Classifying a Rural Road Network for Traffic Counting

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The evolution of a classification system for the South African rural road network is described. An initial attempt to classify a provincial network on the basis of the trip length and trip purpose of traffic, as judged subjectively by local road officials, was tested in a pilot study on traffic counting. The results of the study show that there is a good correlation between average trip length, as calculated from an origin-destination matrix, and various traffic patterns. A final classification system, based on these trip lengths, is recommended.

As a result of the variation in traffic volumes, the annual average daily traffic (AADT) at a specific location can only be determined accurately by means of permanent traffic counters (PTCs). These, however, can only be afforded at a limited number of locations and therefore the traffic on the remainder of the links in a network is counted for short periods only. The AADT on these links is estimated by means of expansion factors derived from the data obtained from the PTCs.

The purpose of the classification of the road network is to group the links according to the uniformity of their traffic patterns to ensure that the expansion factors are calculated from the appropriate group of PTCs and applied to the correct group of short-term counts. Traffic patterns can be described by the regular variation in daily, weekly, and seasonal traffic volumes.

There are various methods of grouping PTCs on the basis of their monthly variation in traffic flows *(1-3)*. However, for the vast majority of road sections, the traffic patterns are unknown, and assigning them to a specific group is difficult. Moreover, when no PTCs have been in operation in a certain area the problem of classifying the network becomes more complicated.

The evolution of a process for classifying the South African rural road network for traffic counts is described in this paper. The process started off by using a framework in which subjective judgment and an intimate local knowledge of the nature of traffic were the main components. This framework was then tested in a pilot study, the results of which were used to develop a final procedure for classification based on trip length.

In South Africa rural traffic counting is the responsibility of the provincial road authorities. Over the years different systems have evolved. In one province 40 links are counted in a revolving system; each link is counted for 1 year every 5 years. In another the 10 PTCs are manually operated for 18 hr a day, and in a third about 90 percent of the PTCs are located on roads with essentially similar traffic patterns. Some systems give the results in terms of equivalent vehicle units (with a heavy vehicle representing three cars) and others give the total number of vehicles and a percentage of heavy vehicles.

Because of the discrepancies in the presentation and accuracy of traffic counts, all attempts at countrywide road planning *(4, 5)* have been severely hampered. The Committee of State Road Authorities (CSRA) therefore decided to form a subcommittee to investigate and report on a uniform traffic-counting system for all South African rural roads. This has also been the main objective of a research project of the Rural Transport Group at the National Institute for Transport and Road Research (NITRR).

Procedures for rural traffic counting in the Northern Hemisphere are well established *(6)*. With a few exceptions these could be adopted for use in South Africa. The main problem, however, was to decide on a uniform classification system for the rural network, which again was a prerequisite for determining the locations of the PTCs.

The main difference between the proposed procedure for South Africa and the traditional procedures used elsewhere is that in South Africa factors are calculated for seasons (four or five per year) instead of months. The seasons are determined as follows: First, the *E*-days are identified; these are exceptional days, usually public holidays, the days following or preceding them, and school holidays, when traffic deviates significantly from the normal patterns. The remaining days with normal traffic, or *N*-days, are then divided into counting seasons with uniform weekly traffic patterns. The short-term counts take place on *N*-days only. In Figure 1 the *E*-days and *N*-days are shown for a specific road.

SUBJECTIVE CLASSIFICATION

Classification of a road network for traffic counting is based on the traffic patterns, which in turn are affected by trip purpose and trip length *(3)* of the traffic on a specific link. With this in mind, the following framework was drawn up for the classification of the South African rural road network:

- Class A: Roads on which commuter traffic over distances less than 100 km is mainly concentrated.
- Class B1: Roads carrying long-distance intermetropolitan traffic closer than 20 km to the major cities.
- Class B2: Roads carrying long-distance intermetropolitan traffic farther than 20 km from the major cities.
- Class C1: Roads carrying interregional, medium-distance traffic.
- Class C2: Roads carrying traffic mainly between neighboring towns.
- Class D1: Collector roads in an intensive agricultural area (crops).
- Class D2: Collector roads in an extensive agricultural area (livestock).
- Class E: Roads with exceptional traffic patterns, such as extremely high volumes of intermittent recreational traffic.

No PTCs would be used on Class-E roads unless it was important to justify a continuous count for its own sake.

To test this framework it was decided to do a pilot study in the Orange Free State.

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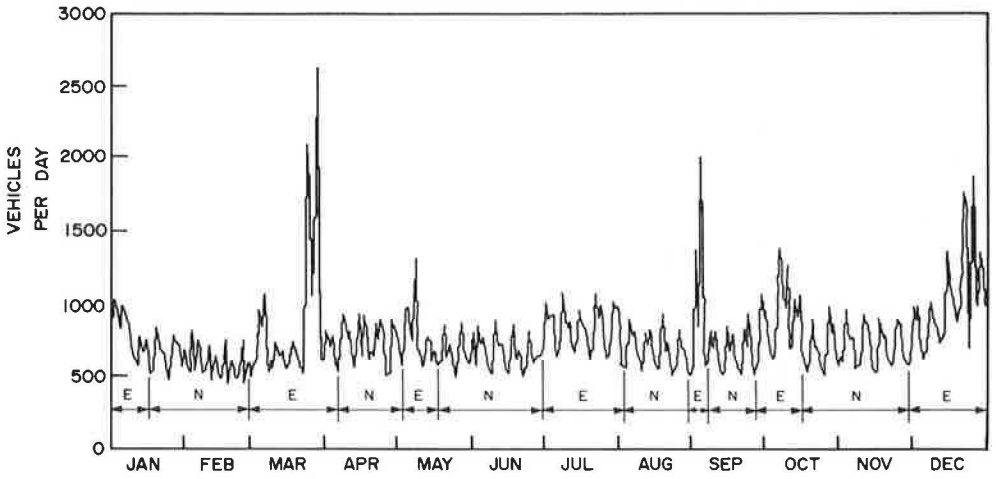

FIGURE 1 *E*-days and *N*-days for a specific road.

PILOT STUDY

The pilot study took place between April 1, 1983, and March 31, 1984. The road network with its 6,000 links was classified in accordance with the framework given in the previous section. This was done by officials of the Roads Department of the Provincial Administration of the Orange Free State, who used their knowledge of the trip purpose on the various links.

For the study it was decided to concentrate on Classes B, C, and D. Twelve positions were randomly selected for the location of the PTCs, which were allocated to the classes as follows:

Class	*Counters*
B2	1, 2, 3, and 4
C1	5 and 6
C2	7 and 8
D1	9 and 10
D2	11 and 12

The distribution of the counters throughout the province is shown in Figure 2.

FIGURE 2 Location of counters.

After the data had been collected it was obvious that the year could be divided into five distinct counting seasons:

Season	*From*	*To*
1	April 14, 1983	May 10, 1983
2	May 17, 1983	June 21, 1983
3	August 3, 1983	September 20, 1983
4	October 13, 1983	December 1, 1983
5	January 20, 1984	March 21, 1984

In spite of a number of interruptions while data from the PTCs were being collected, the original goal of the pilot study was achieved.

Because of the low traffic volumes at Counters 11 and 12 (12 and 19 vehicles per day, respectively) and high daily variations, no meaningful analysis could be done for Class D2. It is in any case doubtful whether roads in this class would ever be included in a formal traffic-counting program.

TRAFFIC PATTERNS

Traffic patterns can be described as regular variations in traffic volumes and are sometimes quantified by means of monthly expansion factors *(3)*. Regular daily, weekly, or seasonal relationships can, however, also be used to quantify the traffic patterns for the different classes of road, and these relationships were specifically analyzed.

Daily Traffic Variation

Because short-term manual counts are usually undertaken for less than 24 hr, it is important to know what is happening to traffic volumes during the rest of the day. In the pilot study 16-hr counts (from 6 a.m. to 10 p.m.) were used. The data from the PTCs were used to determine the 24-hr-to-16-hr relationship (24/16) for each counter and class of road. This relationship gives an indication of the proportion of nighttime traffic on a road section. In Figure 3 the nighttime traffic is shown as a percentage of the daytime traffic for the different counters and classes. The differences between the classes is statistically significant at the 99 percent confidence level.

Weekly Traffic Variation

A typical weekly traffic pattern is shown in Figure 4. One way of quantifying this pattern is to calculate the ratio of the traffic on a

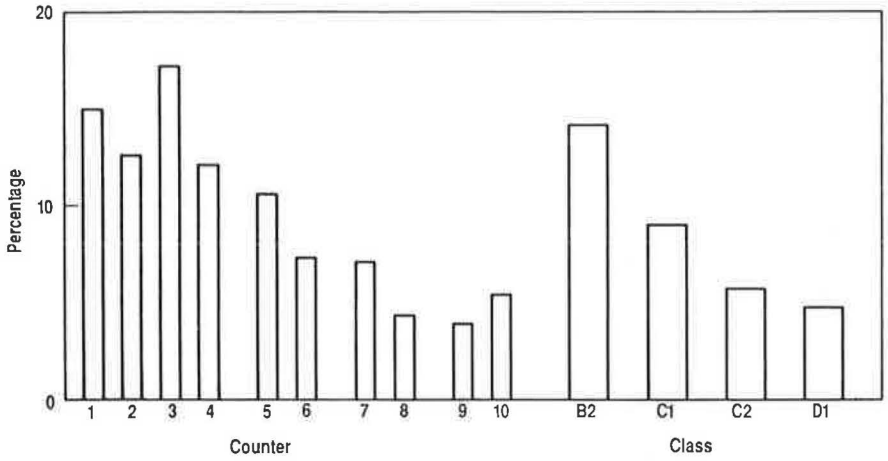

FIGURE 3 Nighttime traffic as a percentage of daytime traffic.

Friday to the weekly average daily traffic (*F/WD*). This is indicative of the amount of weekend traffic. The *F/WD* ratio for the different counters and classes is shown in Figure 5. This ratio differs very little for Classes B2 and C1.

Seasonal Traffic Variation

Long-term traffic variation on a road can be expressed in various ways, for example as

- Seasonal expansion factors,
- The coefficient of variation of the daily traffic volumes on a road, and
- The ratio between *E*-day and *N*-day traffic volumes (*E/N*).

Because *E*-days are not used for short-term counts and because of the exceptional traffic volumes on *E*-days, it is clear that the *E/N*-day ratio will be reflected in both the expansion factors and the coefficients of variation. It was therefore decided to use only the *E/N*-day ratio to quantify the seasonal traffic variations.

For this purpose 13 specific *E*-days were identified. They were mostly public holidays or days on which the provincial schools were closed. For each of these days the traffic volume was divided by the average *N*-day traffic. The *E/N*-day ratio for each counter and class is shown in Figure 6. It is interesting to note that on Class-D roads the traffic volume on *E*-days is on average less than on *N*-days. This was also found to be the case for roads carrying mostly commuter traffic, such as Class-A roads *(7)*.

EFFECT OF TRIP LENGTH ON TRAFFIC PATTERNS

It is well known that trip length has an effect on traffic patterns *(3)*. However, to determine the average trip length or trip-length distribution, an origin-destination survey is necessary. The cost of this is prohibitive when a large number of road sections must be considered.

At the end of 1983 the South African Rural Traffic Model *(5)* became available. This model was developed to predict future demand of traffic on the rural road network of South Africa. The model network, which consists of 1,324 links, covers 85 percent of the surfaced national and provincial roads in the country as well as some 5000 km of unsurfaced roads. By using the calibrated origin-destination matrix together with the assignment routine of the model, it was possible to calculate the average length of through trips for each link. Unfortunately, the links on which Counters

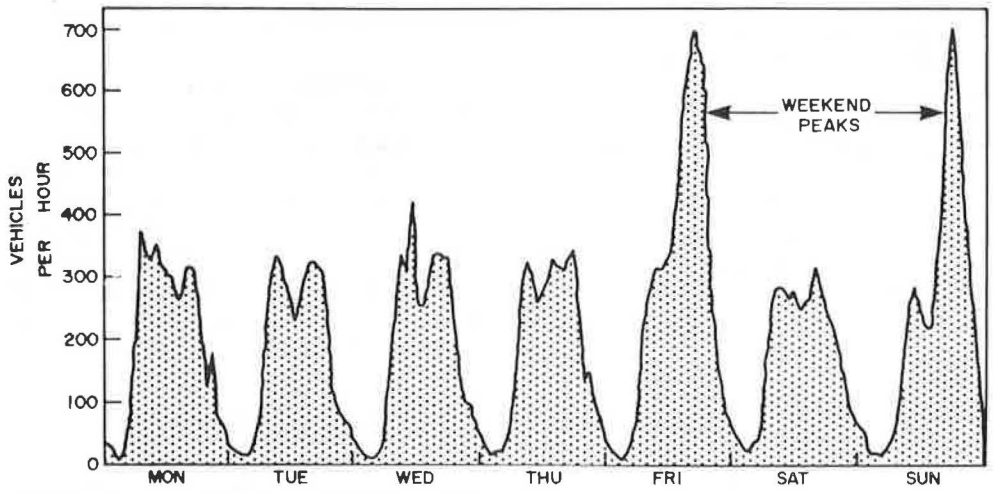

FIGURE 4 A typical weekly traffic pattern.

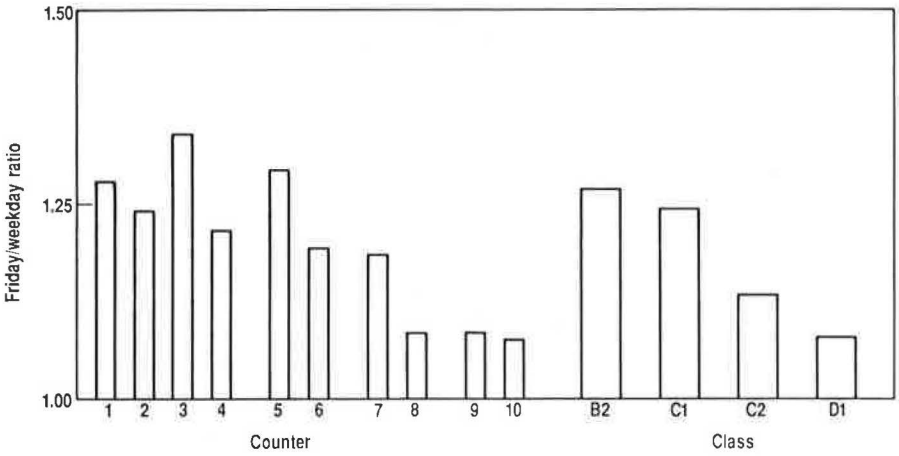

FIGURE 5 Friday-to-average weekday traffic.

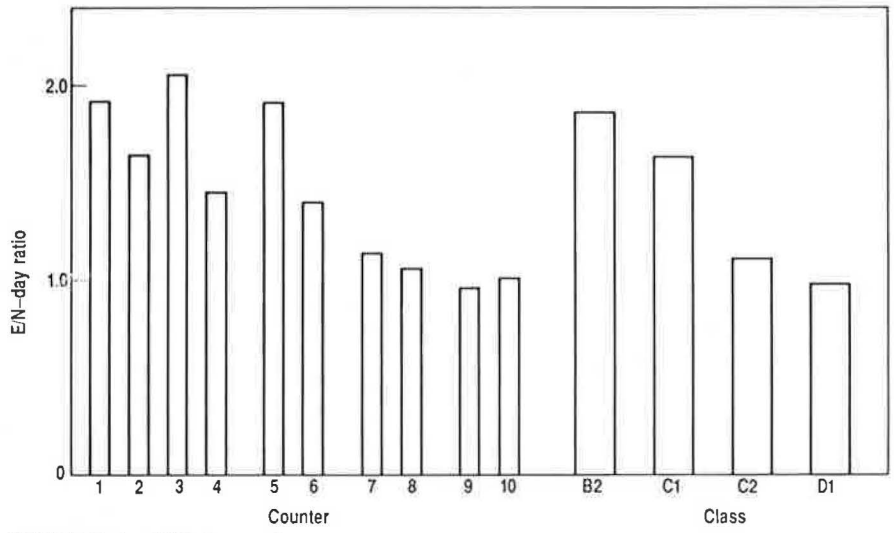

FIGURE 6 *E/N*-day ratio.

7–10 were located were not part of the model network. Therefore the following assumptions were made:

- For Class-C2 roads (counters 7 and 8) the average length of through trips is equal to the distance between the two neighboring towns (this follows from the definition) and
- For Class-D1 roads (Counters 9 and 10) the average length of through trips is equal to the length of the link on which the counter is located.

In Table 1 the average lengths of through trips (L) at each counter are given, together with the various traffic patterns as quantified in accordance with the methods described in the previous section. The correlation between the trip lengths and the traffic patterns can best be illustrated by the correlation matrix given in Table 2. From this it is evident that a good correlation exists not only between trip length and traffic patterns but also between the daily, weekly, and seasonal patterns themselves. The effect of trip length on the *E/N*-day ratio is shown in Figure 7.

With an estimate of through trip length available for the most important links in the South African rural road network, it is now possible to classify these links for the purpose of traffic counting. For the other, less important, links the assumptions made about trip length appear to be adequate.

Another way to determine trip length on a specific road is to do a license plate survey. In three of the four provinces in South Africa it is easy to identify the town of registration of a vehicle from the license plate. Where a manual short-term counting program is used, a sample of license plates can be recorded and used for the classification of the specific road section.

TABLE 1 TRIP LENGTHS AND TRAFFIC PATTERNS

Counter No.	Trip Length (km)	Traffic Patterns		
		Daily (24/16)	Weekly (*F/WD*)	Seasonal (*E/N*)
1	463	1.150	1.279	1.92
2	368	1.126	1.241	1.64
3	557	1.172	1.340	2.05
4	176	1.121	1.216	1.46
5	358	1.106	1.294	1.91
6	159	1.073	1.193	1.40
7	45	1.071	1.184	1.14
8	53	1.043	1.084	1.06
9	40	1.039	1.085	0.96
10	35	1.054	1.076	1.01

TABLE 2 CORRELATION MATRIX

	L	24/16	*F/WD*	*E/N*
L		0.935	0.916	0.969
24/16	0.935		0.921	0.922
F/WD	0.916	0.921		0.966
E/N	0.969	0.922	0.966	

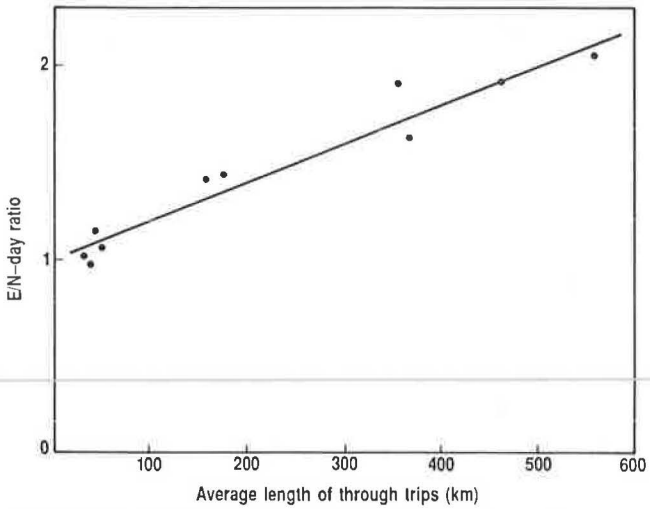

FIGURE 7 Effect of trip length on the *E/N*-day ratio.

CONCLUSIONS AND RECOMMENDATIONS

The results of the pilot study on traffic counting show that the subjective judgment of officials of a roads department can lead to a reasonable classification of the road network. When no data from PTCs or data on trip distance and trip purpose are available, subjective judgment is still the only way to classify the road network.

An interesting aspect of the results is the good correlation among the short-, medium-, and long-term traffic patterns, which indicates that roads that carry a high proportion of nighttime traffic also have relatively high traffic volumes during weekends and on holidays (*E*-days).

The most important finding of the study is that the average length of through trips on a link, as estimated by the South African Rural Traffic Model *(5)*, can be used for a uniform countrywide classification of the road network. It is therefore recommended that the following classification, based on trip lengths, be used:

Class	*Description*	*Trip Length*
A	Urban commuter roads	0–100 km
B	Intermetropolitan roads	>350 km
C	Interregional roads	100–350 km
D	Rural access roads	<100 km
E	Roads with exceptional traffic patterns	Not applicable

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