Economic Evaluation of Trends in Travel Time Reliability in Road Transport

Analysis of Traffic Data in the Netherlands from 2001 to 2011

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This study aimed to demonstrate that travel time reliability and road network robustness from the user's perspective could be measured with the use of detailed traffic data and according to a definition proposed by international experts. These measurements can be used to describe and explain the trend of travel time reliability and to describe the trend of extreme travel time delays (or nonrecurrent congestion). In the Netherlands, the trend of travel time unreliability increased until 2008 but was followed by a decline in subsequent years until 2011. Socioeconomic factors, such as population growth and employment, appeared to be the underlying factors for the increase in travel time unreliability. Serving as a counterbalance were various transport policy measures, such as the addition of lanes, traffic management, and speed limitation and control, which were implemented primarily during the years 2009 to 2012. Finally, the study demonstrated how the volume of travel time reliability could be used as a component for the cost–benefit analyses of adding infrastructure and for calculating the social costs of travel time unreliability for users of the main trunk road network.

This paper presents the results of an empirical study of the trend in travel time reliability on the Dutch main trunk road network between 2001 and 2011. The paper first addresses the definition and measurement of travel time reliability on the trunk road network in the Netherlands from the user's perspective. The (average) travel time and the reliability of travel time are different concepts, each with its own distinct meaning for road users. In addition to the total amount of travel time reliability, the extremely long travel times for users that result from the network's lack of robustness are considered and measured.

Considering the definition and measurement of travel time reliability, the trend from 2001 to 2011 is explained, as based on elaborate empirical, statistical analysis of contributing factors derived from historical data and records. For that purpose, data were used that pertain to traffic volumes and speeds, accidents, weather, roadwork, population, jobs, car ownership, fuel prices, and policy measures. The explanations for the trend in travel time reliability were then compared with that of time loss as a result of traffic jams and delays. Also, the impact on induced traffic is presented. The results provide important information for ex post and ex ante studies.

The effect of policy measures on the volume of travel time reliability is—together with the value of reliability—an important component in cost–benefit analyses. This study allows one to quantify the effects that policy measures have on the volume of travel time reliability. The value of reliability was previously identified in a parallel study conducted by the KiM Netherlands Institute for Transport Policy Analysis (*1*). By combining volumes and values, one can economically evaluate the social benefits of adding infrastructure.

A more elaborate report of this study is available in Dutch (*2*).

DEFINITION OF RELIABILITY AND ROBUSTNESS

The concept of travel time reliability and robustness, as well as the indicators used, are considered from the road network user's perspective. Although this subject was previously approached in various travel behavior studies, numerous researchers have explored this concept more fully in recent years (*3–6*). In the United States, for example, the current SHRP 2 comprises a number of such studies.

The scheduling approach, which assumes travelers behave according to preferred arrival or departure times, is one approach for estimating the value of travel time reliability (*7, 8*). Research by Fosgerau and Engelson suggests that the standard deviation of random travel time can be used as a measure of travel time variability (9). In 2010, the Organisation for Economic Co-operation and Development published a report describing how travel time reliability is understood and defined for road transport (*10*). The starting point for this study was the conceptual definition of unreliability as the amount of travel time that is longer or shorter than the user expects (*10*). This definition includes the structural daily variations in travel time, as well as incidental or nonrecurrent long and short delays. To improve reliability, several policy measures can be considered, including expanding network capacity, providing better capacity management, charging for reliability, and providing information about expected travel times. Reliability has become a focal point of transport policy in the Netherlands (*11*). Table 1 provides a summary of the definitions of the indicators explored and considered in the Organisation for Economic Co-operation and Development study and calculated in this study. Some of these indicators focus specifically on the effects of nonrecurring congestion, that is, travel time losses in extreme cases. Other indicators do not have this specific focus, but rather aim to include all sources of travel time variability.

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TABLE 1 Definitions of Indicators of Travel Time Unreliability

Indicator	Definition
All Sources of Unreliability	
Standard deviation	The deviation of the real travel time from the mean travel time.
Buffer index	The delay the traveler calculates in the journey plan. The difference between the 95th percentile of travel time and the mean travel time in relation to the mean travel time [(TT95-M)/M].
80th, 90th, or 95th percentile planning time index	The time required to arrive in time with a probability of 80%, 90%, or 95%. The planning time index is an example of this indicator: the 95th percentile travel time divided by the free-flow travel time.
Nonrecurring Congestion	
Extremely long travel time losses	The amount of travel time exceeding two standard deviations above the mean travel time on sections (for describing analyses) and three 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. For example, the percentage of journeys with a mean speed below 55 km/h. This indicates the probability of a lack of robustness of the road network (probability of failure).

For ex post and ex ante policy evaluations, the travel time the user expects to experience is unknown and difficult to assess. Moreover, as a result of changing circumstances and the multiple stages involved in planning trips, users' expectations will change even when a single trip is being planned. Because there is insufficient information available on the users' expectations, the measurements in this study were based on the actual variations in travel times as measured by using the traffic data available for the Netherlands' trunk road network. These data provide information about the travel times and travel time variations that users are objectively confronted with. In this approach, the average travel time is considered to be the expected travel time. These averages are calculated separately for different road sections, time of day, and months of the year, to take into account the important aspects that travelers are assumed to consider as part of their travel time expectations.

Standard Deviation Approach to Travel Time Reliability

The standard deviation (SD) of travel time was chosen as the indicator to identify the amount of travel time reliability (Figure 1), as this is the only indicator that represents the total variation in users' travel times. This indicator includes incidental long and short delays, as well as structural daily variations. The SD is sensitive to extreme values (outliers), but this sensitivity is assumed to also apply to the user. To measure travel time reliability (read: unreliability or variability), data from 2001 to 2011 were used for all 96 (15-min) periods during working days, ranging from approximately 1,500 points on the trunk road network in 2001 to 3,200 points in 2011. To identify the effects caused by introducing policy measures at certain dates between 2001 and 2011, the SD of travel time was calculated each month in minutes per road section, and per quarter of the day on working days, weighted by the amount of traffic (vehicle kilometers). Statistically, during the course of a year the total travel time variance on the network consists of three sources: variance between days in the month, variance between quarters of the day, and variance between road sections. The largest variance (about 70%) (see Figure 2) was seemingly between days, in minutes per kilometer. It is assumed that this source of variance is the best approximation for unreliability as experienced by the (informed) traveler, because the traveler will be most familiar with the day-to-day variations in travel times on certain road sections (e.g., most commuters travel the same road sections at approximately the same times each day). This approach includes weekly patterns: for example, there is typically less congestion on Wednesdays and Fridays. However, attempts to correct

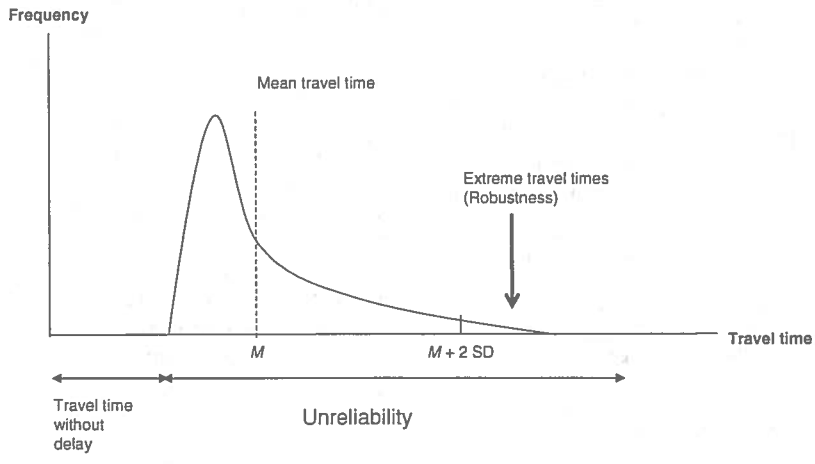

FIGURE 1 Representation of unreliability of travel time and extreme travel times.

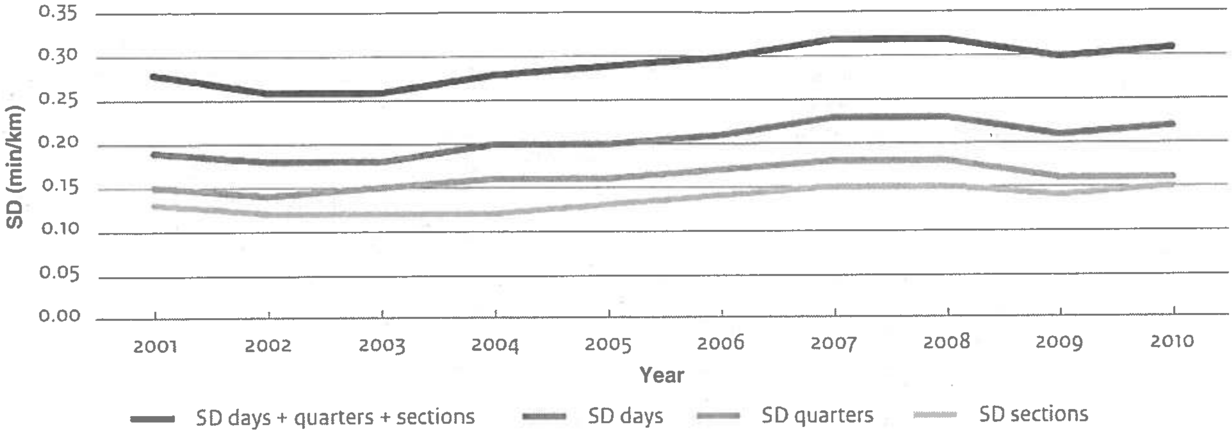

FIGURE 2 Trends in SD of driving times on main road network 2001 to 2010.

for the fact that there is less congestion on Wednesdays and Fridays did not result in significantly smaller SDs.

The buffer index and planning time index do not include all variances, such as long and short delays and daily variations. These indicators are also difficult to use for explanatory analyses with traffic data, given that they refer to the user's entire trip. Consequently, in explanatory analyses, policy measures, incidents, and other local factors cannot be related to these indicators by using traffic data. Moreover, a disadvantage of the buffer index is that the trend measured with this indicator not only changes when extreme travel times increase, but also when the mean travel time increases or decreases.

All of the other reliability indicators in Table 1 relate to situations with travel times that have low probabilities of occurring and relatively long delays. A certain share of travel time unreliability consists of extremely long time delays, which may have resulted not only from assignable incidents, such as accidents or certain weather conditions, but also from incidental high levels of traffic demand. In such instances, the road network appears to lack robustness. From the road user's perspective, robustness (and its opposite, vulnerability) is defined as the extent to which extreme travel time delays occur. The road user's perspective was chosen as the means of identifying the consequences that travel time unreliability has for society and for evaluating policy instruments aimed at reducing unreliability.

SD Approach of Extreme Travel Time

Analyses were conducted to explore the indicators of long time delays cited in Table 1. The aim was to find an indicator of long time delays (nonrecurrent congestion) that differentiates between unreliability as measured by the SD in daily travel time variations, and by extreme, nonrecurrent variations. The chosen indicator calculates road sections with lengths between 15 and 35 km (Figure 1). A first precondition to identifying extreme congestion cases is that travel times should exceed two SDs above the mean travel time. To prevent extreme travel times with relatively short travel times from being included in the extreme travel time indicator, a second precondition was then applied, stating that travel times should also exceed the mean travel time plus 0.5 min per kilometer. Cases in the data set that include both preconditions are considered "extreme," and the vehicle hours lost in these cases are used to measure the impact of the extremities. Vehicle hours lost are used to measure congestion in Dutch evaluation studies and include the number of vehicles involved and their additional travel times resulting from circumstances. In cases of extreme travel times, the sum of all vehicle hours is used as an indicator for the network's (lack of) robustness, which is a comprehensive indicator that is fairly easily perceived in evaluation studies.

The primary reason for choosing the SD-based indicator of extreme travel time is that this indicator matches the indicator for travel time reliability, which is also SD-based and seemingly meets the objective of differentiating between daily and extreme, nonrecurrent congestion. To test the indicators' practical use for monitoring trends, the trends for all indicators are presented and discussed elsewhere in this study.

EXPLANATORY ANALYSIS OF THE TREND OF RELIABILITY

A theoretical framework was developed and tested to explain travel time delays and travel time reliability on the network from 2001 to 2011. This resulting analytical framework (Figure 3) describes the influence of population, jobs, car ownership, economic growth, fuel prices, taxation changes, weather conditions, traffic accidents, roadwork, traffic flow and capacity, and policy measures pertaining to travel time delays and travel time reliability. Special attention was given to the impact of policy measures, the construction of additional lanes, new road links, speed reduction enforcement, and traffic management measures (dynamic route information systems and ramp metering).

In line with traffic flow theory and the fundamental diagram, it is assumed that variations in travel times on certain sections of the network are caused by variations in the volume of traffic in proportion to capacity (*12*). Socioeconomic factors, such as population and employment rates, influence the amount of traffic, while other factors, such as weather conditions and the addition of infrastructure, influence capacity and, to some extent, traffic volumes. To determine the contributions of each of these factors, regression analyses were conducted on data aggregated per stretch of road per month during the period 2001 to 2011.

The traffic data are based on permanent recordings of traffic volume and speed taken at approximately 1,500 to 3,200 stretches of the road network. Similarly, the Dutch Ministry of Infrastructure

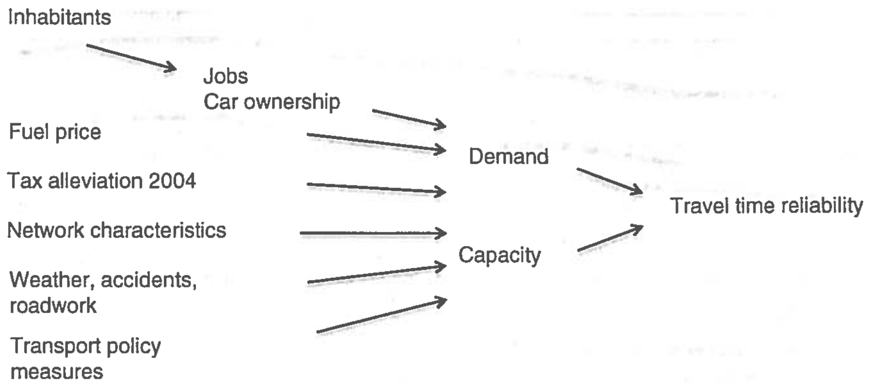

FIGURE 3 Theoretical model to explain the trend of travel time reliability on main road network from 2001 to 2011.

and the Environment recorded accidents, roadwork, and weather conditions. Statistics Netherlands provided additional data, such as population, job, and car ownership rates.

Regression analyses were calculated to explain the travel time delay and reliability trends from 2001 to 2011. The dependent variable was the per month and per road stretch variable, while the independent variables were traffic volumes, traffic capacity as a constant (maximum number of vehicles per section), weather characteristics, number of accidents, roadwork, and newly introduced policy measures, such as new roads, lane extensions, and traffic management (Equation 1). Regression coefficients were used to calculate the influence that independent factors had on the dependent variables in the regression model. The resulting model can be regarded as a pretest and posttest design for all policy measures of a certain type, with the network's other sections and periods serving as a control group (*13*). For example, the impact a lane extension had on travel time delay was identified by using dummy variables that indicated the change in time delay in the network, at road sections, at extensions 0 to 5 and 5 to 10 km upstream and downstream, and at crossing roads. No additional effects were found at road sections situated 10 to 20 km before and after road extensions. Another example, to determine the effects of road accidents, dummy variables were used to indicate the change in travel time delay during accidents and in their aftermath at road sections 0 to 5 and 5 to 10 km upstream, and 0 to 5 km downstream from accident locations.

$$Y_{ijk} = C + \beta_{pl}P_{il} + \gamma_s S_{il} + \delta_j Y_j + \phi_i M_i + \eta V_{ijk} + \varepsilon_{ijk} \qquad (1)$$

where

Y_{ijk} = hours of delay/SD of travel time (min) per month i, year j (between 2001 and 2011), and stretch k;
C = constant;
P_{il} = set of indicators P that defines whether policy measure p at location l is active ("1") or not ("0") in month i (indicating the difference before and after implementation of the measure);
S_{il} = set of indicators to define the situational characteristics per month i at stretches around the location l with accidents, capacity reductions by roadwork, weather conditions, and reciprocal of road capacity (as a constant);
Y_j = set of dummy variables for calendar year j;
M_i = set of dummy variables for calendar month i;
V_{ijk} = traffic volume and square of traffic volume per month i, year j, and stretch k;
$\beta, \delta, \phi, \gamma, \eta$ = partial regression coefficients indicating the impact of a factor on the monthly trend per stretch of the dependent variables; and
ε_{ijk} = error term.

Regression analyses produced coefficients for 1,337 variables (1,289 for the components described above of 318 policy measures), which is too much to present individually in this paper. Of these coefficients, 87% were statistically significant ($\alpha < .05$). In general, the fit (r squared) has an order of magnitude of 0.5.

The coefficients estimated for the policy measures (β_p) reflect the SD's number of minutes of reduction (or increase) and are aggregated across months and stretches of road. The obtained estimated values for accidents, roadwork, policy measures, and so forth, are expressed as percentages relative to the aggregated value of the indicator variable (travel time delay and travel time reliability), as observed in the base year.

A gravity model was used to analyze the impact that local external (E) trends in population, employment, and car ownership had on travel time delay and reliability. This analysis was conducted according to the distances between road stretches and municipalities per year. The calculations were done with the following model (Equation 2):

$$\ln Y_{jk} = \ln c_j + \beta_i \ln\left(\sum_{m=1}^{m}\left(\frac{E_{ijm}}{D_{km}^{-0.75}}\right)\right) + \varepsilon_{jk} \qquad (2)$$

where

Y_{jk} = hours of delay per SD of travel time (min) per year j and stretch k,
c_j = constant,
E_{ijm} = external factor i (E_i is population, number of jobs, and cars) per municipality m per year j,
β_i = elasticity of external factor i in vehicle hours of delay,
D_{km} = distance in kilometers between the center of gravity of stretch k and geometric center of municipality m, and
ε_{jk} = error term.

Models 1 and 2 are designed to incorporate all relevant social and traffic-related factors that determined travel time delay and reliability in the entire network from 2001 to 2011. The models have a larger level of aggregation than a traffic flow model. Spatial relationships are accounted for by defining the areas influenced by various measures and situational characteristics. Temporal correlations occurring in a month were avoided by using aggregations to a monthly level and by including temporal factors in the model.

To identify the impact of fuel price levels, price elasticities tested in several other studies were used (*14*). To identify the impact of the Dutch government's 2004 tax plan, which enabled commuters to profit from an abolition of taxes levied on reimbursements for commutes longer than 30 km, time series analyses were conducted of the annual amount of home-to-work car use for commutes longer than 30 km from 1985 to 2009 (Equation 3) and then compared with a forecast derived from the National Model System (*15*):

$$Y_j = C + \beta \mathrm{Inh}_j + \gamma \mathrm{Job}_j + \delta \mathrm{Car}_j + \varphi \mathrm{GDP}_j + \kappa T_j + \lambda D_j + \varepsilon_j \qquad (3)$$

where

Y_j = car use in kilometers in year j,
C = constant,
Inh_j = number of inhabitants per year j,
Job_j = number of jobs per year j,
Car_j = number of passenger cars per year j,
GDP_j = gross domestic product per year j,
T_j = linear trend per year j,
D_j = dummy variable (1985 to 2003 = 0; 2004 to 2009 = 1),
$\beta, \gamma, \delta, \phi, \kappa, \lambda$ = partial regression coefficients, and
ε_j = error term.

The statistical relationship between total car use (in km) and travel time delay and travel time reliability was used to determine the 2004 tax plan's effects on travel time delay and travel time reliability, respectively.

To validate the methods used, the analyses results were compared with evaluations of separate policy measures (*2, 16*) and with the results of the Netherlands National Transport Model (*17*). The results appeared to be consistent with these studies, as did the results over several years and periods (*2, 18*).

Adding capacity by adding lanes often induces additional traffic. The impact of adding lanes on traffic volume has been calculated with a model similar to the model formulated in Equation 1: traffic volumes are estimated as a function of external factors (population, number of jobs, and car ownership) and policy measures on the main trunk road network. Preparatory regression analyses indicated that adding external variables such as developments in GDP, age distribution, and situational characteristics did not result in better estimates of induced traffic. Therefore, the increase in traffic resulting from added capacity seems to be controlled for by external factors.

RESULTS

Trend of Reliability and Extreme Travel Times

From 2001 to 2011, the trends in travel time reliability for users of the main trunk road network and the hours of delay were equal, although after 2004 the SD's relative level was somewhat smaller (Figure 4). The in-vehicle hours of delay are the hours lost by driving slower than 100 km/h (regarded as a proxy of the mean free-flow speed). The trend in average travel time is more uniform.

According to the reliability and vulnerability (extreme values) indicators, the trend for SD and the buffer index are most sensitive to change. The SD-based extreme travel time indicator has a more uniform pattern of development than the SD indicator of reliability.

The amount and trend of travel time reliability differ during various times of day, especially during morning and afternoon peak hours (Figure 5). Spatial differences in travel time reliability are presented in Figure 6. The highest levels of unreliability are concentrated around and between the four largest cities (Amsterdam, Utrecht, Rotterdam, and The Hague). These differences in time and space of reliability correspond with those of travel time delay.

Explaining the Trend of Reliability

The analytical results pertaining to the impact that policy measures and other factors have on travel time reliability are summarized in Figure 7. This figure, for example, reveals that the addition of 694 km of new lanes to the total measured network of 3,182 km has resulted in a 1% increase in travel time unreliability. Similar analyses were conducted to explain the trend of travel time delays. These analyses reveal that demographic growth, employment, and car ownership are the underlying factors in the growth of unreliability and congestion and that policy measures were capable of serving as a counterbalance.

The increase of unreliability by variation of travel times in the Netherlands was reduced not only by a 14% increase in additional lanes, but also by a 7% increase in traffic management measures. Speed limit enforcement involving routine speed checks and the introduction of lower speed limits (from 100 km/h to 80 km/h) reduced unreliability by 5% but resulted in a 4% increase in travel time delays. Starting in 2004, reimbursements (of up to 19 eurocents per kilometer) for home-to-work commutes longer than 30 km were rendered tax free. A time series analysis demonstrated that following this taxation change, the number of kilometers for commutes longer than 30 km during the period 2004 to 2009 were significantly higher than during the preceding period of 1985 to 2003 ($p = .009$). Taken into account were changes in population, employment and car ownership rates, GDP, and a linear trend. For commutes of less than 30 km, no significant difference between the period 2004 to 2009 and preceding years was found. As a consequence of this tax alleviation, the increase in car kilometers and travel time delays from 2001 to 2011 was at approximately the same level as the ex ante evaluation conducted by the National Transport Model (+2% and +6%, respectively) (*15*).

Goodwin and Noland defined induced traffic as "all the traffic which would be present if an expansion of road capacity occurred, which would not be there without the expansion" and concluded a consensus estimate of "elasticities of vehicle miles of travel with respect to increases in lane miles of between 0.3 and 0.5 and perhaps somewhat higher in the long run" (*19*). The elasticity of vehicle miles on the trunk road network in the Netherlands in 2012 is calculated by dividing the total additional traffic volumes (expressed as a percentage, +4%) estimated at and near the locations with extended capacity by the total increase in lane miles (+9%) in the period 2000 to 2012. It is assumed that the resulting elasticity of 0.4 comprises all direct effects (such as on departure time, mode choice, and destination) on transport behavior (controlling for other factors such as population and jobs) and does not include effects on land use and economy. In addition to this it is noted that in the Netherlands induced traffic is also taken into account by the transport models (particularly the Netherlands National Transport Model, the National Model System, and a disaggregate transport model) that are used for forecasts for cost–benefit analyses of adding infrastructure.

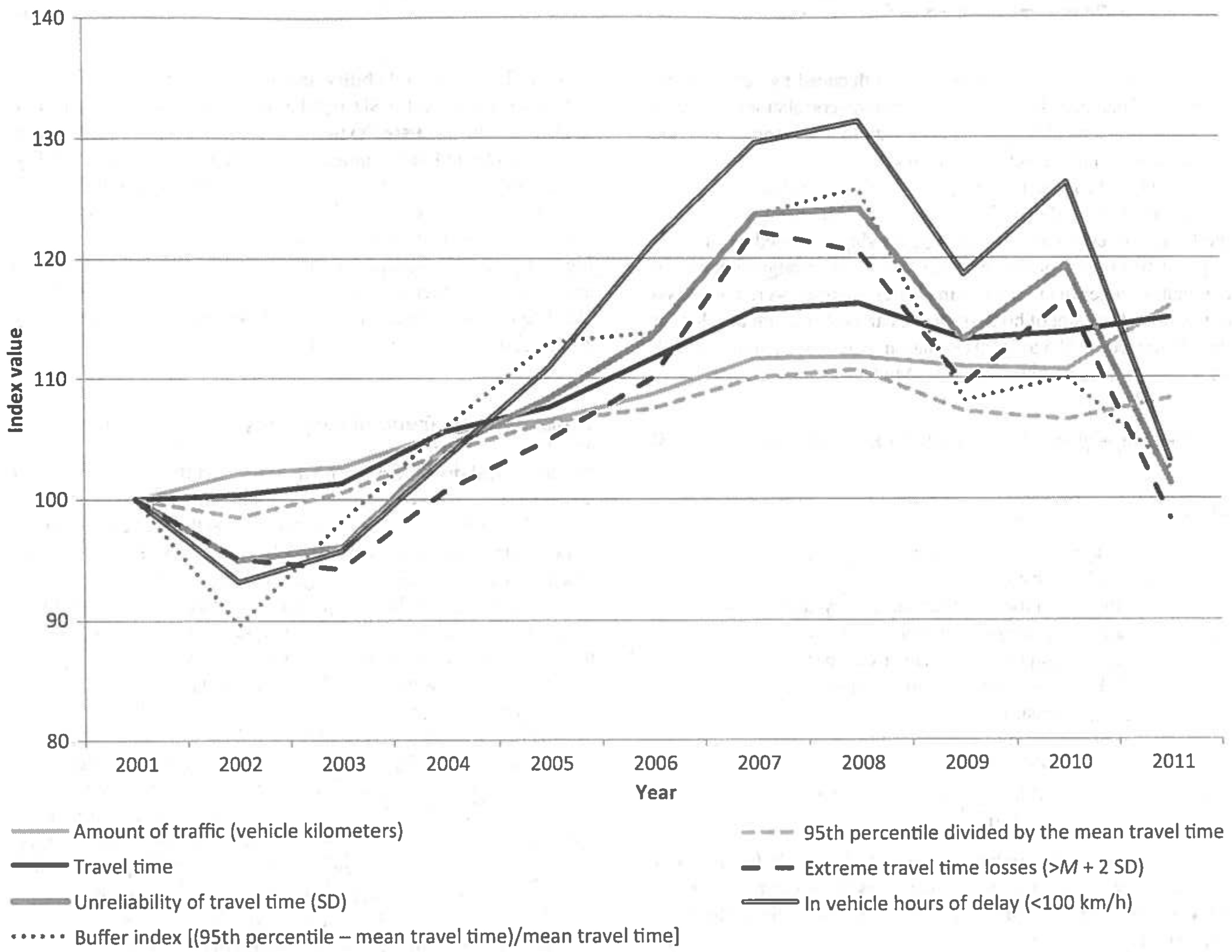

FIGURE 4 Trend (expressed as index of base year 2001) of indicators for travel time reliability, travel time delay, and travel time on trunk road network from 2001 to 2011 (2001 = 100).

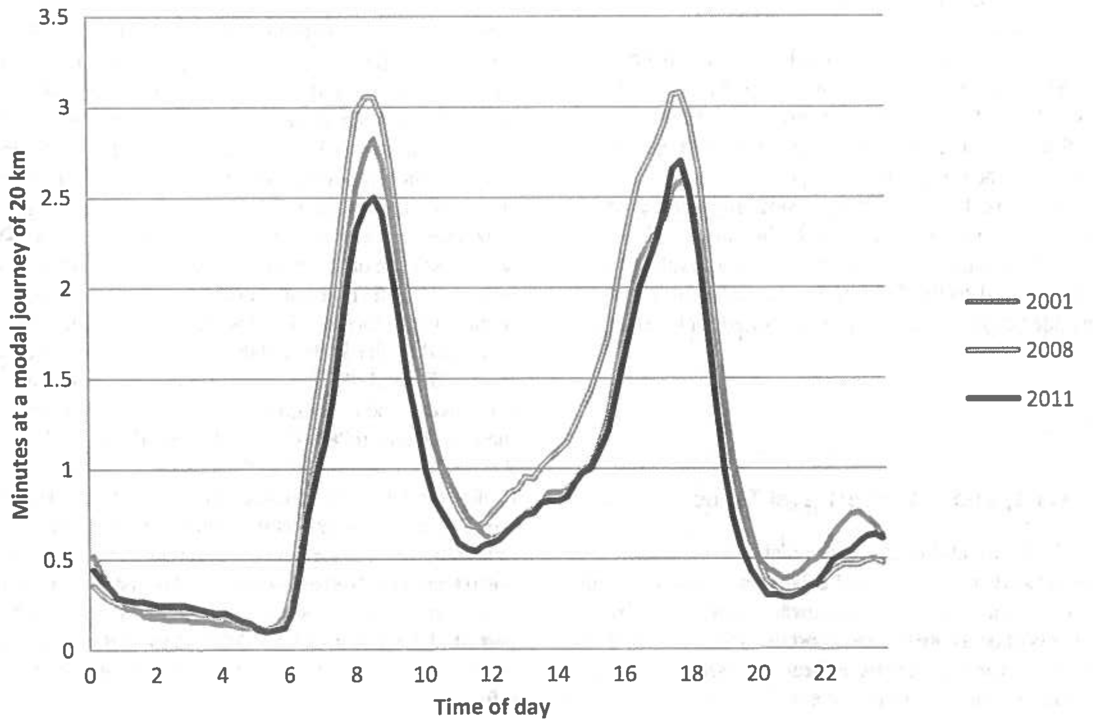

FIGURE 5 Travel time reliability in relation to SD per time of day on main trunk road network in the Netherlands.

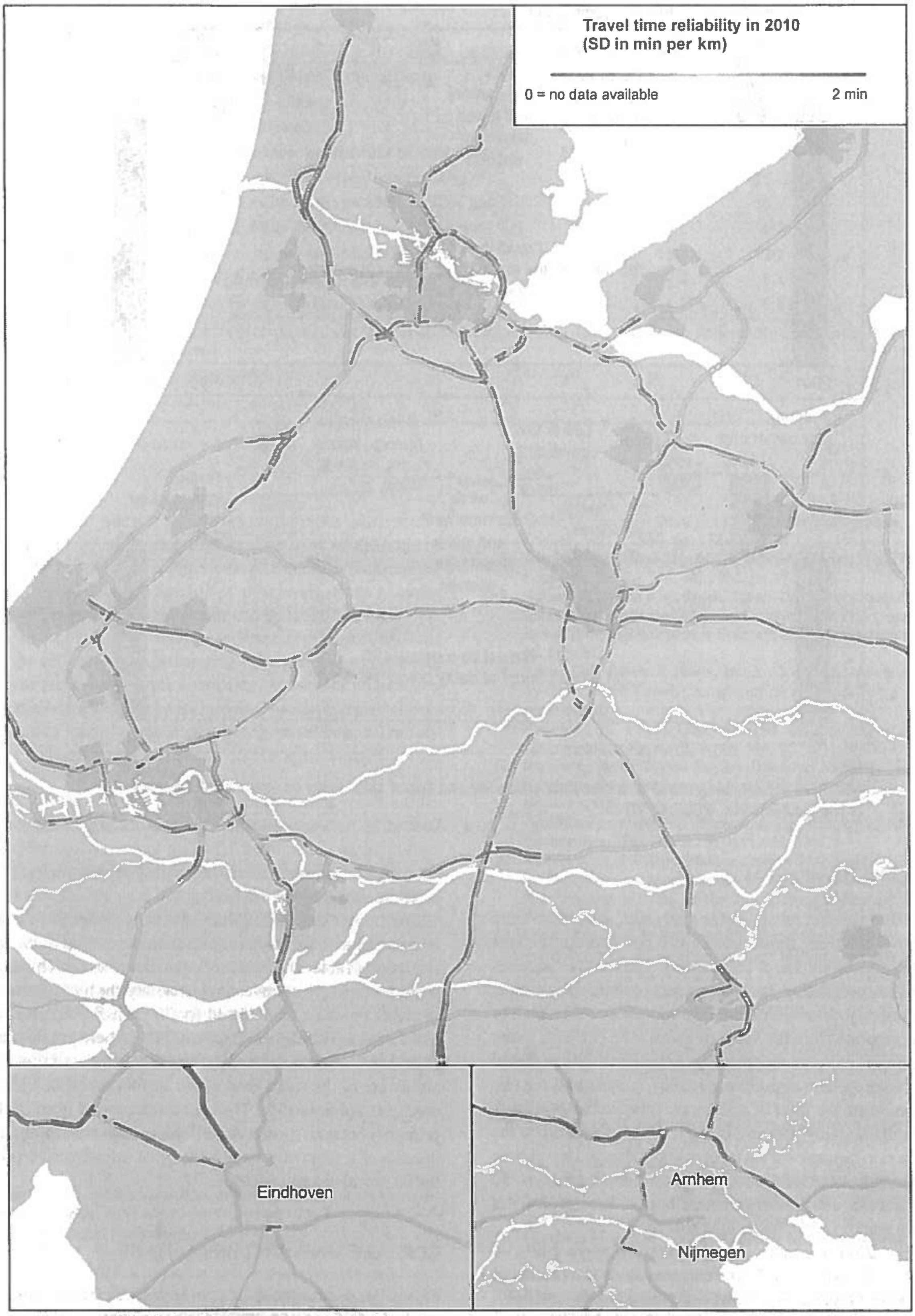

FIGURE 6 Spatial differences in travel time reliability in relation to SD on main trunk network in the Netherlands.

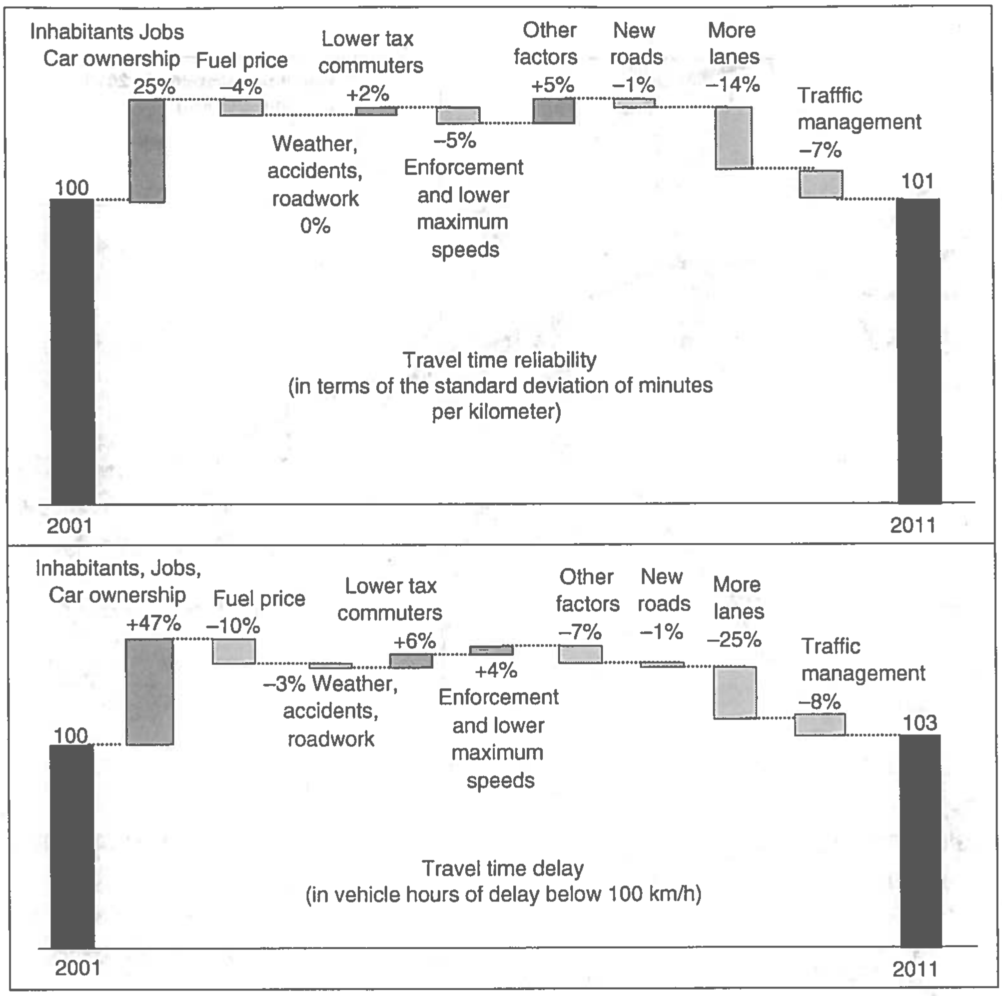

FIGURE 7 Explaining trend of travel time reliability and travel time delay on main trunk network in the Netherlands, 2001 to 2011.

Social Costs of Unreliability

To determine the cost of unreliability for road users, as separate from the cost of travel time, one must measure two components: the cost of unreliability and the volume of unreliability. The KiM Netherlands Institute for Transport Policy Analysis recently completed a project aimed at objectively determining the first component: the value of reliability, as separate from the value of travel time (*1*). This paper presents the second component: the volume of unreliability in regard to hours of variation. The cost of unreliability is measured for two purposes: to estimate the level of and annual trend in the total costs of travel time unreliability for users of the trunk road network in the Netherlands and to estimate the social benefits of changed travel time reliability by adding road infrastructure in cost–benefit analyses. To date, the impact that adding infrastructure has on unreliability was expressed as a markup of the travel time reduction.

From 2010 to 2011, the total costs of travel time unreliability on the Netherlands' trunk road network decreased from 586 million to 433 million euros (Table 2). The costs were calculated by multiplying the costs of unreliability per hour by the volume of unreliability. The volume was calculated by multiplying the vehicle kilometers with the standard deviation of travel time unreliability. The decrease in the volume of unreliability that occurred from 2010 to 2011 was caused by a decrease in the unreliability per kilometer. The number of kilometers increased slightly.

The impact that adding infrastructure has on the social benefits of travel time reliability is expressed as a markup of the travel time reduction (Table 2). To identify the extent to which infrastructure projects can improve travel time reliability, the reduction of variations in travel times was calculated for 78 projects implemented on the main trunk network from 2001 to 2011. To perform this calculation, Equation 1 was used. The approximate benefits of travel time reliability are of the same level as the current practice, which is based on expert opinions (*20*). The benefits decreased from 2010 to 2011, primarily because travel time reliability improved through the introduction of a relatively large number of infrastructure projects and traffic management measures.

CONCLUSIONS AND DISCUSSION

This paper demonstrates that travel time reliability in road transport can be identified and measured in a systematic and detailed manner, producing clear and concise results. In the Netherlands, the trend in travel time reliability from 2001 to 2011 appears to be largely equal to the trend in travel time delays.

TABLE 2 Costs of Unreliability on Main Trunk Network in the Netherlands

Parameter	2000	2010	2011
Costs of Travel Time Unreliability on the Trunk Road Network in the Netherlands			
Costs of travel time unreliability (€ millions)	NA	586	433
Passenger traffic (€ millions)	NA	445	328
Freight traffic (€ millions)	NA	142	105
Costs per hour passenger traffic (value of reliability) (€)	NA	5.75	5.87
Costs per hour freight traffic (value of reliability) (€)	NA	15.40	15.73
Volume of unreliability passenger traffic (million hour)	61.6	77.3	56.0
Volume of unreliability freight traffic (million hour)	7.3	9.2	6.7
Traffic volume passenger traffic (billion vehicle km)	58.4	65.9	67.9
Traffic volume freight traffic (billion vehicle km)	7.0	7.9	8.1
SD per kilometer (h/1,000 km; 0.8 = 4.8 min per 100 km)	1.056	1.173	0.824
Social Benefits of Reliability as a Proportion of Profits of Travel Time to Evaluate Projects of Infrastructure			
Current practice (*20*) (%)	25	25	25
Analyses trunk road network (%)	NA	37	23

NOTE: NA = not available.

Second, empirical microlevel analyses of traffic and social–economic data can explain how a trunk road network on the scale of the Netherlands' has performed during the past decade. This method provides additional information for ex post evaluations because the impacts of several policy measures can be identified more systematically and comparably than in separate project evaluations. Moreover, the effects that implementing policy measures have had on travel time reliability, travel time delay, and travel volume (by means of induced traffic) can be identified. The method also allows policy makers to identify recent changes in travel time reliability and explain changes using up-to-date information about the root causes (*21*).

Third, the volume of travel time unreliability can be measured for estimations of the costs of travel time unreliability for users of the road network and for estimations of the social benefits of changed travel time reliability in cost–benefit analyses of adding infrastructure.

It appears that the increase of unreliability by variations of travel times in the Netherlands from 2001 to 2011 was caused primarily by population and economic growth increasing the number of jobs and the car ownership rates. The analyses also demonstrated that this increased unreliability could be reduced not only by adding more lanes, but also by traffic management measures, such as dynamic route information panels, ramp-metering installations, and speed control. Speed reductions appeared to reduce unreliability, but caused an increase in travel time delays.

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