Evaluation of a National Traffic Police Force

DAVID M. ZAIDEL, IRIT HOCHERMAN, AND A. SHALOM HAKKERT

The evaluation of the National Traffic Police (NTP) in Israel, which was recently organized, is described. The creation of NTP entailed an organizational change in the structure of the traffic police force and a doubling of personnel and other resources. An independent, comprehensive evaluation was mandated to accompany the project. The evaluation program consists of four components: organizational analysis, monitoring of police operations, monitoring of traffic behavior, and analysis of accident trends. The methodology is described and results of the first phase of evaluation, which included the first three components, are presented. The major findings were as follows: inputs and outputs increased about twofold, roughly proportional to the increase in resources; no overall improvement in traffic behavior occurred. However, some places showed an improvement, and there was an indication of a relation between improvement in traffic behavior and the intensity of police presence. A higher-than-routine level of enforcement was necessary to achieve this improvement.

Police traffic operations in Israel used to be coordinated by local and district commanders of the national police force as part of their many other duties. At the district level there were personnel and subunits specializing in traffic-related services, but there was no national-level command, control, and communication structure dedicated to traffic enforcement and other traffic operations.

In September 1991 a National Traffic Police (NTP) force was established as an operational branch at the national police headquarters in Jerusalem, and all existing interurban traffic units came under its direct command. The transfer was gradual; the first phase, which is described in this paper, included two of the three rural districts, North and Center, covering about 2500 km of roads. These two districts include all the major, high-volume highways in Israel and account for about 80 percent of the injury accidents on interurban roads—2,600 injury accidents in 1991. The remaining South district was added in 1993.

NTP introduced an organizational change that put traffic police officers and traffic operations under a separate, nationally coordinated command. In addition, it entailed an increase in resources—manpower, vehicles, and associated enforcement equipment were nearly doubled in size.

NTP was empowered and expected to experiment with and modify strategies and tactics of traffic operations and active enforcement to achieve a higher level of traffic safety on Israeli roads. NTP was set up on a trial basis for 21 months; to our knowledge, it is one of the largest experiments in police traffic enforcement ever attempted. Most reported experiments or projects in this area tend either to be localized, general enforcement campaigns or to focus on specific target behaviors and populations, such as speeding or DWI offenders (*1–3*). Other experiments deal with particular variations in operational strategies, such as the impact of marked versus unmarked patrol cars (*4*).

In contrast, the NTP project was planned from the outset on a large geographic scale, comprehensive in scope, long range, and involving a permanent increase in enforcement resources rather than temporary shifts in their allocation. Given the national scope of the project, one might look not just for localized effects of enforcement, but also for apparent changes in the "normative standards of driving behavior" (*5*).

The Transportation Research Institute is evaluating the total operation of NTP to help improve NTP's functioning and to provide data for those required to determine its success. This paper describes the design and methodology of the evaluation and provides some results pertaining to the first 10 months of operation.

EVALUATION APPROACH, GOALS, AND OBJECTIVES

The underlying rationale of the evaluation plan is the relationship between traffic police activity and the level of traffic safety. It is hypothesized that an increase in resources and the organizational change will bring about an increase in enforcement, which, in turn, will increase both the objective and subjective probability of apprehension. Thus, deterrence and detection may cause changes in drivers' behaviors that are related to safety. These changes, in turn, will translate into a reduction in the number and severity of road accidents (*2,6*).

With this underlying assumption, NTP is viewed as an industrial plant working around the clock, using a variety of resources and producing interim and end products. The plant uses an "industrial process" of patrolling and enforcement to manufacture safety and efficient traffic flow. The ultimate indicator of the level of safety is the number and severity of accidents. Intermediate measures are behavioral patterns associated with safety, such as speed, conflicts at intersections, and seat belt use.

Evaluation is an integral part of modern industrial processes, which incorporate quality control and monitoring of inputs and outputs at all stages of production to optimize the production process and achieve the set goals and objectives. Similarly, the NTP evaluation plan assumes that the NTP structure and mode of operation are not rigidly defined, but rather evolve through a continuous feedback process. The

Transportation Research Institute, Technion—Israel Institute of Technology, Haifa 32000, Israel.

evaluation program, while not performed by NTP itself, is closely coordinated with this process and contributes to it.

In broad terms, the evaluation program was designed to monitor the organizational changes and their impact on NTP functioning and traffic operations, monitor changes in enforcement activity, measure changes in traffic or drivers' behavior and relate them to police actions, and, eventually, assess changes in traffic accidents that might be attributable to the new NTP. The evaluation program consisted of four components: organizational analysis, monitoring of NTP operations, monitoring of traffic behavior, and accident analysis.

This paper describes the first 10 months of NTP's operation. This period was deemed too short to induce discernible changes in accident trends. Therefore, accident analysis was deferred to the second phase of the evaluation.

ORGANIZATIONAL ANALYSIS

Methods

The organizational analysis entailed a structural and functional analysis of NTP at all levels of command, control, and field operation. The functions, units, stated goals and objectives, resources, procedures, tasks, and external and internal constraints of NTP were mapped and flowcharted according to various models of organizational behavior pertinent to industrial production and hierarchical organizations.

Various sources of information provided input to the organizational analysis. These include periodic visits to most NTP branches; interviews of key personnel in the NTP as well as in other branches of the police that were affected by it; and written records of command staff meetings, planning documents, and guidelines. A periodic questionnaire survey of NTP officers solicited their personal views on enforcement strategies and tactics, job satisfaction, the functioning of their units, and so forth. Data acquired during the monitoring of NTP operation, described in the next section, were also used to corroborate impressions and views obtained during site visits.

The organizational analysis was an important part of the first phase of the evaluation. It provided useful insights to the NTP and police command and contributed to organizational changes within NTP and the department of traffic. The major objectives of NTP were defined and prioritized, and operational measures of success were defined for each objective.

Findings

The analysis identified a number of bottlenecks in the process of enforcement within the police organization and inside related systems such as the judicial system. An example of a topic that was brought up during the organizational analysis is the process of active enforcement, or the production of citations. Data gathered and analyzed during the monitoring of police operations indicated that on the average, three to five citations are given by a patrol unit during a shift. Efforts to increase the level of enforcement brought the number up to seven citations per shift. The questionnaire revealed that the handling of a single citation requires a total of 20 to 30 min. This was corroborated during field visits. It was thus calculated that the limit to enforcement is set at a maximum of 10 citations per shift. This meant that a significant increase in enforcement cannot be achieved under the existing system, and the need for automatic enforcement was underlined. Further analysis of the production process of citations recorded by automatic equipment revealed bottlenecks down the line in units that were not accountable to NTP, such as the film processing lab and the central computer unit. It became clear that until all of these constraints are treated, no significant increase in enforcement is feasible. Thus, a complete revision of the processing of citations was suggested by the evaluation team and is now being examined by police officials.

The questionnaire surveys of police officers basically confirmed impressions that were formed during interviews and site visits, identified areas that acquired additional training, and demonstrated an overall high degree of job satisfaction and a positive attitude toward the new structure.

MONITORING OF TRAFFIC POLICE OPERATIONS

Methods

Monitoring of the NTP operations provided useful information for two aspects of the evaluation. First, it provided data on the efficiency of NTP traffic operations and the way they change with experience. Second, it provided quantitative measures of traffic operations, including active enforcement over time and across the road network, which could be linked with changes in drivers' behavior.

The main source of data was routine planning and reporting forms used regularly (on a daily or per shift basis) by the regional units. One such form, filled out daily, provides data on basic input parameters and efficiency measures, such as the number of active police officers and cars operating on each shift, the number of citations given, and the amount and types of enforcement equipment used and their output. Another form provided data on actual deployment of police cars on the road network for each shift. These forms were collected and coded regularly.

Another source of data was the files of the police central processing unit, which provided reliable data on citations given by NTP officers by type of citation, unit, time, and so forth.

Crude data on the number of NTP cars observed on the road were gathered by the evaluation team during trips to the traffic monitoring sites and during the observation there.

The data were analyzed to provide average monthly values of performance and efficiency indicators. These indicators included

- Input measures, such as number of patrol cars and police officers per shift;
- Efficiency measures, such as resource utilization rates for police officers, patrol cars, and enforcement equipment; and
- Intensity measures, such as total mileage driven by patrol cars, number of patrol cars observed per kilometer of road, rate of patrolling on each road section, total number of citations, and number of citations per patrol car per shift.

Findings

After a period of adjustment that lasted several months, all measures of activity showed an increase commensurate with the increase in resources. As of March 1992, activity measures reached a plateau at a level of about twice that of the pre-NTP period.

The main output measure is the number of citations given. This measure was analyzed by type of offense, by unit, area, time of day, and so forth. Figure 1 shows the total monthly citations given on the roads under NTP jurisdiction. An increase of about 100 percent was reached after a few months of operation. No evidence of any gain in efficiency is present—the increase in output can be attributed entirely to the increase in resources. Seasonal variation due to harsh weather (in the winter) and vacations (in the summer) is also apparent.

The routine deployment of patrol cars was based on a division of the road network into sections of 10 to 20 km each. Each section was assigned a priority level based on both traffic volumes and annual accident rates. A more detailed description can be found elsewhere (*7*). There are 118 such road sections under the jurisdiction of the two NTP regions, divided into two enforcement categories—A and B. Sections assigned Priority A should be patrolled every weekday shift, whereas sections in Category B should be patrolled two or three times a week. In addition, a special operations unit was formed in 1992 and provided extra coverage on a rotating basis to road sections that were considered especially unsafe.

After a period of adjustment, the deployment reached a level of 11 to 13 shifts per week on each Type A section. The level of coverage of Type B sections varied but was on the average less than two shifts per week. Sections that were reinforced by the special operations unit were patrolled by an average of at least 17 car shifts per week. On the average, a police car patrols the assigned section for 5 to 6 hr per 8-hr shift.

The independent observations made by the traffic monitoring team produced an estimate of four NTP patrol cars observed per 100 km of road (mostly Priority A roads).

Efficiency measures were mainly useful in illuminating problem areas in operation. For instance, the low rate of use of some of the enforcement equipment indicated the need for more training and precipitated some procedural changes in their use.

MONITORING OF TRAFFIC BEHAVIOR

Methods

The national scope of the NTP and the comprehensive nature of its operation required special methodological considerations with regard to what, where, when, whom, and how to observe and monitor. It was obvious that every desired driver behavior (or traffic characteristic) could not be monitored and that the monitoring could not be performed on every road and during all times. Yet the monitored behaviors should represent what happens on the road network much of the time and indicate whether there are changes in the behavior over time or locations. In addition, it has to be shown that such changes could be attributed to the NTP and that they are, eventually, related to improved safety.

The general approach in designing the monitoring system was to use a large sample of representative road sections and take repeated measures of the chosen behaviors. Some behaviors were automatically monitored over a number of hours, whereas more complex types of behaviors were manually collected over shorter periods, overlapping the autonomic records. Because of the importance of traffic volume in determining most other traffic characteristics, it was decided to always record traffic volumes along with other measurements.

The large number of observation sites recognized the large variability in traffic behavior due to local differences in traffic volume, vehicle mix, roadway characteristics, visibility, weather conditions, and other attributes. At the same time an effort was made to reduce the uncontrolled variance by limiting the variety of observation sites and following a procedure of repeated observations under as similar conditions as practically possible.

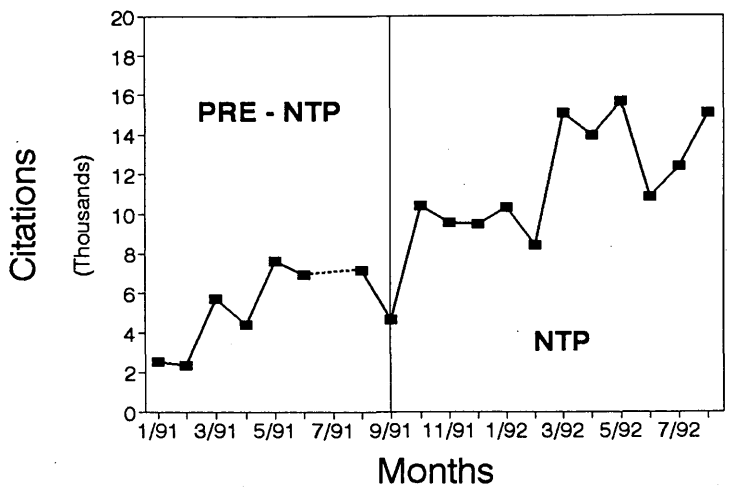

FIGURE 1 Number of citations produced each month.

Monitored Behaviors

The behaviors to be monitored were selected according to the following criteria:

- The behavior is enforced (at least in principle) by the police,
- The behavior is associated (at least in principle) with safety,
- The behavior can be reliably monitored and quantified, and
- The behavior can provide sufficient data for statistical analysis and inference.

The traffic behaviors that were selected for monitoring can be divided in two groups: (*a*) speed and following distance (measured on road sections) and (*b*) approach speed on the nonpriority road and the friction between turning vehicles, measured at nonsignalized T junctions.

Monitoring Sites

The sampling frame for selecting the observation sites was the list of 75 patrol sections with ADT greater than 5,000 vehicles. Twenty-four road segments were selected, 12 in each of the two NTP districts. The actual observation site in each road section was selected following an on-the-road survey. A nonsignalized junction with a sufficient volume of traffic was located and checked for the monitoring conditions. Traffic behavior at road sections was monitored on the main road leading to the junction but at a far enough distance to ensure independent behavior. The sampling, site selection, and actual observations were carried out independently of any planned or actual police activity at the road sections.

Monitoring Procedure

During Phase I, data were collected by the same team of observers, who visited each site five times, once every other month. Vehicle volumes, speeds, and following distances on the main road were recorded by electronic traffic counters. Counters were usually left for the whole day. Approach speed on the minor road was measured with a hand-operated portable radar (speed-gun) from inside a parked vehicle. Only free-moving vehicles were measured. At least 120 readings per measurement period were taken at each site.

The level of friction at the junction was assessed by an observer positioned at a convenient spot overlooking the junction. The observer counted and classified the turning maneuvers at the junction. Each turning maneuver was classified into one of three categories, depending on the amount of friction it generated in traffic at the time of its execution: normal, medium, or high. A minimum of 150 turning maneuvers per junction were observed at each measurement period.

Overview of Analysis

The purpose of the analysis was to detect meaningful changes in the behavioral measures of traffic, from the onset of the NTP project until the last (fifth) round of field measurements.

It took NTP a few months to restructure, reorganize, train new officers, acquire new vehicles, develop new operational procedures, and make other adjustments. Therefore, it was expected that the first round of observations would represent a baseline condition, after which some (hopefully positive) changes would take place as a result of NTP's stronger impact on traffic.

Specifically, the analyses were to find, across five measurement rounds, trends in the following summary measures:

- Average speed on main roads,
- Percentage of vehicles moving at speeds higher than the legal speed limit (90 km/hr),
- Percentage of following distances smaller than 1 sec or 2 sec,
- Average approach speed to a junction on the minor road, and
- Percentage of high and medium friction turning maneuvers at junctions.

As noted earlier, traffic volume has a major influence on the momentary values of other traffic characteristics. Therefore, automatic recordings of volumes and speeds were made for many hours, and the repeated data for each site were collected under conditions that were as similar as possible.

On the basis of data from all measurement rounds, a "common window of analysis" was identified for each site such that during similar hours of the day, during all measurement rounds, traffic volume was about the same. In most instances, it was a period of about 2.5 to 3.0 hr in the afternoon, just after the noon peak hour and before the next evening peak. The off-peak period ensured free-flowing traffic and allowed a better comparison of the behavior parameters over time.

A priori, there was only a very small chance for NTP to have a discernible impact on traffic behavior on a national scale. Therefore, the analysis was designed to enhance the possibility of finding any positive effects of enforcement on traffic behavior (if the effects were indeed there). The statistical analysis consisted of three steps. The first tested the hypothesis of a consistent change in behavior over time at a specific site. The second combined results from all sites to test the hypothesis of an overall change in behavior. These two steps were performed separately for each of the behavioral measures. The third step tested the association between police enforcement and changes in traffic behavior.

In the first step, statistical tests were performed at the single-site level. The occurrence of change in behavior was tested using three different comparisons within the five measurement periods: Period 1 versus Periods 2 through 5; Periods 1 and 2 versus Periods 3 through 5, and Periods 1 through 3 versus Periods 4 and 5. The choice of three different comparisons allowed the change in behavior to occur at any point in time after the first, baseline, measurement.

Mean speeds were tested using a one-way ANOVA with contrasts. The data of the other measures—percentage over speed limit, percentage following distances < 2 sec, percentage of high and medium friction at junction—were cross tabulated according to the different periods compared and tested with a χ^2 test for significance of the differences.

The results of the tests indicated, for each comparison, the direction of change: "positive" (a significant decrease in speed

or friction between vehicles, an increase in gaps), "negative" (a significant increase in speed, etc.) or "not significant."

The results of the three comparisons were combined into one measure of overall direction of change: positive (pos), negative (neg), or inconsistent (n.s). Table 1 gives an example of this procedure for mean speeds on the main road.

To test the hypothesis of an overall change in behavior, the results were combined over all sites. For each measure, the number of sites with positive change was compared with the number of sites with negative change, and a binomial test was used to test for a predominant trend.

To relate changes in traffic behavior to police enforcement, a crude measure of "enforcement level" was obtained for each site. It was based on the mean number of patrolling shifts per week assigned to the road section during the month preceding the field measurements. Each site was also assigned to one of three categories indicating an overall direction of change in traffic behavior. The measure of enforcement level was related to the overall trend of change at the site.

Findings

Changes in Speed

Table 1 is a summary table of mean speeds on the main road at 15 sites that are on two lane highways. The table also gives the trends of speed change on the basis of the ANOVA and tests for contrasts. The last column displays the overall trend. The binomial test for the significance of having 7 out of 10 comparisons positive by chance shows that it is likely at a probability of $p = .17$ (one-tail). Examination of the table indicates that the differences between measurement rounds are usually small—less than 5 percent.

Approach speeds on the minor roads have changed even less than speeds on the major roads connecting with them. For 21 sites with relevant data, 9 showed a decrease in speed over time, 5 showed an increase, and for 7 there was no clear change. There is clearly no evidence of a predominant trend of change here.

The percentage of vehicles going over 90 km/hr (speed limits are 80 km/hr) varied from as low as 1 to as high as 35 percent over the 15 two-lane sites. In all but five of the sites there was no significant trend of change. The expectation that this measure would be more sensitive to enforcement effect was not fulfilled. In retrospect, it is not surprising in view of the inevitable larger variance in the high tail end of a speed distribution. The mean is actually a more reliable measure.

Changes in Percentage Following Too Closely

Generally, there was no significant change in the values of these measures across the five periods. Only a few of the individual comparisons were significant in the χ^2 test and, consequently, the predominant trend was "no change."

The percentage of vehicles following at a distance of 2 sec or less hovered around the 20 percent value. It was clearly volume dependent: up to 27 percent at the site with the highest traffic volumes and down to 10 percent at the lower volume scale.

Changes in Level of Friction at Junctions

The friction data were aggregated across all turning maneuvers. The percent of medium- and high-level encounters ranged from 1 to 10 percent. At 17 out of 25 junctions there was no significant change between periods. Of the eight sites that showed a relatively consistent trend of change, seven were in a positive direction, less friction at later periods of measurement (one-tailed $p = .035$.)

TABLE 1 Mean Speed by Site, Measurement Period, and Direction of Speed Change

Site ID	Mean speed (km/h) on main road					Direction of speed change			
	Period 1	Period 2	Period 3	Period 4	Period 5	p1/p2-p5	p1-2/p3-5	p1-3/p4-5	Overall
1	74.85	76.33	76.33	75.36		n.s	n.s	neg	neg
3	79.71	72.99	77.97	80.42	76.85	neg	neg	pos	n.s
4	75.75	74.22	73.69	74.00		pos	pos	pos	pos
5	75.29	71.82	70.26	72.88		n.s	pos	pos	pos
6	78.13	77.79	77.53	76.27	78.78	n.s	n.s	n.s	n.s
7	75.11	76.12	74.23	74.21	74.40	pos	pos	n.s	pos
8	67.08	68.08	65.42	65.17	64.07	pos	pos	pos	pos
9	66.73	67.59	67.49	66.79	68.59	n.s	n.s	n.s	n.s
10	79.58	76.30	77.22	76.56		pos	pos	pos	pos
11	70.50	73.07	66.39	70.89	63.51	pos	pos	pos	pos
12	83.06	79.95	82.36	81.61		n.s	n.s	pos	n.s
15	67.98	73.41	67.74	68.08	69.37	n.s	pos	neg	n,s
16	70.45	70.30	69.05		71.83	neg	n.s	n.s	neg
17	83.65	83.67	86.38	82.75	83.72	pos	n.s	n.s	pos
23	66.22	65.61	65.97	66.15	67.80	neg	n.s	n.s	neg

Did Enforcement Influence Traffic Behavior?

So far, analysis of the results for each measure and across all relevant sites showed no significant changes between periods, with the possible exception of the friction measure. However, it was also shown that there were large differences between sites. Some showed a fairly consistent trend of improvement on all or some of the measures, many showed no change or an inconsistent trend, and a few showed a negative trend of change. Is there some common feature between the subgroups of sites that can explain the differences? Table 2 presents an attempt to relate the predominant trend of change at a site to the level of enforcement.

The 20 sites with data on most of the measures for most of the periods were classified according to the trend of change on all the measures into three categories: positive, no change, and negative. Sites with at least two behaviors that displayed a positive change and no behavior that displayed a negative change were defined as sites with an overall improvement in traffic behavior. Sites with at least two negative changes and no positive change were assigned to the category of negative change. All other sites were assigned to the group of no consistent change.

The same sites were independently classified on the basis of police operational records according to the level of enforcement that was assigned to the road section that included the site. The level of enforcement was measured by the mean number of patrolling shifts (typically a single patrol car for a 10- to 20-km section) per week. The medium level of enforcement, 11 to 13 shifts per week, represented the standard enforcement practiced by the police. Lower-priority sections were patrolled less frequently. The high level of enforcement represented a special concentrated effort on selected routes for a couple of months before the field measurements.

Table 2 indicates the number of sites associated with each level of enforcement and the direction of change that has occurred in the behavioral measures. The sites on roads that were subjected to a relatively high level of enforcement tended to show mainly a positive effect (five out of seven), sites with the medium, standard enforcement concentrated in the no change category (also five out of seven), and the six sites with an enforcement level lower than standard split evenly between the three categories of change.

TABLE 2 Sites, by Level of Enforcement and Direction of Change in Traffic Behavior

Level of Enforcement	Positive change	No change	Negative change	Total
HIGH 14+	5	1	1	7
MEDIUM 11-13	0	5	2	7
LOW > 10	2	2	2	6
TOTAL	7	8	5	20

The result is intriguing but must be considered very tentative in view of the small number of cases in the table. The relationship suggests that it may take much more than a low or medium level of enforcement to have a reasonable chance of influencing traffic behavior in terms of the measures evaluated in this study. There is some indication in the data that concentrated police activity in a generally targeted area may improve traffic behavior.

Since it is not possible with limited resources to boost the level of police activity everywhere, all of the time, it is also clear that more attention must be given to what police are doing in the process of enforcement and how to increase its impact apart from increasing manpower and vehicles on each road.

ACKNOWLEDGMENT

This study was cosponsored by the Highway Safety Administration of the Ministry of Transport, the Police, and the Treasury Department.

REFERENCES

1. M. Armour. The Effect of Police Presence on Urban Driving Speeds. *Australian Road Research*, Vol. 14, No. 3, 1984.
2. G. Nilsson. Speed Limits, Enforcement and Other Factors Influencing Speed. In *Enforcement and Rewarding Strategies and Effects* (M. J. Koornstra and J. Christensen, eds.). Leidschendam, the Netherlands, 1991.
3. D. M. Zaidel. A Modelling Perspective on the Culture of Driving. *Accident Analysis and Prevention*, Vol. 24, No. 6, 1992.
4. D. Shinar and A. J. McKnight. *The Effects of Enforcement and Public Information on Compliance.* New York, 1985.
5. J. A. Rothengatter. Normative Behaviour Is Unattractive If It Is Abnormal: Relationships Between Norms, Attitudes and Traffic Law. In *Enforcement and Rewarding Strategies and Effects* (M. J. Koornstra and J. Christensen, eds.). Leidschendam, the Netherlands, 1991.
6. T. Makinen, L. Beilinson, and M. Salusjarvi. Traffic Enforcement Strategies and Tactics. Presented at 2nd International Conference on New Ways and Means for Improved Road Safety and Quality of Life, Tel Aviv, Israel, Oct. 1991.
7. A. S. Hakkert, A. Yelinek, and E. Efrat. Police Surveillance Methods and Police Resource Allocation Models. In *Enforcement and Rewarding Strategies and Effects* (M. J. Koornstra and J. Christensen, eds.). Leidschendam, the Netherlands, 1991.

Publication of this paper sponsored by Committee on Methodology for Evaluating Highway Improvements.