.48 – 1.03)	0.10 (0.04 – 0.26)	1.800 (1.408 – 2.303)
11 or more	0.05 (0.01 – 0.28)	0.20 (0.10 – 0.39)	0.15 (0.07 – 0.35)	0.05 (0.02 – 0.18)	0.450 (0.279 – 0.731)
21 or more	0.002 (0.000 – 0.184)	0.10 (0.04 – 0.26)	0.10 (0.02 – 0.56)	0.025 (0.006 – 0.139)	0.227 (0.106 – 0.494)
51 or more	0.000 (not defined)	0.05 (0.02 – 0.18)	0.05 (0.01 – 0.28)	0.005 (0.000 – 0.092)	0.105 (0.038 – 0.307)
101 or more	0.000 (not defined)	0.025 (0.006 – 0.139)	0.025 (0.006 – 0.139)	0.000 (not defined)	0.050 (0.015 – 0.181)

It can be seen that the estimates are highly uncertain, in particular with respect to the frequency of the largest accidents, involving more than 50 or more than 100 fatalities.

## The preventability of major accidents

The preventability of major accidents was assessed by reference to three sets of data or studies:

1. A study of four cases in Norway – two of which ended as major accidents, two of which did not end as major accidents.
2. A review of studies that have assessed the preventability of transport accidents.
3. An examination of long-term trends in safety in each transport mode.

Each year, there are many unwanted events in transport. Some of these unwanted events result in major accidents; other events go more or less unnoticed by the public, because they do not result in accidents. By applying a model of accident occurrence as a failure of safety barriers, four cases in Norway were analysed. It was concluded that the safety barriers were adequate to prevent major accidents in

two cases, insufficient in the other two cases. One can, however, easily imagine measures that would have made the safety barriers effective in the two major accidents, and thus most likely have prevented these.

Studies that have surveyed measures to improve safety in various transport modes all conclude that a number of safety measures can be taken that may greatly improve safety. In general, it is reasonable to think that measures that make any accident less likely, or reduce its harmful impacts, will also reduce the likelihood of major accidents.

In Norway, a long-term trend towards fewer accidents can be detected in all transport modes. This trend cannot be very precisely estimated in aviation and maritime transport; in both these modes of transport major accidents make a major contribution to the total number of accident fatalities. There are, however, no reasons to believe that a favourable trend applying to accidents in general should not apply to major accidents as well.

## **Targets and priority setting for the prevention of major accidents**

An analysis is made to determine whether a policy objective of preventing major accidents can be rationally pursued along with other objectives for improving safety, and whether assigning a higher priority to the prevention of major accidents than to the prevention of smaller accidents can be rationally justified.

Objectives for a policy designed to improve transport safety may include (but not necessarily be limited to):

1. Seeking the maximum reduction of the total number of fatalities,
2. Trying to reduce disparities in fatality risk,
3. Preventing disasters (accidents with multiple fatalities)

In principle, these objectives can be traded off against each other by means of multiattributive utility analysis.

Demand for the prevention of major accidents is always strong in the wake of a disaster. Major accidents are widely interpreted as signs of a drastic deterioration of safety. Such an interpretation is generally not justified, and the panics following major accidents reflect a lack of rational risk assessment in the public. There does not seem to be any ethically defensible basis for giving higher priority to measures designed to prevent major accidents than to measures designed to prevent an equivalent number of fatalities in minor accidents.