



How to measure Travel Time Reliability?

- **Unreliability of travel time** can be **measured** with the standard deviation of **observed** travel times on the Trunk Road Network in the Netherlands
- This unreliability includes recurrent **and non-recurrent** congestion

Definition of “unreliability of travel time”:

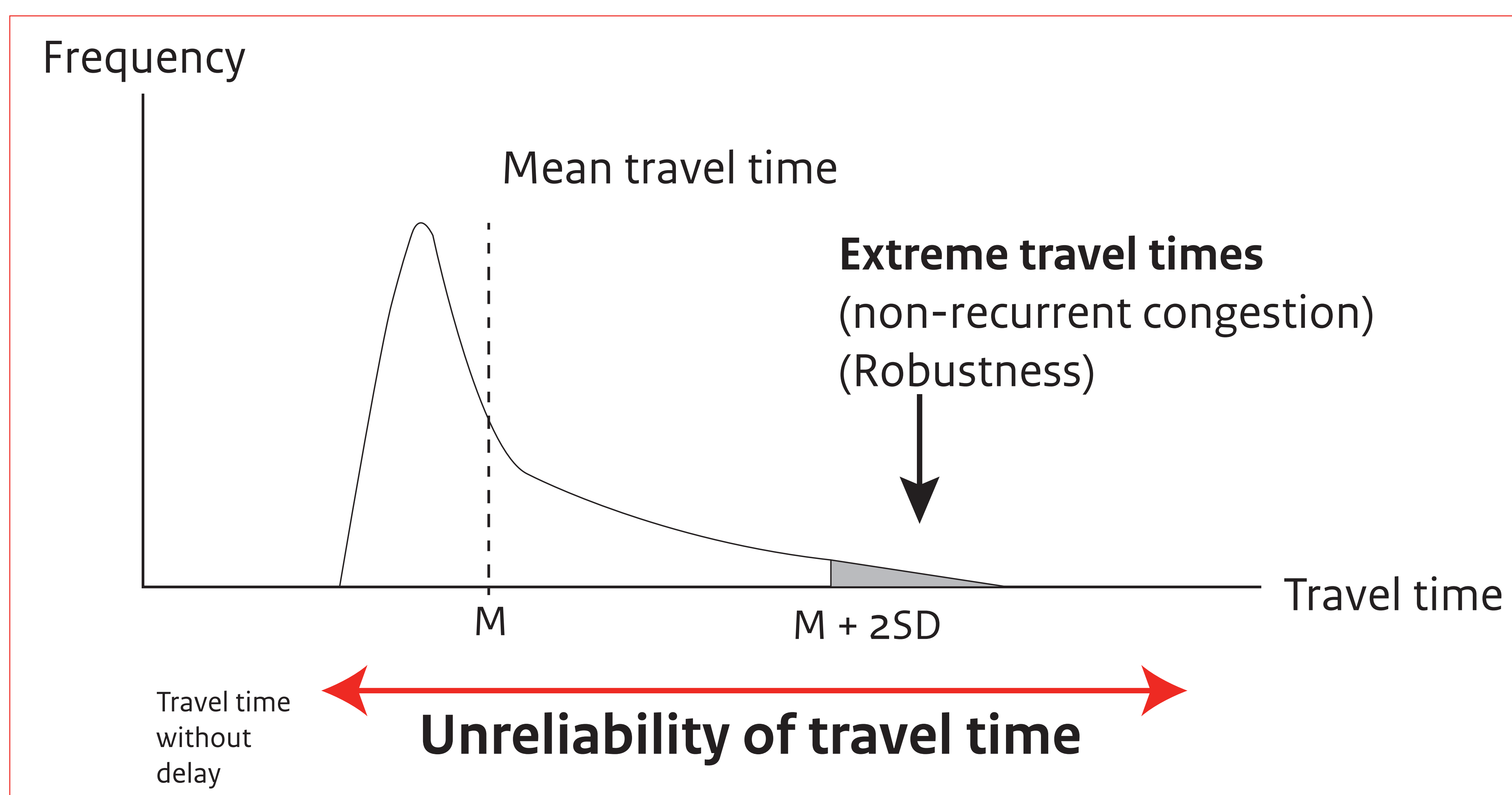
“amount of travel time longer or shorter than user expects”
(OECD, 2010)
(recurrent and non-recurrent congestion)

Why?

- SD represents total variation in travel times
- expectation user: unknown
- to identify impacts of policy measures, local variations of travel time have to be known
- not a composite measure (such as Buffer-index)

Measurement:

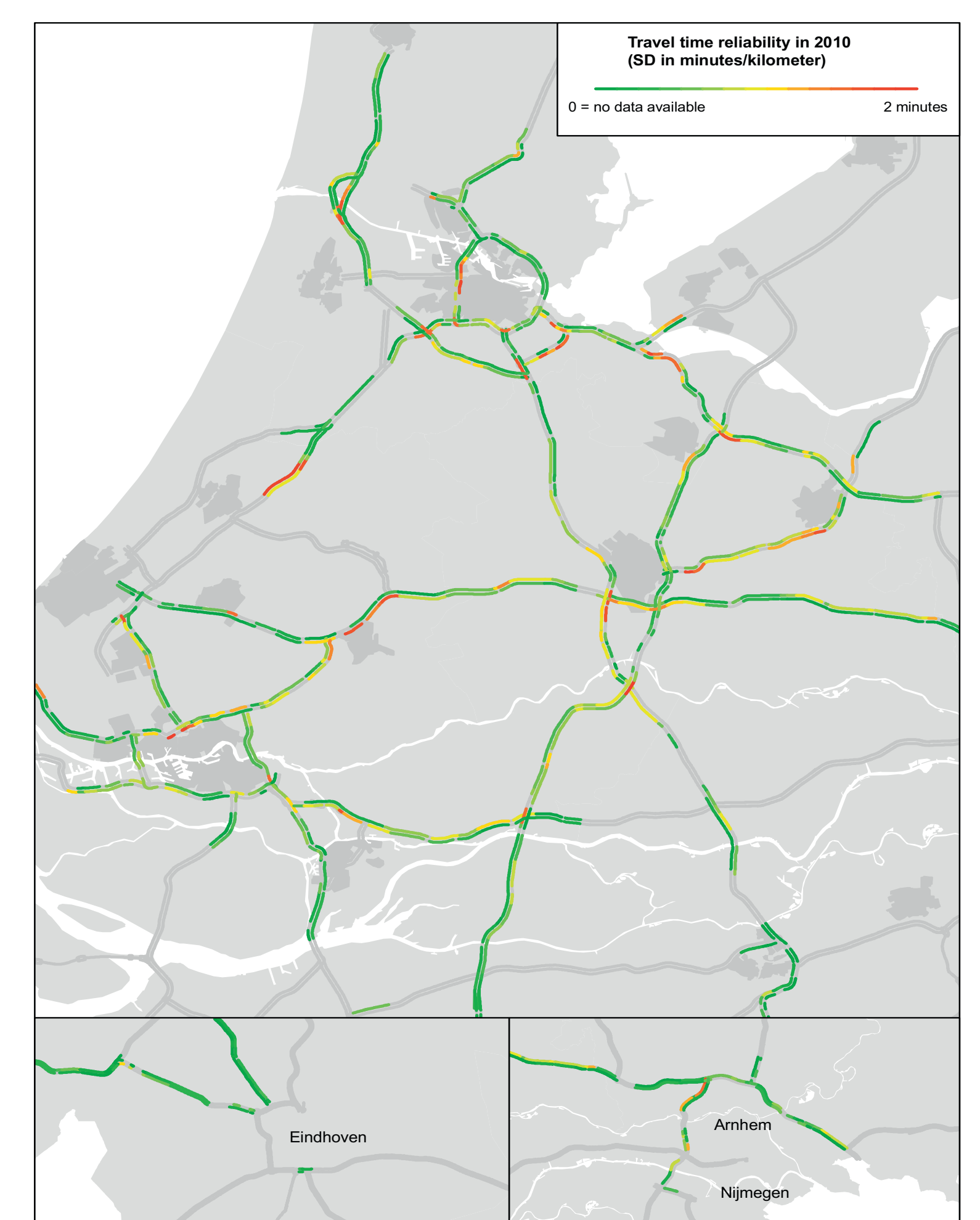
- actual variations in travel times at 1500-3200 stretches of the network
- Standard Deviation (SD) between working days of the month per quarter of an hour per stretch



Extreme travel times (non-recurrent delays):

“vehicle hours lost above 2 standard deviations above the mean
($> M + 2 * SD$)”

Travel Time Reliability on the Main Trunk Network in the Netherlands in 2010 (in terms of Standard Deviation per kilometre)



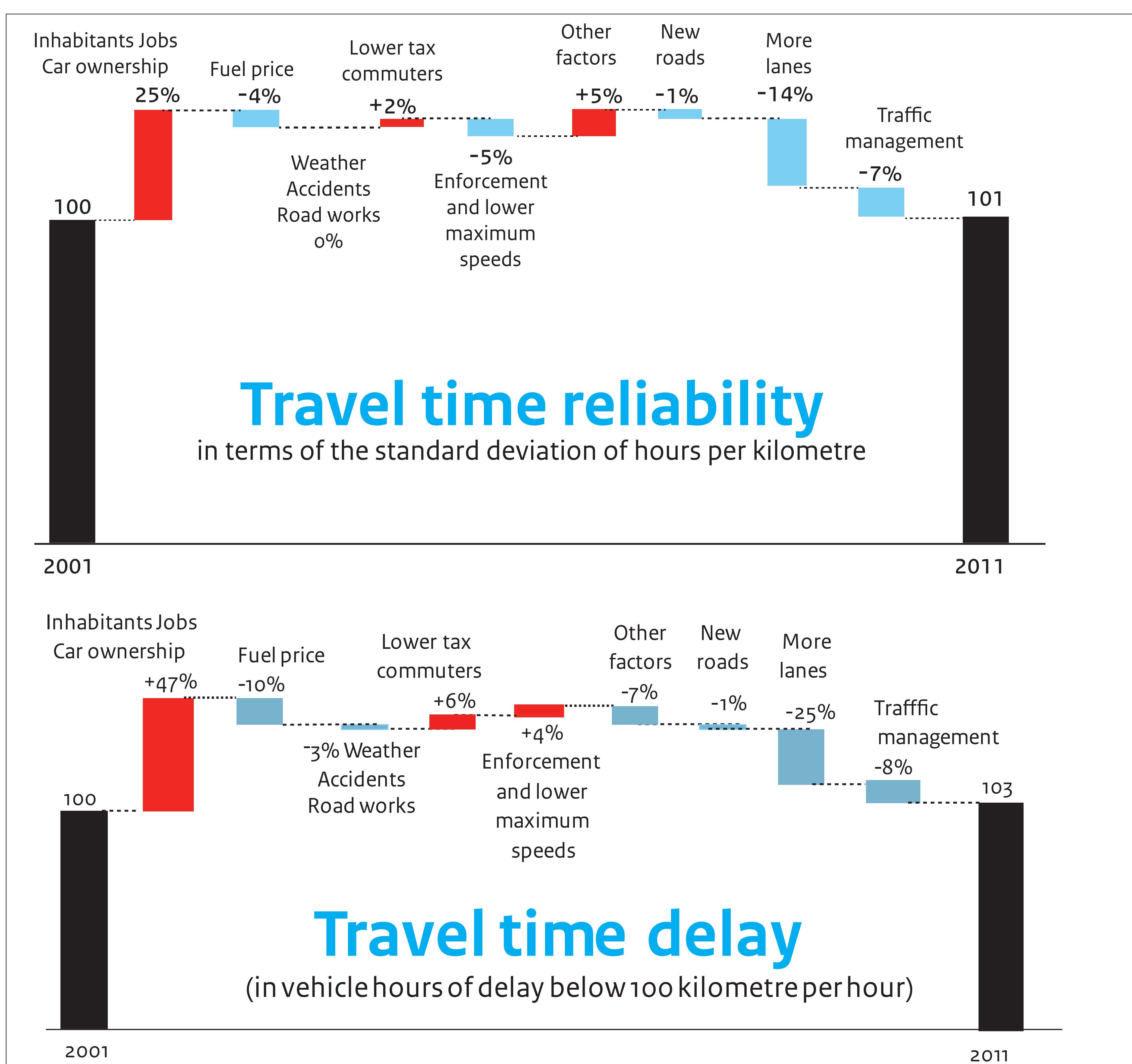
Overview of Indicators of Travel Time Unreliability

Indicator	Definition
Standard deviation	The deviation of the real travel time from the mean travel time
Buffer index	The percentage extra travel time a traveller should leave earlier than on average, to still arrive on time in 95% in the cases $((TT_{95}-M)/M)$
Planning time index	The total travel time that should be planned when an adequate buffer is included $(TT_{95}/\text{free flow travel time})$.
Extremely long travel time losses	The amount of travel time exceeding 2 standard deviations above the mean travel time on sections (for describing analyses) and 3 standard deviations on stretches of the network (for explaining analyses).
Probability of extremely long travel time	The probability that the travel time exceeds a certain level. E.g. the percentage of journeys with a mean speed below 55 km/hour.



Explanation of the trend in reliability

- The **trend of reliability** on the Trunk Road Network in the Netherlands can **empirically be explained** by social factors and policy measures
- The **trend of travel time delay** can empirically be explained by social factors and policy measures



Data:

intensities and speeds of vehicles every 15 minutes on 1500-3200 stretches of the network 2000-2011, population, jobs, car ownership, fuel prices, incidents, road works, weather conditions, policy measures

Method:

- pretest and posttest design to identify the impacts of policy measures and other factors on affected sections of the network using the other periods and network sections serving as a control group
- coefficients estimated by regression analysis (87% of 1500 variables are significant; fit equals 0.5)
- computations of changes relative to the base year



Economic Evaluation of Reliability

- **The benefits for users of improved reliability by adding lanes can be measured empirically** and compared with the benefits of travel time reduction
- **The costs of unreliability for users can be measured empirically:** multiply the value of reliability by the volume of unreliability

Benefits by adding lanes

	value of reliability		Volume of unreliability		Unreliability of travel time	
by improved reliability						
<i>for users in 2011 by lanes added 2000-2011</i>						
Passenger traffic	€ 5.87	x	4.300.000 hour	=	€ 26 mln	
Freight traffic	€ 15.73	x	800.000 hour	=	€12 mln	
Total					€ 38 mln	
by improved travel time						
<i>for users in 2011 by lanes added 2000-2011</i>						
passenger traffic	€ 9.19	x	11.400.000 hour	=	€ 105 mln	
Freight traffic	€ 43.11	x	1.700.000 hour	=	€ 73 mln	
Total					€ 178 mln	
Theory: Ratio benefits reliability/travel time						25%
(current practice according to professional guess)						
Evidence 2011: Ratio benefits reliability/travel time						21%
(according to empirical analyses Trunk Road Network 2000-2011)						

Costs by unreliability on Trunk Road Network in 2011

Costs for users of Trunk Road Network because of congestion in the Netherlands in 2011	value of reability		Volume of unreliability		Unreliability of travel time
Passenger traffic	€ 5.87	x	56 million hour	=	€328 mln
Freight traffic	€ 15.73	x	6,7 million hour	=	€ 105
Total					€ 433 mln

Authors of the paper for TRB 93rd Annual meeting, Washington, January 13, 2014:

Han van der Loop, KiM Netherlands Institute for Transport Policy Analysis, Ministry of Infrastructure and the Environment
 Jan Perdok, MuConsult
 Jasper Willigers, Significance