Highway Program Evaluations

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Long-range highway program costs in various states, for construction and maintenance to provide adequate highways, are reviewed in relation to travel, population and motor vehicle registration.

Reduction of annual costs to common indices provides opportunity to examine similarities and differences among the states. Indices, even though based on estimates computed by various methods and individuals in different localities, have less variation among states than might be expected.

System costs per vehicle mile are shown to be least on the heavily-traveled principal city systems, even though per-mile construction costs are greatest. Conversely, highest vehicle-mile costs are on lightly-traveled local road systems.

Conversion of total costs to per capita and other indices also makes program data more easily understood and provides a better basis for economic analysis.

● HIGHWAY POLICY, financing, and administration rely more and more on results of comprehensive, long-range highway needs studies. The studies are new tools, developed only within the last 10 years. Their reliability and reasonableness have been carefully reviewed and accepted by legislators and administrators as a basis for action, the most notable being the 1956 Federal-Aid Highway Act.

Congress called for a nationwide study of highway needs in 1954, following several studies of needs of the federal-aid systems previously presented by AASHO. The report, "Needs of the Highway Systems 1955—1984," indicated that an annual average expenditure of $9.9 billion, at 1954 prices, would be required over the next 30 years to develop, improve, and maintain all 3,300,000 miles of roads and streets in the nation. Projected travel in that period would approximate an average of 900 billion vehicle miles annually. Thus, for the first time it was possible to estimate that, at 1954 price levels, about 1.1 cents per vehicle mile would do the job. Values were higher than that amount prior to 1928 and lower since that date, falling to 0.6 cents by 1941, 0.5 cents in 1945, climbing back to 1.0 cents in 1953 and 1.07 cents in 1954 (1, 2).

It has been stated by Wilfred Owen of the Brookings Institution that about 10 percent or less, of the total cost of motor vehicle operation has been expended for highways (3). He suggests that a higher proportion would be beneficial in reducing total operating costs and providing other benefits. If total vehicle costs now range from 8 to 10 cents per vehicle mile, then the future highway needs would approximate only 11 to 14 percent of the total—or a somewhat higher percentage if the improved highways reduce total costs, as expected.

Despite the billions of dollars reported, the validity and conservativeness of the national estimates becomes apparent upon closer examination. Although $9.9 billion per year for 30 years totals $297 billion, the growth of traffic should be able to support the necessary expenditures, especially when other sources of income are also involved, if past relations are any criteria.

Beyond the implicit reasonableness of the data is acceptance of the engineering techniques and methods of measurement developed in the highway needs studies of the last 10 years. In numerous states and before Congress, the presentation of facts and detailed explanation of how they were obtained has acquainted legislators and the public with the engineering approach as a sound basis for decision-making.

Relations have been developed in the highway needs studies which place the total highway problem in proper perspective. Usually for the first time, not only are total requirements evaluated, but cost relations of various systems, governmental responsibilities and classes of work are established. When compared to the past and the estimated future, the data assume proportions that are generally found to be more understandable.

Reduction of annual costs to common indices also provides opportunity to examine and evaluate similarities and differences among the states. The indices, even though based on estimates computed by various methods and different individuals in many localities, have less variation than might be expected.

All indices reported are based on 20-year programs. That is, costs required over a 20-year period for the following purposes are included, except where otherwise indicated:

1. Improvement of currently deficient facilities to standards adequate for 20-year future traffic—commonly known as the backlog of work;
2. Additional needs which will develop during the 20-year period on facilities not included in the first item;
3. Replacements of both preceding items in the period, on the basis of road life statistics;
4. Stop-gap work required to keep currently deficient sections in service until finances permit full standard improvements;
5. Maintenance and operation; and
6. Engineering and administration.

Estimated values of population, motor vehicle registration and travel during the same 20-year period[1] are then related to the program costs, all of which are stated at price levels prevailing in 1954. Data are limited to 14 of the highway needs studies in which the Automotive Safety Foundation has participated and in which sufficient information is readily available to permit development of the relations.

Costs per Mile of Travel

Table 1 summarizes results of the several studies for all roads and streets in the states listed.

TABLE 1

TOTAL HIGHWAY COSTS—ALL ROADS AND STREETS[a]

Year	State	Cents per Vehicle Mile	Year of Study	State	Cents per Vehicle Mile
1948	Kansas	1.50	1949	Nebraska	1.45
1955[b]	Kentucky	1.24	1952	North Dakota	1.50
1954	Louisiana	1.13	1950	Ohio	0.95
1955[b]	Michigan	1.00	1948	Oregon	0.93
1954	Minnesota	0.93	1955	Tennessee	1.07
1949	Mississippi	1.18	1948	Washington	0.91
1956[b]	Montana	2.10	1954	West Virginia	1.33[c]

[a]20-year program at 1954 prices.
[b]Includes interstate freeway system; [c]excludes local streets.

The unweighted average of the 14 states is 1.23 cents per mile of travel, and the median is about 1.15 cents. If weighted in terms of vehicle miles or program costs, the average would be less since generally the less populous states are shown to have higher costs. It will be noted that the average values are near the total of 1.1 cents for all roads and streets in the nation, as previously described.

For convenience in further analysis, Table 1 is re-arranged in Table 2 in order of cost per vehicle mile, showing also the 1950 state population.

Many variables among the states preclude a completely consistent pattern. For example, Oregon's total population and population density per square mile or per road mile would suggest its position in the higher-cost group. However, both Oregon and

[1] These are computed on a straight-line basis; i.e., present and 20-year future estimates (as presented in the respective studies) are averaged. The curvelinear form of many projections was not taken into account, tending to understate these values and overstate costs to a small degree.

TABLE 2

Cents per Vehicle Mile	State	1950 Population	Cents per Vehicle Mile	State	1950 Population
0.91	Washington	2,379,000	1.18	Mississippi	2,179,000
0.92	Oregon	1,521,000	1.24	Kentucky[a]	2,945,000
0.93	Minnesota	2,982,000	1.33	West Virginia	2,006,000
0.95	Ohio	7,947,000	1.45	Nebraska	1,326,000
1.00	Michigan[a]	6,372,000	1.50	Kansas	1,905,000
1.07	Tennessee	3,292,000	1.50	North Dakota	620,000
1.13	Louisiana	2,684,000	2.10	Montana[a]	591,000
0.99	Average of 7 states	3,882,000	1.47	Average of 7 states	1,653,000

[a]Includes interstate freeway system.

Washington are expected to have faster future growth of population and travel than any comparable states, thus reducing the relative cost of a future 20-year program.

Travel growth has considerably exceeded nearly all forecasts. Naturally, if travel exceeds the forecasts with less than a comparable rise in total program costs, then costs per vehicle mile would be less, provided price levels do not increase. Data in Table 2 suggest that those states with currently high volumes of travel, or with relatively rapid increases forecast, actually have lower costs per vehicle mile than other states, despite the greater need for higher cost facilities. In part, that may be due to a relatively better current status of improvement in many of the more populous states, thus reducing the catch-up costs required within the 20-year period.

Only Michigan, Kentucky, and Montana included costs of developing the interstate system, both rural and urban, to the high standards recently adopted by AASHO. All studies, however, planned for such multi-lane highways, expressways, and freeways as were indicated by traffic needs, but not necessarily with such desirable consistency as is now contemplated.

For some of the states previously listed, plus the Province of Ontario, Table 3 shows relations of 20-year program costs per mile of travel on specific classes, or systems, as they were classified in the studies. In most cases, it was assumed that the percentage of total state travel on each system would remain at existing proportions throughout the 20-year period, with travel on each system increasing at the estimated statewide rate.

Table 3 shows that, with only two exceptions, the more heavily traveled systems have lower costs per mile of travel. That is true despite the higher standards and greater costs per mile on the principal routes, as indicated in Table 4. One exception is in Minnesota where urban state highways are shown to cost somewhat more than the unusually low-cost rural highways. That was due, at least in part, to the present excellence of the rural state highway system (whose costs would rise as a result of present interstate standards) and, conversely, the need for a major freeway system in the Twin Cities. The other exception is Oregon, where difficulty in allocating costs and vehicle mileage between rural state highways and county primary roads may account for the apparent discrepancy.

Table 3 also reveals other variables which reflect specific situations in various states:

Urban Primary State Highways. Higher costs in West Virginia reflect difficult construction in mountainous terrain. In North Dakota, fewer vehicle miles relative to needs account for the highest costs listed. The reverse is true in Ohio, but in Mississippi it is believed that estimates of needs were inadequate (Table 4).

Rural Primary State Highways. Two of the highest figures listed (Kansas and North Dakota) reflect large mileages and quite inadequate systems, coupled with relatively light traffic as compared to other more populous states. Again, West Virginia's costs

TABLE 3

TOTAL HIGHWAY COSTS BY SYSTEMS[a]

State	Primary State Highways Urban (Cents per Vehicle Mile)	Primary State Highways Rural (Cents per Vehicle Mile)	County Primary Roads	Local Roads
Kansas	0.57[b]	1.37[b]	2.22	5.80
Kentucky	0.84[b]	0.90[b]	1.87	5.30
Minnesota	0.81	0.60	1.56	2.40
Mississippi	0.45	0.57	2.17	3.67
Nebraska	0.75	1.04	1.82	5.70
North Dakota	1.02	1.34	2.00	2.10
Ohio	0.57	0.81	1.40	1.81
Ontario	----	0.88[c]	----	----
Oregon	0.34	1.07[d]	0.92	3.10
Washington	0.37	0.87[d]	1.33	3.02
West Virginia	0.83	1.27	2.07	4.25
Unweighted Average	0.66	0.97	1.74	3.72

[a]20-year program at 1954 prices, [b]includes interstate freeway system, [c]includes province-wide freeway system, [d]includes secondary state highways.

reflect heavy construction in mountainous terrain. On the other hand, Mississippi's system was well-developed, much of it newly built between 1936 and 1941, and maintenance requirements are less in southern states.

The Ontario system also falls within the general pattern of the states. Needs are considerable, including the development of an extensive freeway system and many other multi-lane facilities along with improved highways in the thinly-populated northern area. Predicted traffic growth, however, is also great, with the result that costs are in line with those elsewhere.

County Primary Roads. There is less spread among the states than for other systems which suggests a greater degree of uniformity in travel and costs. Low-cost states such as Washington, Ohio, and Minnesota possibly reflect the good county engineering which exists there, the easier terrain in the latter two, and more readily available materials.

Kansas has extensive mileage of relatively lightly traveled roads and lacks cheap surfacing materials—both combining to increase costs per mile of travel. Mississippi county roads were in very poor condition, with material also at a premium.

Local Roads. Variations also apply to the local road systems. In addition, the standards applicable to the large mileage in North Dakota were especially low in keeping with the very light traffic (Table 4). Furthermore, variations may result from greater difficulties in estimating traffic and vehicle miles on these systems. Because of the low percentages of total travel on local roads, a small variation would have a considerable effect on the vehicle-mile cost.

Annual Costs Per Mile

The total annual costs per mile, including construction, maintenance and administration, for 20-year programs tend to approximate the perpetual cost per mile of owning and operating the road systems—the true annual cost, exclusive of interest. There is considerable variation among the states, since these costs reflect specific standards of construction and maintenance, as well as present degree of improvement, terrain and other factors, without the smoothing influence of predicted vehicle miles of travel (Table 4).

In all cases, urban state highways are highest annual cost-per-mile facilities, and costs of rural systems are graduated downward in accord with function and use. However, costs per vehicle mile are generally in reverse order, indicating the relative value of such high-cost facilities to the motorist.

It should be noted that the "Total" of Table 4 does not include city arterial and local streets, and is too limited a sample to be taken as indicative of values elsewhere than in the listed states. Nevertheless, the data provide valuable comparisons for consideration in other studies.

Some of the reasons for the variations have been noted with respect to Table 3, in which Michigan does not appear because of lack of data with respect to vehicle miles by systems. In Table 4, however, it should be pointed out that Michigan primary

TABLE 4

TOTAL ANNUAL COSTS PER MILE BY SYSTEMS[a]

State	Urban State Highways	Rural State Highways	Primary County Roads	Local Roads	Weighted Total
Kansas	$10,100	$ 4,770	$ 810	$290	$ 745
Kentucky	25,600[b]	10,600[b]	2,150	830	2,200
Michigan	(------$18,500[b]----)		3,100	900	3,160
Minnesota	17,900	3,600	1,075	275	1,080
Mississippi	4,700	2,900	1,500	415	940
Nebraska	10,000	3,700	950	245	735
North Dakota	6,400	2,650	650	130	610
Ohio	22,900	6,400	1,980	610	2,250
Ontario	----	12,600	---	---	---
Oregon	14,300	5,280[c]	1,750	410	1,560
Washington	15,000	6,200[c]	1,190	445	1,500
West Virginia	21,600	11,400	2,100	730	2,620
Unweighted Average	$14,850	$ 6,380	$1,570	$480	$1,580

[a]20-year program at 1954 prices, [b]includes interstate freeway system, [c]includes secondary state highways.

county road programs include considerable multi-lane construction in the vicinity of Detroit and other cities, accounting in part for the indicated cost. Snow removal costs also exceed those of many states.

Other Indices

Conversion of total program costs to per capita and per-vehicle costs (Table 5) brings the millions or billions involved into more readily understandable form and provides a basis for comparison and evaluation of the costs among states. Population and number of vehicles on which Table 5 is based are average totals as projected for the 20-year programs in the individual states.

The unweighted average annual per capita cost for all 14 states is $46; the annual average cost per vehicle is $116.

Conversion of these costs to any other common base may be of interest; for example, the Michigan cost is the equivalent of 12 cents per day per capita; in West Virginia the cost would average about 40 cents per day for each motor vehicle.

With due regard for variables and with proper adjustment for price changes, such evaluations and comparisons provide a valuable guide in judging the adequacy and validity of needs estimates.

Furthermore, by relating these future estimates to past conditions, the economic feasibility may be clearly indicated. Michigan data showed, for instance, that actual expenditures (without price adjustment) from 1920 to 1931 were at rates averaging about 45 percent higher than the proposed 20-year program per vehicle mile. From 1931 until 1955, expenditures averaged only about 60 percent of those proposed (per vehicle mile), but in 1956, about 87 percent was available. In Kentucky, the state was

TABLE 5

ANNUAL COSTS—ALL ROADS AND STREETS[a]

State	Average Cost per Capita	Average Cost per Vehicle	State	Average Cost per Capita	Average Cost per Vehicle
Kansas	$ 58	$143	Nebraska	$42	$113
Kentucky[b]	44	118	North Dakota	58	117
Louisiana	41	106	Ohio	30	76
Michigan[b]	45	102	Oregon	35	89
Minnesota	42	96	Tennessee	39	102
Mississippi	28	142	Washington	32	91
Montana	114	188	West Virginia[c]	42	144

[a]20-year program at 1954 prices, [b]includes interstate freeway system, [c]excludes local streets.

spending about 1.1 cents per vehicle mile in 1953-54; the future program was estimated to cost about 1.24 cents.

Highway needs and financing studies have indicated that the future long-range investment requirements are not out of line with past performance when growth factors are accounted for. But acceleration to catch up with deferred work is shown to be the major present problem. Each study should be designed to develop the significant relations that will encourage attainment of adequate highway, road and street systems.

REFERENCES

1. "Highway Facts," Automotive Safety Foundation (1952).
2. "Highway Statistics," U.S. Department of Commerce, Bureau of Public Roads.
3. Wilfred Owen, "Automotive Transportation," Brookings Institution (1949).