ACCIDENT COSTS: SOME ESTIMATES FOR USE IN ENGINEERING-ECONOMY STUDIES

Dock Burke and W. Frank McFarland, Texas Transportation Institute, Texas A&M University

The primary objective of this paper is to devise and implement a procedure for estimating accident costs, based on cost data developed by several state highway departments, that are readily applicable for use in engineering-economy analysis. The overall approach is to generate weighted averages for the costs of accidents wherein the estimates from previous studies provide the direct cost input and the 1969 Texas accident experience provides the weights to be assigned to these costs. Direct costs include property damages, medical costs, legal and court fees, values for loss of work time and loss of vehicle use, and damages awarded in excess of costs. An involvement is that portion of an accident relating to a single vehicle and the death, injury, or property damage associated with it. Using the involvement as the basic statistical unit, the data are cross-classified by various combinations of accident severity, vehicle type, and accident type. For each of the resulting categories, the cost components are adjusted by price index inflators, and a mean involvement cost is calculated from these adjusted data. In addition to the direct cost per involvement, another type of cost, the present value of expected future earnings, is estimated for involvements where persons were fatally injured. An estimate for the cost of an accident can be obtained by combining the appropriate direct cost for the vehicles involved with the present value of future earnings lost due to fatalities occurring in the accident.

•IN 1949, the Bureau of Public Roads published a manual of procedures that was to serve as a guide in conducting comprehensive statewide research on motor-vehicle accident costs (1). The study design, which implemented recommendations developed by a committee of the Highway Research Board, was to provide data for the following purposes:

1. The determination of those costs of motor-vehicle accidents that might be saved for the vehicle owner by the elimination of accidents;
2. The determination of all other costs of motor-vehicle accidents, including expenditures made to prevent accidents or to protect against liability for damages and losses;
3. The correlation of certain characteristics of accidents for which adequate summaries are not generally available, such as age and sex of driver;
4. The establishment of general accident rates, such as commercial vehicle accidents per unit of travel compared with similar rates for passenger cars; and
5. A contribution to other studies being conducted through the Highway Research Board.

To date, five states have completed and published the results of studies based on the framework described in the BPR manual (2, 3, 4, 5, 6). In addition to providing a large quantity of detailed data, some of these studies have served as the data base

Publication of this paper sponsored by Committee on Application of Economic Analysis to Transportation Problems.

for papers published by the HRB (6, 7, 8, 9). In spite of the amount of work that has been accomplished regarding these accident-cost studies, there exists a data gap with regard to readily accessible cost information that can be used as coefficients in engineering-economy analyses (exceptions include 4, 10, 11).

The purpose of this paper is to present some of the results of a larger study conducted at the Texas Transportation Institute under the sponsorship of the Texas Highway Department and the Federal Highway Administration (14). The cost estimates presented here were developed to serve as input data for use in benefit-cost, cost-effectiveness, and other types of engineering-economy models.

The data base used is a combination of the information collected by the states of Utah, New Mexico, Massachusetts, and Illinois (hereafter referred to as the data states). In the aggregate, over 19,000 accident involvements and their associated costs and characteristics composed the data base. To complement this information, data describing the Texas accident experience in 1969 (a total of more than 544,000 involvements) were used to develop a weighting system for the construction of the accident cost series.

BASIC CONCEPTS AND DEFINITIONS

Each of the studies by the data states was the product of an extensive questionnaire-interview process in which individuals involved in accidents were queried to determine the direct cost of their portion of the accident. Each of the data states made its raw information available to the BPR, and in 1968 the Bureau compiled and reorganized the data to ensure mutual compatibility. These data were provided by the BPR for use in this study and serve as the basis for the cost estimates presented here.

A traffic accident is any accident involving one or more motor vehicles in motion that occurs on a traffic-way and results in death, injury, and/or property damage. Ideally, the determination of accident costs would be made using the individual traffic accident as the basic statistical unit over which a sample would be taken. However, such a procedure is operationally difficult and costly to implement when more than a single vehicle is involved. Consequently, an alternative procedure was developed using the involvement rather than the accident as the basic statistical datum.

An involvement is that portion of an accident relating to a single vehicle and the death, injury, and/or property damage associated with that vehicle. By way of example, assume that a car collides head-on into a truck, resulting in death, injury, and property damage in the car and property damage only in the truck. Such an outcome produces a fatal car-truck accident and two involvements: a passenger car involvement and a truck involvement. The accident-involvement dichotomy is of critical importance in derivation of cost estimates and is discussed further in a later section.

The criteria for the selection of the elements to be included in the cost estimates are based on the distinction between direct and indirect costs (1, p. 9 et seq.). In general, direct costs include the following major components: (a) property damages to vehicles, vehicular cargoes, and nonvehicular property; (b) medical costs, including doctor's fees and charges for hospitals, drugs, medicines, appliances, and ambulance service; (c) legal and court costs; (d) value of work time lost due to nonfatal injuries; and (e) miscellaneous costs. In summary, direct costs include those expenses (primarily "out-of-pocket") that can be directly attributable to accident occurrences.

Indirect costs are the "money value of damages and losses to persons and property that are the indirect result of accidents" (1, p. 9) and include items such as loss of future earnings due to fatal injury, loss of use of vehicle, accident prevention activities, et al. Since the data states relied exclusively on the direct cost components as the sources for their cost estimates, little will be said about indirect costs. There is, however, at least one indirect cost item—the loss of future earnings due to fatal injury—that should be discussed if for no other reason than the magnitude of the dollar value it entails. The loss of future earnings due to death represents the dollar amount of potential goods and services that is lost to society when one of its members dies. The introduction of such an item brings forth, at least implicitly, the notion of a measurement for the value of a human being and all its attendant moral and philosophical trappings. At any rate, the decision to include or exclude the loss of future earnings has a very significant impact on the estimated costs of fatal involvements and accidents. For example, in the Ohio study (4, p. 32) the estimated direct cost per fatal passenger car involvement is $4,236. In the Washington Metropolitan Area Study (11, p. 77), the inclusion of loss of future earnings led to a cost per fatal passenger-car involvement estimated at $49,435.

In reflecting only the direct costs, the cost for fatalities generated by the data states might be interpreted as representing some set of minimum values. To these minima could be added an estimate for loss of future earnings. The result would be a more comprehensive estimate of the costs of fatal accidents and involvements.

RESEARCH METHOD

Briefly summarized, the method used to derive a set of cost estimates for use in engineering economy studies is as follows:

1. Calculate the average (mean) direct cost of an involvement;
2. Utilize accident-involvement ratios (based on the 1969 accident experience in Texas) to convert direct costs per involvement to direct cost per accident;
3. Calculate the average loss of future earnings (using the age and sex distribution of fatally injured persons in Texas in 1969) per fatal accident; and
4. Add the value in step 3 to the costs for fatal accidents in step 2.

General Considerations and the Data System

Underlying this method of determining the cost estimates for involvements and accidents is the notion that the magnitude of the direct costs is dependent on (a) the cost per unit of the relevant components (e.g., dollars per hospital day, dollars per wrecker haul, dollars per hour of mechanical labor) and (b) the number of units involved (e.g., 20-day hospital stay, 50-mile wrecker tow, 3 hours' labor in repair shop). The number and type of such units that result from an accident are partly a function of the physical characteristics of the accident, such as the number of vehicles involved, type and manner of collision, number and type of personal injuries, vehicle speed, and so forth. What is being sought is a selection of the physical characteristics that will allow a categorization that tends to group accidents similar in cost.

The characteristics obtained to systematize the cost data were chosen on the basis of (a) their hypothesized importance in determining involvement costs and (b) the type of information available from the data states. For example, vehicle speed reasonably could be hypothesized as an important determinant of involvement costs, i.e., the higher the speed of the involved vehicle, the higher the involvement cost. Nevertheless, since vehicle speeds are not among the information comprehensively provided by the data states, direct classification of involvements according to speed is not possible. A less direct way of accounting for the influence of speed on the resulting costs is possible by using a rural-urban dichotomy, because rural travel implies higher speeds than urban travel. As a result, the classification system that is used here reflects the need to combine analytical categories with categories determined by data availability. [A more complete classification system is presented elsewhere (14); in addition to the severity, accident type, and vehicle type developed here, the categories of accident location (rural-urban), highway type, and highway system are included.]

The most important characteristic of an accident is probably its severity. Whether persons were killed, injured, or unharmed affects the magnitude of both the direct and indirect costs. A classification of fatal, injury, or property damage only (PDO) would be expected to show increasing costs from the least severe (PDO) to the most severe (fatal). Because, in the studies made by the data states and in this paper, the entire system of classification of involvements revolves around the severity category, it is of some importance that costs-per-involvement for a given severity be approximately the same in each of the data states. If this is so, the data from the four studies can be combined and treated as a single data system from which the direct cost of an involvement having certain physical characteristics can be adequately estimated by the average (mean) cost of other like involvements.

In addition to severity, two other physical characteristics—accident type and vehicle type—were selected on which to classify involvements for calculating their average costs. Accident type refers essentially to the manner in which an accident occurred. To a larger degree, it also indicates whether the accident involved one vehicle or several vehicles. Thirteen types of accidents were codified by the data states and used for the present paper (Table 1). They include head-on, sideswipe, turning, and rear-end collisions, which involve more than one vehicle, as well as collisions of single motor vehicles with pedestrians, bicycles, trains, animals, fixed objects, and other objects.

The type of vehicle characteristic permits classification of involvements on the basis of passenger car, single-unit truck (e.g., pickup, bobtail), and combination-unit truck.

Using these three characteristics—severity, accident type, and vehicle type—an analysis of variance was made to compare the costs of like involvements among the four data states. The results indicated that, at the 5 percent level of confidence, there was no significant difference in the mean involvement costs among the data states for similar involvements. The raw data from the data states were combined and subsequently treated as a single data system.

To treat the information from the data states as a single, combined data base, it is necessary to aggregate the data in a manner compatible with the sampling procedures used by those states. To this end, the statistical treatment of the resulting combined data base is somewhat constrained. Such constraint is manifested in the following manner: Involvements must first be segregated into severity classes before further classification is accomplished, and, inversely, severity classes cannot be combined in the process of deriving involvement cost estimates. This procedure is used because, in the context of a combined single data base, the sampling rates of the individual states cannot be utilized in determining mean involvement costs. These rates, which permitted the individual states to aggregate across different severities, were determined by the accident experience of the respective states and (along with the resulting expansion factors that were used to expand state samples into state totals) have quantitative meaning only with respect to the individual state. On the other hand, when the involvements of the data states are grouped by severity, the implicit assumption is that these involvements are from statistical populations that include only involvements of like severity. Thus, a fatal involvement in Illinois and a fatal involvement in Utah are viewed as equivalent observations from the population of fatal involvements.

The most important aspect of this treatment is the limitation it places on the interpretation of the resulting mean cost estimates. Although it is possible to determine the mean cost of selected involvements of like severity, it is not possible to derive the mean cost of selected involvements of differing severities. In the former case, the involvements are equally weighted; in the latter, no weights can be assigned since the exact nature of the quantitative relationship (in the combined data system) among the severity categories cannot be specified due to the different sampling rates selected for the original individual state studies.

Price Adjustments

In determining the average cost of involvements, the direct cost components must be adjusted via a price index in order to convert costs into comparable magnitudes. Because governmental price indexes are not constructed on an individual state basis, adjustments for relative cost differentials among the states cannot be made. To adjust for price differentials due to time differences and to put all the cost data on a comparable basis, two price indexes are used—the overall Consumer Price Index and the medical cost component of the Consumer Price Index. [The individual studies were conducted in 1953, 1955-7, 1955-6, and 1958. All the data were adjusted to 1969 levels.] The direct-cost items containing medical, hospital, physician, and nursing fees are adjusted by the medical cost component of the Consumer Price Index. All other direct costs are adjusted by the overall index. After the direct costs are adjusted for price level changes, the mean cost of the involvement (as defined by the severity, accident type, and vehicle type) is calculated. The results are given in Tables 1 and 2.

Table 1. Direct cost in dollars per involvement for passenger cars by accident type and severity, from data states.

Accident Type	Severity: Fatal	Injury	PDO
Multi-vehicle			
Head-on	8,593	1,518	235
Std. error	1,469	223	11
Rear-end	6,482	1,000	161
Std. error	1,432	62	4
Angle	6,505	950	198
Std. error	644	42	5
Sideswipe	6,946	594	131
Std. error	2,299	80	9
Turning	5,232	945	169
Std. error	1,439	87	6
Parking	—	485	66
Std. error	—	95	3
Other	7,731	862	123
Std. error	4,523	161	6
Single vehicle			
Pedestrian	5,395	1,441	28
Std. error	329	206	5
Train	6,846	1,834	439
Std. error	986	733	163
Bicycle	4,518	1,006	61
Std. error	678	402	13
Animal	3,066	1,878	308
Std. error	1,650	424	23
Fixed object	3,057	1,934	273
Std. error	308	278	19
Other object	5,578	1,139	91
Std. error	4,262	164	2
Non-collision[a]	3,909	1,681	219
Std. error	508	118	12
All	5,574	1,137	165
Std. error	295	40	2

[a]For example, vehicle running off the road or overturning.

Table 2. Direct cost in dollars per involvement for single-unit and combination trucks by accident type and severity, from data states.

	Severity by Truck Type					
	Single-Unit			Combination		
Accident Type	Fatal	Injury	PDO	Fatal	Injury	PDO
Multi-vehicle						
Head-on	5,897	1,567	425	6,705	5,313	1,273
Std. error	1,887	204	72	1,542	1,966	496
Rear-end	4,372	561	113	6,076	796	190
Std. error	1,399	58	11	3,281	271	46
Angle	7,269	728	164	6,689	1,659	386
Std. error	1,149	55	9	2,876	846	93
Sideswipe	3,199	933	101	—	477	83
Std. error	2,847	336	11	—	143	24
Turning	5,068	735	120	3,761	1,818	102
Std. error	1,977	96	7	1,128	1,145	35
Parking	—	306	66	—	665	145
Std. error	—	150	16	—	638	74
Other	1,017	751	111	1,134	239	384
Std. error	417	188	18	703	124	200
Single-vehicle						
Pedestrian	4,685	1,370	—	4,615	1,625	—
Std. error	571	219	—	1,154	358	—
Train	12,524	3,017	1,206	—	8,056	1,670
Std. error	3,342	1,177	482	—	2,256	685
Bicycle	3,978	761	41	3,000	285	—
Std. error	1,273	297	11	897	121	—
Animal	1,738	2,018	348	—	6,891	1,529
Std. error	1,234	747	45	—	5,651	902
Fixed object	7,469	1,908	545	15,706	7,671	2,198
Std. error	1,568	1,248	55	5,497	3,989	769
Other object	—	752	75	—	311	105
Std. error	—	271	15	—	146	22
Non-collision	3,310	2,212	847	12,184	6,488	2,924
Std. error	596	288	93	2,071	1,038	673
All	5,274	951	193	6,698	2,073	695
Std. error	411	43	8	918	332	97

Loss of Future Earnings

To derive a measure for the loss of future earnings for fatally injured persons, estimates are made using data developed by Weisbrod in his analysis of the economic costs of diseases (12, 13). Weisbrod's present values of net future earnings (discounted value of expected future earnings minus expected consumption) are adjusted by the Consumer Price Index to bring the data up to 1969. To convert Weisbrod's data into estimates due to highway fatalities, the age and sex composition of those persons killed in Texas accidents in 1969 is used to calculate a weighted mean representing the loss attributable to a highway fatality.

Although the price index adjustment is assumed to be correct for increases in earnings (including inflationary and productivity changes), two other factors probably cause the resulting estimates to be undervalued. The first of these is due to changes in life expectancies. Weisbrod's calculations employed actuarial data obtained in 1961. In the ensuing years life expectancies have lengthened, and current estimates based on his data are probably undervalued. Second, by deducting personal consumption expenditures from earnings, Weisbrod chose to ignore the value to a deceased person of his own consumption activities. An alternative to this approach would have been to use the present value of gross future earnings, which is philosophically different from and yields quantitatively larger results than the method used herein. At any rate, the net effect of these two factors is to generate values for losses of future earnings due to fatalities that are smaller than they might or should be. The resulting estimates are given in Table 3.

ACCIDENTS AND ACCIDENT COSTS

Utilizing the involvement cost and loss of future earnings data, a set of accident cost estimates can be derived for selected accident categories. Limitations of involvement cost data restrict the discussion of accident costs to three types: (a) passenger car accidents (single and multi-vehicular); (b) truck accidents (single and multi-vehicular); and (c) car-truck accidents (multi-vehicular only). The development of these accident cost estimates is, briefly, the result of combining the direct involvement costs and indirect costs into a weighted average cost—the weights having been determined from the accident experience in Texas in 1969. The procedures used to develop Tables 4 through 7 are discussed below.

Truck Accidents

Since truck involvement and involvement cost data are available for single-unit and combination trucks, the direct cost estimates for all truck involvements are weighted averages of the direct costs of single-unit- and combination-truck involvements. The weights used in deriving these weighted averages are based on the relative proportions of the two types of trucks involved in accidents in Texas. Thus, for example, the direct cost of a truck-pedestrian fatal accident would be the sum of the cost of a single-unit truck-pedestrian involvement (multiplied by the percentage that single-unit involvements are of total truck involvements) and the cost of a combination-truck-pedestrian involvement (multiplied by the percentage that combination-truck involvements are of total truck involvements).

In the case of single-vehicle accidents, there is no difference between involvement costs and accident costs. For multi-vehicular accidents, the estimated accident costs are some multiple of the involvement costs. In the case of truck-only accidents, it is assumed that 2 trucks are involved per multi-vehicle accident. This assumption gives a downward bias to the estimates of this kind of accident since some truck accidents undoubtedly involve more than 2 trucks. However, in the absence of the precise data, the assumption of 2 trucks per multi-vehicular truck accident is used.

Passenger Car Accidents

As in the case of trucks, a single-vehicle passenger car accident is equivalent to an involvement. Thus, accident costs for single-car accidents are the same as the involve-

Table 3. Weighted average of present values of net future earnings in dollars, discounted at 10 percent and 4 percent, for persons killed in Texas accidents, 1969.

	Present Value	
Persons Killed	10 Percent Discount	4 Percent Discount
Male	23,200	45,200
Female	16,900	33,300
All	21,300	41,600

Table 4. Direct cost in dollars per fatal accident by accident type and vehicle-type combination in Texas, 1969.

	Vehicle-Type Combination			
Accident Type	Car	Car-Truck	Truck	All
Multi-vehicle				
Head-on	18,152	14,809	12,432	16,516
Rear-end	14,229	11,516	10,068	12,093
Angle	13,219	13,591	14,172	13,413
Sideswipe	14,760	10,145	6,398	12,799
Turning	10,584	9,891	9,318	10,242
Parking	–	–	–	–
Other	7,731	–	2,104	6,392
All multi-vehicle	14,635	13,198	10,775	13,781
Single-vehicle				
Pedestrian	5,395		4,674	5,279
Train	6,846		12,524	8,119
Bicycle	4,518		3,000	4,281
Animal	3,173		1,738	2,446
Fixed object	3,057		8,842	4,108
Other object	5,578		–	–
Non-collision	3,909		5,402	4,283
All	7,780	13,198	7,478	8,627

Table 5. Direct cost in dollars per injury accident by accident type and vehicle-type combination in Texas, 1969.

	Vehicle-Type Combination			
Accident Type	Car	Car-Truck	Truck	All
Multi-vehicle				
Head-on	3,091	3,744	4,452	3,341
Rear-end	2,071	1,596	1,192	1,932
Angle	1,915	1,759	1,618	1,873
Sideswipe	1,227	1,398	1,608	1,302
Turning	1,901	1,821	1,752	1,875
Parking	967	828	668	923
Other	1,755	1,137	1,428	1,722
All multi-vehicle	1,994	1,856	1,745	1,955
Single-vehicle				
Pedestrian	1,441		1,381	1,433
Train	1,834		4,127	2,242
Bicycle	1,006		755	974
Animal	1,878		2,684	2,031
Fixed object	1,934		1,948	1,942
Other object	1,139		215	1,072
Non-collision	1,681		2,952	1,839
All	1,879	1,856	2,393	1,917

Table 6. Direct cost in dollars per property-damage-only accident by accident type and vehicle-type combination in Texas, 1969.

	Vehicle-Type Combination			
Accident Type	Car	Car-Truck	Truck	All
Multi-vehicle				
Head-on	470	766	1,062	595
Rear-end	320	282	242	310
Angle	416	375	354	405
Sideswipe	258	229	196	246
Turning	338	287	236	321
Parking	132	135	139	133
Other	135	236	226	152
All multi-vehicle	316	331	287	318
Single-vehicle				
Pedestrian	–		–	–
Train	439		1,367	685
Bicycle	61		38	58
Animal	308		607	373
Fixed object	273		1,018	381
Other object	91		82	89
Non-collision	219		1,407	499
All	305	331	679	334

Table 7. Cost in dollars per reported accident for all severities by accident type and vehicle-type combination in Texas, 1969, with loss of future earnings discounted at 4 percent.

	Vehicle-Type Combination			
Accident Type	Car Only	Car-Truck	Truck Only	All
Multi-vehicle				
Head-on	3,100	4,000	4,500	3,500
Rear-end	600	700	1,200	700
Angle	900	1,100	1,200	900
Sideswipe	400	400	500	400
Turning	700	800	900	700
Parking	200	200	200	200
Other	400	300	400	400
All multi-vehicle	800	1,000	600	800
Single-vehicle				
Pedestrian	5,000		5,800	5,100
Train	6,000		8,500	6,600
Bicycle	2,100		2,100	2,100
Animal	500		1,000	600
Fixed object	1,500		2,500	1,600
Other object	400		200	400
Non-collision	1,800		3,300	2,100
All	1,000	1,000	2,000	1,100

ment costs. For multi-vehicular accidents involving passenger cars, costs are determined by (a) assuming the involvement of one passenger car per car-truck and car-other accident; (b) subtracting from total passenger car involvements (of a given severity and accident type) the number of cars involved in car-truck and car-other accidents; and (c) dividing the residual determined in (b) by the number of passenger-car-only accidents (by accident type) to determine the average number of passenger cars involved in the respective types of multi-vehicular accidents. For example, there are 731 passenger cars involved in fatal head-on accidents. There were 176 car-truck, 10 car-other, and 258 car-only fatal head-on accidents. If one car is involved per car-truck and car-other accident, there were 545 cars involved in the 258 car-only accidents. This results in an average of 2.11 cars per fatal head-on accident.

The accident costs for the car-only accidents, then, are obtained by multiplying the average number of cars involved in accidents (of given severity and accident type) by the costs per car involvement in those accidents.

Car-Truck Accidents

The accident cost of a car-truck accident is the sum of the cost per truck involvement and cost per car involvement, since it is assumed that only one car and one truck are involved. As is the case of truck-only, multi-vehicular accidents, this assumption gives a downward bias to the cost per car-truck accident since there probably are some of these accidents involving two or more cars or trucks.

Because no appropriate involvement cost estimates were available from the data states, no accident cost estimates have been derived for those accidents (2 percent of all Texas accidents) involving vehicles other than cars-only, trucks-only, and cars-trucks.

In computing weighted averages for accident costs including loss of future earnings (Table 7), it is assumed that (a) in pedestrian and bicycle fatal accidents only one fatality occurs per accident and (b) for all other accident types the number of fatalities that occur per accident is 1.26. This average was obtained by prorating the fatality data in Texas, having allowed for the occurrence of one fatality per pedestrian accident and per bicycle accident.

LIMITATIONS OF THE DATA

While the accident costs developed in this paper may be useful as inputs in engineering-economy analyses, they are not without their limitations. The potential user of these estimates should at least keep in mind the following:

1. The weights, as derived from the 1969 accident experience in Texas, may not be valid for some uses.
2. Changes in vehicle operating speeds, vehicle design, and highway design may have caused changes in the involvement costs that are not adequately reflected in these estimates.
3. In the absence of more detailed information, the data in Table 7 were developed assuming 1.26 fatalities per accident (except in the cases of pedestrian and bicycle accidents). Consequently, a special caveat is in order regarding their use, although the data are illustrative of the results obtained from following the procedures detailed in this paper.

SUMMARY AND CONCLUSIONS

This paper has presented some of the accident cost information developed in a comprehensive study that made use of extensive data developed in four statewide accident cost studies together with other information covering all accidents in Texas in one year.

It is the authors' opinion that the accident costs provided in this paper will be quite useful as inputs in engineering-economy studies. These accident costs have at least three advantages over other comparable cost estimates currently available in the literature:

1. They are provided on a cost-per-accident basis,
2. They are updated to recent times, and
3. They cover a much larger sample than any other estimates now available.

ACKNOWLEDGMENTS

This investigation was conducted under the cooperative research program sponsored by the Texas Highway Department and the Federal Highway Administration. The contents of this paper reflect the views of the authors who are responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of the Federal Highway Administration.

REFERENCES

1. A Proposed Study for the Determination of the Cost of Motor Vehicle Accidents. U.S. Bureau of Public Roads, 1949.
2. Cost of Motor Vehicle Accidents to Illinois Motorists, 1958. Illinois Department of Public Works and Buildings, Division of Highways, 1962.
3. The Economic Costs of Motor-Vehicle Accidents. New Mexico State Highway Department.
4. Ohio Department of Highways. The Analysis of Motor Vehicle Accident Costs in the State of Ohio. Ohio State Univ., 1970.
5. Economic Cost of Motor Vehicle Accidents. Utah State Department of Highways.
6. Dunman, R. Economic Cost of Traffic Accidents in Relation to the Human Element. HRB Bull. 263, 1960, pp. 40-49.
7. Billingsley, C. M., and Jorgenson, D. P. Direct Costs and Frequencies of 1958 Illinois Motor-Vehicle Accidents. Highway Research Record 12, 1963, pp. 48-76.
8. Dunman, R. Economic Costs of Motor Vehicle Accidents. HRB Bull. 208, 1959, pp. 16-28.
9. Johnston, J. E. Economic Cost of Traffic Accidents in Relation to Highway Planning. HRB Bull. 263, 1960, pp. 50-53.
10. Smith, R. N., and Tamburri, T. N. Direct Costs of California State Highway Accidents. California Division of Highways, 1967.
11. Motor Vehicle Accident Costs: Washington Metropolitan Area. Wilbur Smith and Associates, 1966.
12. Weisbrod, B. A. Economics of Public Health. Univ. of Pennsylvania Press, Philadelphia, 1961.
13. Weisbrod, B. A. The Valuation of Human Capital. Jour. of Political Economy, Vol. 69, No. 5, 1961.
14. Burke, D. Highway Accident Costs and Rates in Texas. Texas Transportation Institute, 1970.