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IN THIS ISSUE

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Travel Patterns in 50 Cities

BY THE DIVISION OF HIGHWAY PLANNING
BUREAU OF PUBLIC ROADS

Reported by FRANK B. CURRAN, Statistician, and JOSEPH T. STEGMAIER, Highway Research Engineer

During the past 15 years origin-and-destination traffic surveys of the home-interview type have been conducted in more than one hundred cities. This article presents information regarding the purpose for which trips were made by residents in 50 of these urban areas and the mode of travel they used. Data are also included pertaining to basic household characteristics of the areas such as the numbers of dwelling units, residents, and automobiles owned, and the relations between these characteristics and the volume of trips classified according to purpose and mode of travel. The urban areas have been grouped by population size to disclose whatever travel trends or patterns may exist among cities in the several population groups.

The percentage distribution of major trip purposes is fairly uniform in cities of all sizes. Analysis by mode of travel, however, shows a variable pattern. The proportion of trips by automobiles and taxis increases as city size decreases. On the whole, mass transit is by far the most prevalent mode of travel in the largest cities, but its relative importance varies depending upon the trip purpose. Trips for social and recreational purposes, for instance, generally involve the use of automobiles.

In most cases, the volume of daily trips by residents within an urban area is directly related to the numbers of persons, dwelling units, and automobiles registered in the area. The relations vary, however, depending upon the trip purpose and mode of travel.

AMONG the more important factors affecting the planning of streets and highways are the means by which residents travel within the city, the purposes for which the trips are made, and the relations between these trips and residential characteristics such as the number of persons living in the area, the number of dwelling units they occupy, and the number of automobiles they own. At the time this article was prepared, information of this sort was available from origin-and-destination traffic studies[1] of the home-interview type which had been made in 101 urban areas since 1944. The product of these studies includes a great mass of data on the local travel habits of urban residents on an average weekday during the period of the survey.

Data from these studies have already been analyzed and the results have been put to use in each of the individual urban areas surveyed. However, knowledge of the general or average pattern for groups of cities of similar size should be very beneficial to highway planners. Thus it may be possible to establish norms that might be helpful in anticipating the changes which will take place in the traffic patterns of a city as the pattern of living changes.

The primary intent of this article, therefore, is to call attention to the more significant aspects of the many-sided travel patterns for 50 of these cities, considered either singly or in combination. Information from the recent past regarding travel habits of city residents should be valuable to urban planners, highway engineers, and economists in attacking the transportation problems of the present and future. It is also hoped that the article will serve to call attention to the quantity and quality of data that have become available as a result of such surveys. A list of the selected cities showing survey dates and population at the time of the study is given in table 1. It should be noted that almost one-third of the studies were conducted during the latter part of World War II and the year following the end of the war. Some of the variations in trip-purpose and travel-mode patterns which are discussed later may be associated with the year of the basic survey or the geographical location of the study area.

Table 1.—Population and period of survey in 50 urban areas

Urban area	Population	Period of survey
Albuquerque, N. Mex.	116, 056	June 1949–July 1949.
Altoona, Pa.	85, 347	July 1950–Sept. 1950.
Appleton, Wis.	39, 172	June 1953–July 1953.
Baltimore, Md.	912, 809	Sept. 1945–Oct. 1945.
Bay City, Mich.	69, 231	July 1948–Oct. 1948.
Charleston, S. C.	73, 205	Feb. 1947–Mar. 1947.
Chester, Pa.	127, 408	June 1951–Oct. 1951.
Columbus, Ga.	79, 192	Oct. 1945–Dec. 1945.
Dallas, Tex.	533, 606	Nov. 1950–Mar. 1951.
Duluth, Minn.-Superior, Wis.	130, 847	May 1948–June 1948.
Fargo, N. Dak.-Moorhead, Minn.	49, 852	June 1949–Aug. 1949.
Grand Rapids, Mich.	220, 977	July 1947–Oct. 1947.
Harrisburg, Pa.	103, 303	June 1946–Sept. 1946.
Honolulu, T. H.	214, 236	Apr. 1947–Sept. 1947.
Houston, Tex.	878, 629	Mar. 1953–June 1953.
Johnstown, Pa.	87, 509	July 1949–Sept. 1949.
Kalamazoo, Mich.	72, 024	Apr. 1946–May 1946.
Lansing, Mich.	122, 776	Sept. 1946–Nov. 1946.
Macon, Ga.	77, 665	July 1946–Aug. 1946.
Madison, Wis.	104, 074	May 1949–June 1949.
Muskegon, Mich.	83, 724	July 1946–Aug. 1946.
Newark, N. J.	1, 456, 947	Aug. 1945–Jan. 1946.
Norfolk, Va.	335, 910	June 1950–Aug. 1950.
Norristown, Pa.	39, 485	June 1949–Aug. 1949.
Philadelphia, Pa.	2, 233, 531	June 1947–Nov. 1947.
Phoenix, Ariz.	161, 567	Nov. 1946–Feb. 1947.
Pontiac, Mich.	79, 431	Apr. 1947–May 1947.
Portland, Oreg.	453, 128	July 1946–Sept. 1946.
Racine, Wis.	78, 033	Aug. 1949–Oct. 1949.
Reading, Pa.	119, 851	Nov. 1946–Dec. 1946.
Rockford, Ill.	116, 000	July 1950–Aug. 1950.
Sacramento, Calif.	201, 345	Dec. 1947–May 1948.
Saginaw, Mich.	112, 902	July 1948–Sept. 1948.
St. Louis, Mo.	974, 545	Apr. 1945–July 1945.
St. Paul-Minneapolis, Minn.	915, 960	May 1949–Nov. 1949.
Salt Lake City, Utah	196, 571	June 1946–Sept. 1946.
San Francisco, Calif.	1, 468, 933	July 1946–Dec. 1946.
San Juan, P. R.	312, 069	June 1948–July 1948.
Scranton, Pa.	137, 089	June 1950–Aug. 1950.
Seattle, Wash.	518, 563	May 1946–Aug. 1946.
Sharon-Farrell, Pa.	48, 432	June 1949–July 1949.
Spokane, Wash.	138, 381	July 1946–Dec. 1946.
Tacoma, Wash.	138, 700	June 1948–Aug. 1948.
Tucson, Ariz.	126, 900	Mar. 1948–Apr. 1948.
Washington, D. C.	1, 109, 860	May 1948–Sept. 1948.
Wichita, Kans.	238, 302	Nov. 1951–Apr. 1952.
Williamsport, Pa.	55, 216	July 1954–Aug. 1954.
Wilmington, Del.	181, 445	Apr. 1948–July 1948.
Wisconsin Rapids, Wis.	16, 504	Sept. 1950–Oct. 1950.
York, Pa.	77, 350	July 1951–Aug. 1951.

[1] *Traffic planning studies in American cities*, by John T. Lynch. PUBLIC ROADS, vol. 24, No. 6, Oct.-Nov.-Dec. 1945. The procedures used in these studies are given in greater detail in the *Manual of Procedures for Home Interview Traffic Study*, which is available by purchase from the Public Administration Service, 1313 East 60th Street, Chicago, Ill.

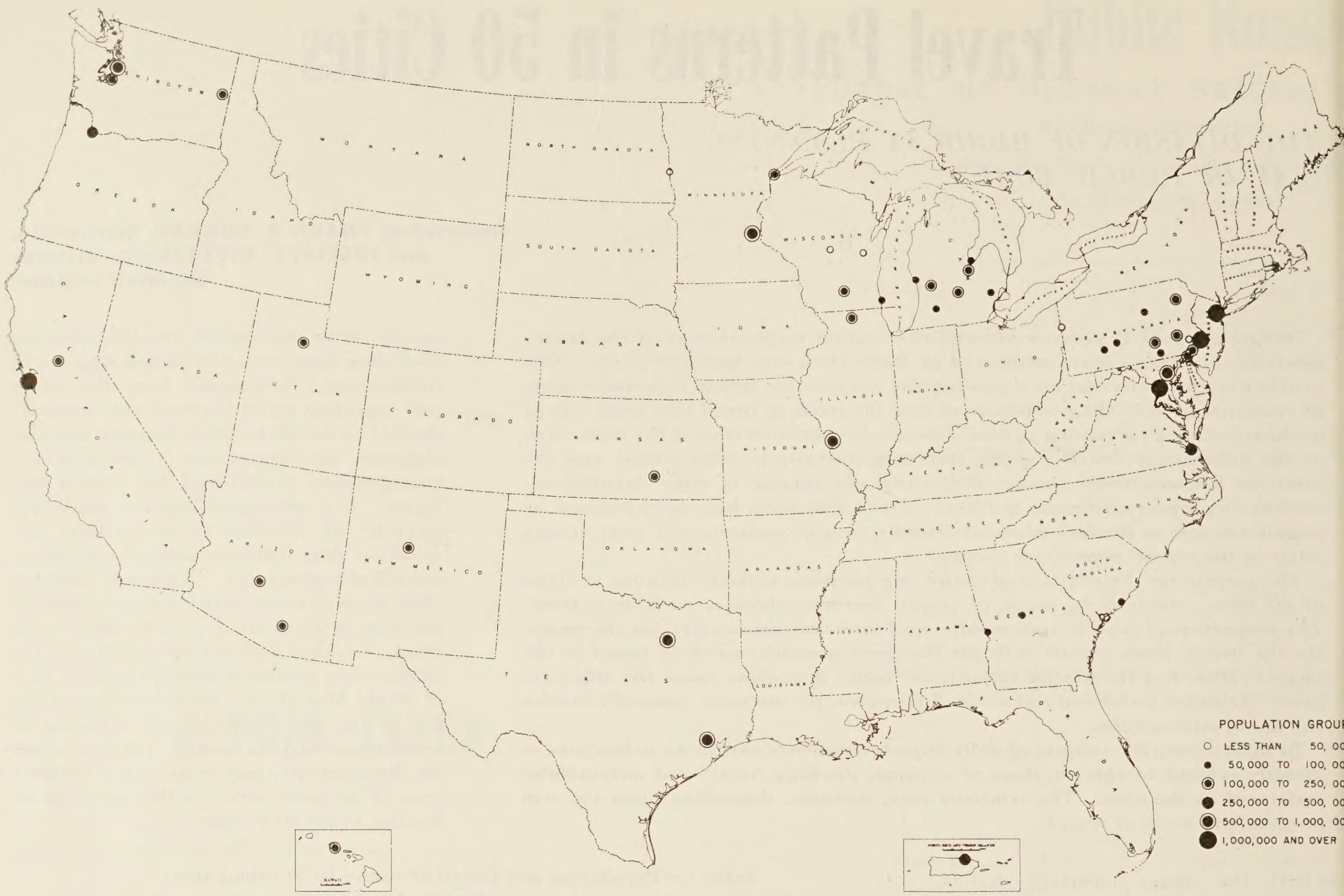

Figure 1.—Geographical distribution of the 50 cities included in study.

Definitions

The *urban areas* referred to in this article are the areas within which the basic surveys were conducted. They generally include the central city as well as any portion of the contiguous built-up area that may exist beyond the corporate limits. Their boundaries are usually delimited by an imaginary line called the external cordon. These areas resemble but do not coincide with *urbanized areas* as defined by the Bureau of the Census. In this article the terms *urban area* and *city* are used interchangeably.

A *trip* is defined as a one-way movement in a vehicle by a resident of the urban area. There are no round trips but rather two or more one-way trips. The only trips considered here are *internal trips*, so called because both origin and destination are within the boundaries of the survey area. *External trips* to or from points beyond the external cordon are not included. The external phase of the basic surveys was concerned only with automobile travel beyond the cordon and only automobile-driver trip information was included. These external automobile-driver trips amounted to about 5 percent of the total internal and external automobile-driver trips in the largest urban areas and about 45 percent in the smallest cities included in this study.

As the term is used in these surveys, *mode of travel* depends upon (1) the type of vehicle used (automobile, taxi, truck, or mass-transit vehicle), and (2) the status of the user (driver or passenger). The modes of travel recorded in most of the individual surveys were as follows: automobile drivers, automobile passengers, taxi passengers, truck passengers, bus or streetcar passengers, railroad passengers, and passengers in other mass-transit vehicles. For purposes of analysis, some of these modes have been combined.

The term *purpose of trip* is used in its obvious sense to explain why a person made the trip. However, for every internal trip recorded, the survey data show not only why the traveler went to his destination (purpose to), but also why he had been at the point of origin (purpose from). The purposes (both to and from) were originally ten: work, business, medical-dental, school, social-recreational, eat meal, shop, change mode of travel, serve passenger, and home. However, as with modes of travel, some of the trip purposes have been combined.

Household characteristics include the numbers of persons, dwelling units, automobiles owned, and persons 5 years of age and over. *Dwelling unit* is used in the sense of the Bureau of the Census—"In general, . . . a group of rooms or a single room occupied or intended for occupancy as separate living quarters by a family or other group of persons living together or by a person living alone."

Scope of Article

Although at the time of this analysis over one hundred comprehensive urban traffic surveys had been completed, trip purpose-to

Table 2.—Distribution by population groups of all urbanized areas, of urban areas where origin and destination studies have been made, and of urban areas included in the present study

Urban area population groups	All urbanized areas, 1950 census		Urban areas with completed O & D studies		Urban areas included in this study	
	Number	Percent	Number	Percent	Number	Percent
Over 1,000,000	12	7.6	6	5.9	4	8.0
500,000–1,000,000	13	8.3	11	10.9	6	12.0
250,000–500,000	24	15.3	9	8.9	3	6.0
100,000–250,000	70	44.6	43	42.6	20	40.0
50,000–100,000	38	24.2	22	21.8	12	24.0
Less than 50,000	--------	--------	10	9.9	5	10.0
Total	157	100.0	101	100.0	50	100.0

purpose tabulations had been prepared in only 50 cities with sufficient uniformity to permit summarizing the results by city groups.

These 50 cities seem to provide a sufficiently good distribution among the population groups studied so that the data are representative.

Figure 1 shows the geographical distribution of the selected cities by population groups. The 50 cities accounted for 10.8 percent of the

Table 3.—Number of trips by each mode of travel in Madison, Wis., classified according to trip purpose

Trips from—	Trips to— Work	Business	Medical-dental	School	Social-recreation	Eat meal	Shop	Change mode of travel	Serve passengers	Home	Total
Automobile Drivers											
Work	8. 008	663	89	41	522	3, 717	990	-----	1, 242	11, 214	26, 486
Business	623	828	10	30	301	190	468	-----	210	2, 164	4, 824
Medical-dental	49	20	10	-----	31	9	119	-----	50	271	559
School	72	20	10	119	139	290	40	-----	150	1, 092	1, 932
Social-recreation	142	190	40	20	1, 377	258	401	10	1, 206	6, 395	10, 039
Eat meal	3, 167	171	-----	169	290	-----	101	-----	439	791	5, 128
Shop	270	251	29	31	598	139	1, 365	11	321	5, 333	8, 348
Change mode of travel	-----	10	10	-----	10	20	21	-----	20	148	239
Serve passengers	1, 924	300	70	209	926	349	620	20	1, 776	5, 827	12, 021
Home	12, 648	2, 624	341	1, 331	5, 749	691	4, 234	99	6, 953	-----	34, 670
Total	26, 903	5, 077	609	1, 950	9, 943	5, 663	8, 359	140	12, 367	33, 235	104, 246
Automobile Passengers											
Work	191	63	30	-----	203	503	196	71	-----	3, 971	5, 228
Business	41	217	30	10	184	20	153	-----	-----	725	1, 380
Medical-dental	-----	21	-----	10	52	-----	72	-----	-----	303	458
School	20	52	53	82	256	188	20	-----	-----	871	1, 542
Social-recreation	92	82	10	89	3, 739	297	451	101	-----	10, 048	14, 909
Eat meal	441	10	-----	267	251	-----	20	-----	-----	690	1, 679
Shop	29	63	10	11	535	62	708	10	-----	2, 673	4, 101
Change mode of travel	30	-----	-----	-----	20	10	22	10	-----	271	363
Serve passengers	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Home	4, 533	901	313	2, 676	9, 384	558	2, 421	285	-----	-----	21, 071
Total	5, 377	1, 409	446	3, 145	14, 624	1, 638	4, 063	477	-----	19, 552	50, 731
Streetcar and Bus Passengers											
Work	130	69	20	10	140	504	220	175	-----	7, 429	8, 697
Business	30	60	-----	20	30	-----	50	10	-----	805	1, 005
Medical-dental	-----	10	-----	10	20	-----	-----	20	-----	300	360
School	161	40	20	90	180	553	201	60	-----	5, 213	6, 518
Social-recreation	20	41	20	20	159	40	70	41	-----	3, 258	3, 669
Eat meal	434	20	-----	454	40	-----	20	-----	-----	363	1, 331
Shop	40	49	10	50	131	-----	150	40	-----	2, 522	2, 992
Change mode of travel	110	10	-----	59	70	10	59	40	-----	161	519
Serve passengers	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Home	8, 153	1, 118	382	5, 556	3, 238	361	1, 730	210	-----	-----	20, 748
Total	9, 078	1, 417	452	6, 269	4, 008	1, 468	2, 500	596	-----	20, 051	45, 839
Taxi Passengers											
Work	41	20	50	-----	30	10	10	-----	-----	413	574
Business	10	10	-----	10	20	10	-----	-----	-----	149	209
Medical-dental	10	-----	-----	-----	10	-----	-----	-----	-----	131	151
School	-----	-----	-----	10	11	20	-----	-----	-----	121	162
Social-recreation	21	11	-----	-----	79	20	-----	-----	-----	481	612
Eat meal	20	-----	-----	-----	10	-----	10	-----	-----	40	80
Shop	30	-----	-----	-----	-----	-----	40	-----	-----	90	160
Change mode of travel	10	-----	-----	-----	20	-----	-----	-----	-----	110	140
Serve passengers	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Home	804	139	110	239	500	60	102	89	-----	-----	2, 043
Total	946	180	160	259	680	120	162	89	-----	1, 535	4, 131
Truck Passengers											
Work	92	-----	-----	-----	-----	-----	-----	-----	-----	31	123
Business	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Medical-dental	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
School	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Social-recreation	-----	-----	-----	-----	-----	-----	-----	-----	-----	10	10
Eat meal	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Shop	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Change mode of travel	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Serve passengers	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Home	11	-----	-----	-----	10	-----	-----	-----	-----	-----	21
Total	103	-----	-----	-----	10	-----	-----	-----	-----	41	154
All Modes of Travel											
Work	8, 462	815	189	51	895	4, 734	1, 416	246	1, 242	23, 058	41, 108
Business	704	1, 115	40	70	535	220	671	10	210	3, 843	7, 418
Medical-dental	59	51	10	20	113	9	191	20	50	1, 005	1, 528
School	253	112	83	301	586	1, 051	261	60	150	7, 297	10, 154
Social-recreation	275	324	70	129	5, 354	615	922	152	1, 206	20, 192	29, 239
Eat meal	4, 062	201	-----	890	591	-----	151	-----	439	1, 884	8, 218
Shop	369	363	49	92	1, 264	201	2, 263	61	321	10, 618	15, 601
Change mode of travel	150	20	10	59	120	40	102	50	20	690	1, 261
Serve passengers	1, 924	300	70	209	926	349	620	20	1, 776	5, 827	12, 021
Home	26, 149	4, 782	1, 146	9, 802	18, 881	1, 670	8, 487	683	6, 953	-----	78, 553
Total	42, 407	8, 083	1, 667	11, 623	29, 265	8, 889	15, 084	1, 302	12, 367	74, 414	205, 101

Table 4.—Number and percentage of trips by each mode of travel in 50 cities, classified according to trip purpose

Mode of travel	Trip purpose											
	Work and business		Social and recreation		Shop		Miscellaneous		Home		Total	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Automobile drivers	3,679,848	13.2	1,079,942	3.9	910,831	3.3	1,524,373	5.5	4,187,918	15.1	11,382,912	41.0
Automobile and taxi passengers	1,065,361	3.9	1,520,382	5.5	488,798	1.6	486,546	1.7	2,634,629	9.5	6,195,716	22.2
Mass-transit passengers	3,014,103	10.8	736,487	2.6	690,435	2.6	1,270,461	4.6	4,487,541	16.2	10,199,027	36.8
Total	7,759,312	27.9	3,336,811	12.0	2,090,064	7.5	3,281,380	11.8	11,310,088	40.8	27,777,655	100.0

total United States population in 1950, and 16.8 percent of the urban population. As table 2 indicates, the distribution of the 50 cities by population groups among the 157 urbanized areas of the 1950 census is only fair, but it follows very closely the group distribution of the 101 cities from which origin-destination traffic survey data were available.

The present analyses have been limited to two questions: how and why residents make their trips within an urban area. It does not consider two other important questions which relate to the origin and destination of trips within the area. Although these data are available for each city, records of trips from place to place within a city cannot justifiably be combined for more than one city at a time, because it is difficult to relate areas when so little is known about their land-use characteristics.

The process of summarizing data to discover travel patterns, related to purpose of trip and mode of travel, began with the cities where the surveys were made. In each of the 50 cities the procedures recommended in the *Manual of Procedures for Home Interview Traffic Study* were generally followed, and tables were compiled in which trips were classified uniformly by mode of travel and purpose of trip. One tabulation was prepared for each mode of travel, showing the number of trips from each purpose to each purpose. However, the number of travel modes reported in different cities varied; trips by train passengers were reported only in 2 cities and trips by "other" passengers were reported only in 5 cities. A typical example of the basic tabulations for an individual city is presented in table 3.

In the course of assembling and combining the data from different cities it became evident that certain less significant trip purposes and travel modes might advantageously be combined. On the average, the 5 least important trip purposes accounted for less than 12 percent of the total number of trips, and not one of these purposes accounted for as much as 4 percent. These categories were combined to form a miscellaneous group.

Minor trip purposes and the percentages of trips accounted for by each were as follows: to serve passenger, 3.4 percent, change mode of travel, 3.3 percent, school, 2.3 percent, eat meal, 1.7 percent, and medical-dental, 1.1 percent.

In addition, since business trips amounted to less than 5 percent of all internal trips and were often difficult to dissociate from work trips, the two were combined as work and business trips. Thus, the five major trip purposes were work and business, social-recreational, shopping, miscellaneous, and home.

An examination of the data for the 7 modes of travel indicated that 4 modes accounted for less than 2 percent of all trips, and not 1 of the 4 modes accounted for as much as 1 percent of the trips. The least important travel modes were as follows: taxi passengers, 0.8 percent, train passengers, 0.7 percent, truck passengers, 0.2 percent, and other passengers, 0.2 percent.

Since these travel modes represented such small proportions of the total, they were combined with other modes of similar characteristics. Taxi and truck passengers were combined with automobile passengers, whereas passengers using trains or other interurban facilities such as subways, ferries, or highway buses were combined with streetcar and bus passengers. Thus, three major modes of travel appeared to be sufficiently representative: automobile drivers, automobile and taxi passengers, and mass-transit passengers.

Although the trip purposes and travel modes that have lost their identity through summarization are relatively insignificant in the total travel pattern, they may be important

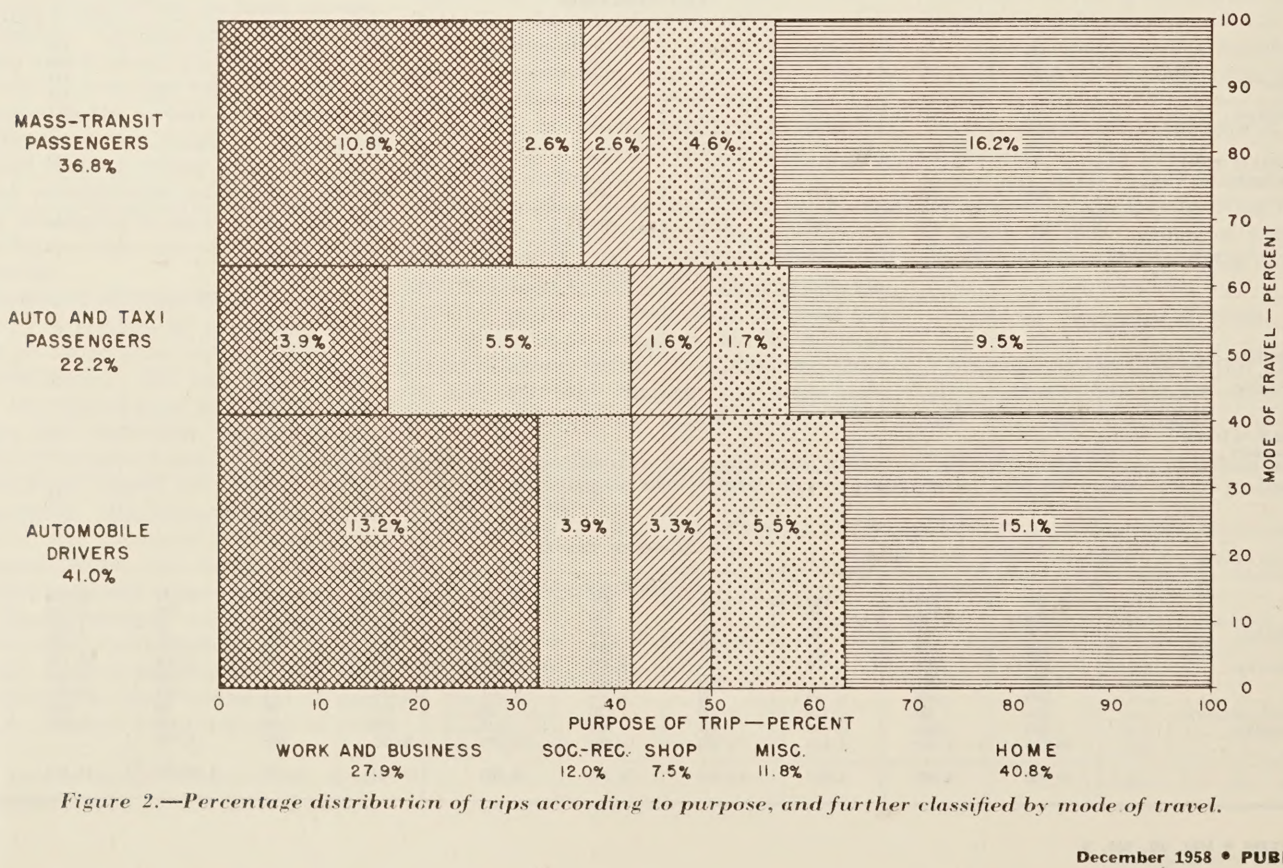

Figure 2.—Percentage distribution of trips according to purpose, and further classified by mode of travel.

Table 5.—Number and percentage of trips by each mode of travel in six population groups, classified according to trip purpose

Mode of travel	Population group	Number of cities	Work and business: Number	Work and business: Percent	Social and recreation: Number	Social and recreation: Percent	Shop: Number	Shop: Percent	Miscellaneous: Number	Miscellaneous: Percent	Home: Number	Home: Percent	Total: Number	Total: Percent
Automobile drivers	1,000,000 and over	4	1,143,303	35.4	300,892	9.3	201,334	6.2	414,396	12.9	1,165,651	36.2	3,225,576	100.0
Automobile and taxi passengers			344,013	19.1	420,539	23.3	116,687	6.5	151,320	8.4	769,472	42.7	1,802,031	100.0
Mass-transit passengers			1,401,980	28.2	345,528	7.0	309,684	6.2	884,034	17.8	2,027,099	40.8	4,968,325	100.0
Total			2,889,296	28.9	1,066,959	10.7	627,705	6.3	1,449,750	14.5	3,962,222	39.6	9,995,932	100.0
Automobile drivers	500,000–1,000,000	6	1,110,178	31.5	309,475	8.8	296,569	8.4	438,527	12.4	1,370,171	38.9	3,524,920	100.0
Automobile and taxi passengers			289,710	16.6	402,040	23.0	145,159	8.3	156,448	9.0	753,517	43.1	1,746,874	100.0
Mass-transit passengers			983,146	33.0	184,998	6.2	201,002	6.8	190,078	6.4	1,418,248	47.6	2,977,472	100.0
Total			2,383,034	28.9	896,513	10.9	642,730	7.8	785,053	9.5	3,541,936	42.9	8,249,266	100.0
Automobile drivers	250,000–500,000	3	234,358	33.9	72,134	10.4	58,241	8.4	84,678	12.2	242,866	35.1	692,277	100.0
Automobile and taxi passengers			70,884	16.9	110,151	26.3	34,775	8.3	31,456	7.5	172,196	41.0	419,462	100.0
Mass-transit passengers			175,776	30.2	52,309	9.0	42,057	7.2	60,348	10.4	251,271	43.2	581,761	100.0
Total			481,018	28.4	234,594	13.8	135,073	8.0	176,482	10.4	666,333	39.4	1,693,500	100.0
Automobile drivers	100,000–250,000	20	888,964	30.4	287,031	9.8	270,770	9.3	433,692	14.8	1,042,586	35.7	2,923,043	100.0
Automobile and taxi passengers			264,644	16.0	428,819	25.9	146,796	8.9	116,747	7.1	696,795	42.1	1,653,801	100.0
Mass-transit passengers			330,220	26.3	115,567	9.2	104,161	8.3	108,051	8.6	596,264	47.6	1,254,263	100.0
Total			1,483,828	25.4	831,417	14.3	521,727	8.9	658,490	11.3	2,335,645	40.1	5,831,107	100.0
Automobile drivers	50,000–100,000	12	242,565	30.0	87,961	10.9	65,073	8.0	117,711	14.6	294,964	36.5	808,274	100.0
Automobile and taxi passengers			79,696	17.5	120,083	26.3	35,941	7.9	24,855	5.5	195,281	42.8	455,856	100.0
Mass-transit passengers			110,197	29.8	33,696	9.1	28,778	7.8	24,280	6.6	172,236	46.7	369,187	100.0
Total			432,458	26.5	241,740	14.8	129,792	7.9	166,846	10.2	662,481	40.6	1,633,317	100.0
Automobile drivers	Less than 50,000	5	60,480	29.0	22,449	10.8	18,844	9.0	35,369	16.9	71,680	34.3	208,822	100.0
Automobile and taxi passengers			16,414	13.9	38,750	32.9	9,440	8.0	5,720	4.9	47,368	40.3	117,692	100.0
Mass-transit passengers			12,784	26.6	4,389	9.2	4,753	9.9	3,670	7.6	22,423	46.7	48,019	100.0
Total			89,678	24.0	65,588	17.5	33,037	8.8	44,759	11.9	141,471	37.8	374,533	100.0
Automobile drivers	All groups	50	3,679,848	32.3	1,079,942	9.5	910,831	8.0	1,524,373	13.4	4,187,918	36.8	11,382,912	100.0
Automobile and taxi passengers			1,065,361	17.2	1,520,382	24.5	488,798	7.9	486,546	7.9	2,634,629	42.5	6,195,716	100.0
Mass-transit passengers			3,014,103	29.5	736,487	7.2	690,435	6.8	1,270,461	12.5	4,487,541	44.0	10,199,027	100.0
Total			7,759,312	27.9	3,336,811	12.0	2,090,064	7.5	3,281,380	11.8	11,310,088	40.8	27,777,655	100.0

under certain conditions and in individual cities. Further comments are given in the appendix on page 120.

Summary for 50 Cities

All of the internal trips by residents of the 50 urban areas have been combined in table 4 and classified according to the 5 purposes and 3 modes of travel. Of the total trips numbering almost 28 million, trips by automobile drivers accounted for the largest share and were followed in order by mass-transit passengers and automobile and taxi passengers. Homeward-bound trips predominated among the five major trip purposes; work and business trips ranked second, and were followed by social-recreational, miscellaneous, and shopping trips in that order.

Although automobile drivers represented the predominant travel mode, mass-transit passengers traveling home constituted the largest mode-purpose category, accounting for nearly one-sixth of all trips. Homeward-bound automobile drivers followed closely with 15 percent of all trips; automobile drivers on work and business trips, 13 percent; mass-transit passenger trips to work and business, 11 percent; and automobile and taxi passengers on their way home, 9 percent. The remaining individual mode-purpose categories accounted for 5 percent or less of the total trips.

These percentage distributions of the total trips by purpose and mode of travel are also shown in figure 2. In this chart the area of each rectangle and the percentage shown

Table 6.—Percentage of trips for each trip purpose in six population groups, classified according to mode of travel

Purpose of trip	Population group	Number of cities	Automobile drivers	Automobile and taxi passengers	Mass-transit passengers	Total
Work and business	1,000,000 and over	4	39.6	11.9	48.5	100.0
Social and recreation			28.2	39.4	32.4	100.0
Shop			32.1	18.6	49.3	100.0
Miscellaneous			28.6	10.4	61.0	100.0
Home			29.4	19.4	51.2	100.0
All purposes			32.3	18.0	49.7	100.0
Work and business	500,000–1,000,000	6	46.6	12.2	41.2	100.0
Social and recreation			34.5	44.9	20.6	100.0
Shop			46.1	22.6	31.3	100.0
Miscellaneous			55.9	19.9	24.2	100.0
Home			38.7	21.3	40.0	100.0
All purposes			42.7	21.2	36.1	100.0
Work and business	250,000–500,000	3	48.7	14.7	36.6	100.0
Social and recreation			30.7	47.0	22.3	100.0
Shop			43.1	25.7	31.2	100.0
Miscellaneous			48.0	17.8	34.2	100.0
Home			36.5	25.8	37.7	100.0
All purposes			40.9	24.8	34.3	100.0
Work and business	100,000–250,000	20	59.9	17.8	22.3	100.0
Social and recreation			34.5	51.6	13.9	100.0
Shop			51.9	28.1	20.0	100.0
Miscellaneous			65.9	17.7	16.4	100.0
Home			44.7	29.8	25.5	100.0
All purposes			50.1	28.4	21.5	100.0
Work and business	50,000–100,000	12	56.1	18.4	25.5	100.0
Social and recreation			36.4	49.7	13.9	100.0
Shop			50.1	27.7	22.2	100.0
Miscellaneous			70.6	14.9	14.5	100.0
Home			44.5	29.5	26.0	100.0
All purposes			49.5	27.9	22.6	100.0
Work and business	Less than 50,000	5	67.4	18.3	14.3	100.0
Social and recreation			34.2	59.1	6.7	100.0
Shop			57.0	28.6	14.4	100.0
Miscellaneous			79.0	12.8	8.2	100.0
Home			50.7	33.5	15.8	100.0
All purposes			55.8	31.4	12.8	100.0
Work and business	All groups	50	47.4	13.7	38.9	100.0
Social and recreation			32.4	45.5	22.1	100.0
Shop			43.6	23.4	33.0	100.0
Miscellaneous			46.5	14.8	38.7	100.0
Home			37.0	23.3	39.7	100.0
All purposes			41.0	22.2	36.8	100.0

therein represent the relation of the number of trips in each mode-purpose category to the total number of trips. Upon examining the horizontal bars for each mode of travel, it is seen at a glance that a larger proportion of automobile drivers were on work and business trips than mass-transit passengers, but relatively more transit passengers were going home. Also, proportionately many more automobile and taxi passengers were on social and recreational trips than was the case with either of the other two modes of travel. This chart, of course, is not typical of any particular city, but represents all of the trips made in the 50 urban areas by residents of these areas on a typical weekday during the various periods studied.

Distribution of Trips by Population Groups

In table 5 the trips are shown by population groups of the urban areas in which they were made. Almost 10 million trips are accounted for in the 1 million and over population group and nearly 375,000 trips in the smallest group, which is for cities of less than 50,000 population. The number of trips in the various purpose-mode cells ranged from less thai 4,000 to more than 2 million.

Purpose distribution

A pattern of uniformity for trip purpose among all population groups is observed in table 5. Generally, there was no pronounced trend in the purpose distribution of trips from one population group to another Exceptions to this observation were an increase in the proportion of social and recreational trips and a slight reduction in the percentage of work and business trips, a

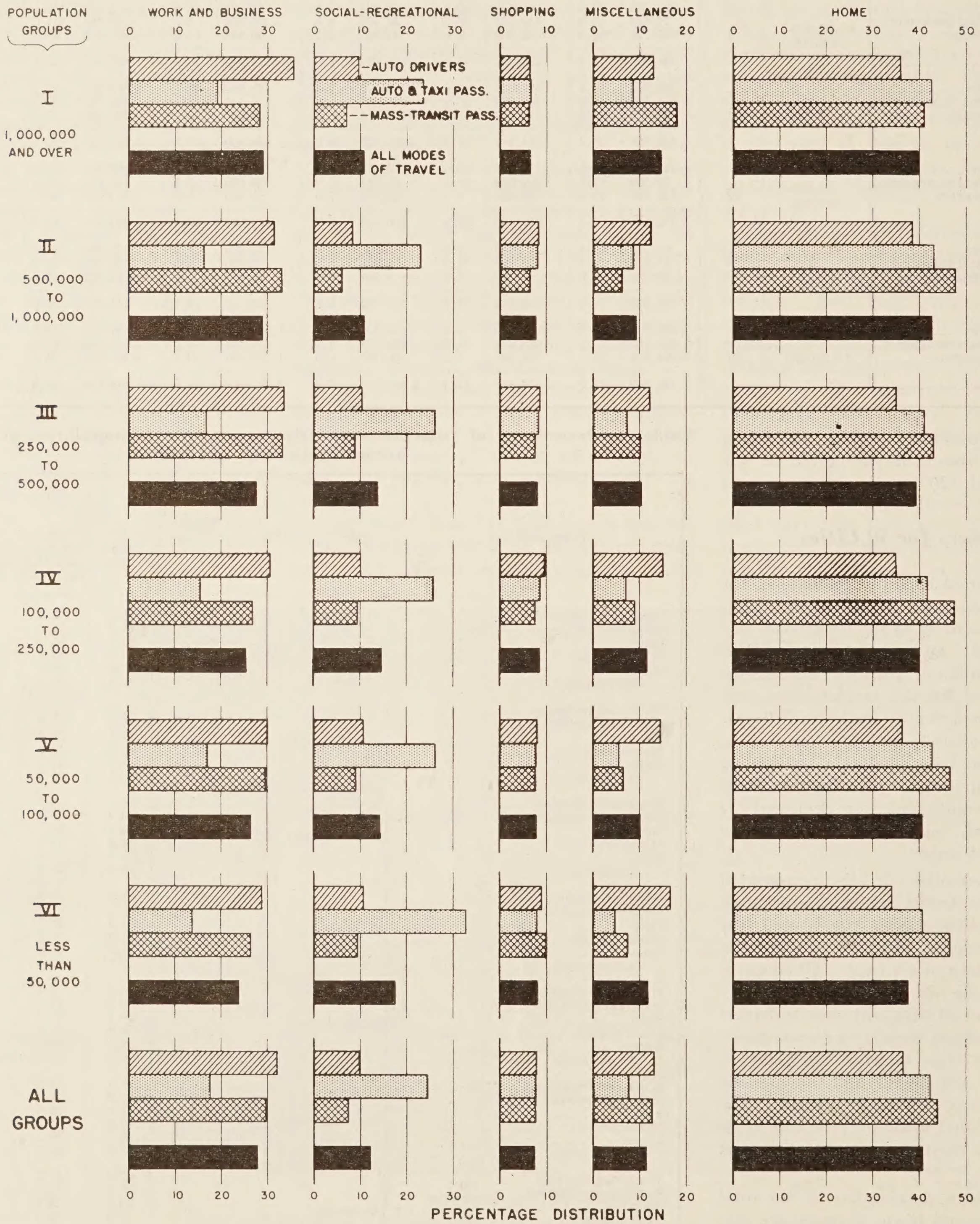

Figure 3.—Percentage distribution of trips according to purpose, and further classified by mode of travel and population group.

population decreases, but these trends did not hold for the individual modes of travel.

The slight effect that city size apparently has on the percentage distribution of trips by purpose is portrayed in figure 3. For each of the six population groups and for each mode of travel, home trips were the most common, accounting for about two-fifths of the trips in all categories. This is not unexpected since home is the return trip destination of the great majority of trips. Work and business trips ranked second in all population groups, totaling about 28 percent of the trips for all purposes.

In the largest population group, trips for miscellaneous purposes ranked third, social and recreational trips next, and shopping trips last. This same ranking held for auto-

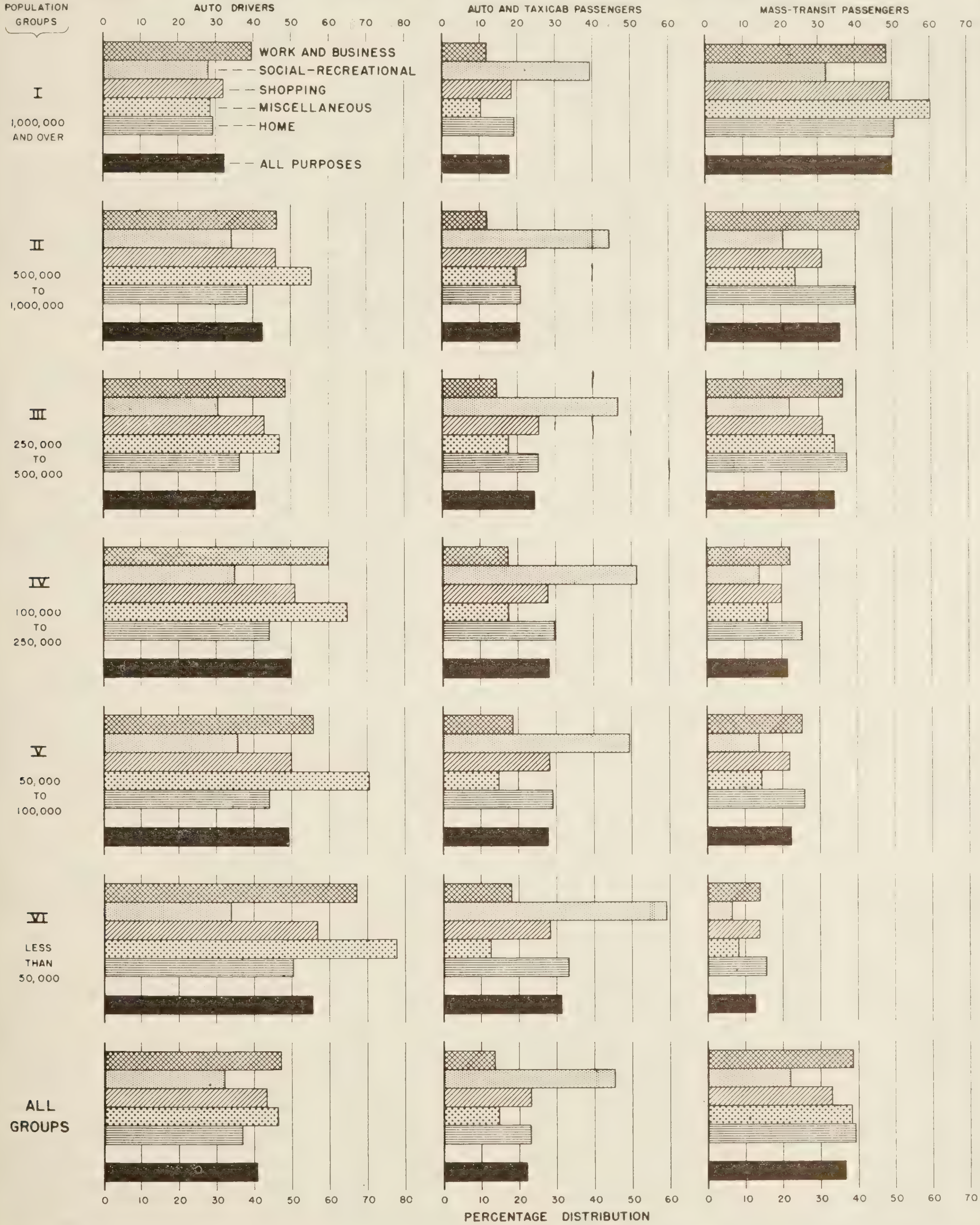

Figure 4.—Percentage distribution of trips according to mode of travel, and further classified by purpose and population group.

Table 7.—Range in percentage of trips for each trip purpose by each mode of travel in six population groups

Mode of travel	Percentage range, by mode of travel, in trips made for purposes of—					
	Work and business	Social and recreation	Shop	Miscel-laneous	Home	All pur-poses
Automobile drivers:						
Maximum	67.4	36.4	57.0	79.0	50.7	55.8
Minimum	39.6	28.2	32.1	28.6	29.4	32.3
Automobile and taxi passengers:						
Maximum	18.4	59.1	28.6	19.9	33.5	31.4
Minimum	11.9	39.4	18.6	10.4	19.4	18.0
Mass-transit passengers:						
Maximum	48.5	32.4	49.3	61.0	51.2	49.7
Minimum	14.3	6.7	14.4	8.2	15.8	12.8

mobile-driver trips in each of the population groups. Although not shown in the tables of this article, a study of the basic data revealed that the relative importance of miscellaneous trips was largely due to the number of automobile drivers who traveled for the purpose of serving passengers. Also in the larger cities a number of change-mode-of-travel trips by mass-transit passengers were classified as miscellaneous. In the other population groups, considering all modes of travel, social and recreational trips ranked third, ahead of trips for miscellaneous purposes.

Among the automobile- and taxi-passenger trips, those for social and recreational purposes ranked second, above work and business trips, and accounted for one-fourth of all trips by this mode. Of the three principal modes, automobile and taxi passengers showed the greatest variation among the different population groups in trips to work and business and for social-recreational purposes, but the least variation in home trips.

Home was the most frequent objective of mass-transit passengers in all population groups. Work and business trips ranked second. For reasons which have been mentioned, miscellaneous trips were relatively important among transit passengers in the largest cities, but in all other population groups social-recreational and shopping trips were about as important as trips for miscellaneous purposes.

Mode distribution

The percentage distribution of trips by mode of travel in the six population groups, shown in table 6, indicates that as the size of city increases the proportion of mass-transit trips generally increases with a corresponding decrease in automobile trips. With some minor exceptions, this trend occurred amor trips in each purpose category.

The mode-of-travel pattern by populatic groups is shown in figure 4. For all purpos combined, the proportion of trips by mas transit passengers ranged from 50 percent i the cities with over 1 million population to 1 percent in the less than 50,000 populatio group. On the other hand, trips by auto mobile drivers ranged from 32 to 56 percen and automobile and taxi passengers, from 1 to 31 percent. On the basis of individu trip purposes, the ranges among populatio groups were much greater in some cases, a seen in table 7.

It is evident from figure 4 that the privatel owned automobile, considering both drive and passengers, was the predominant choic for trips to all purposes in cities of less than million population. Automobile travel wa also greatly preferred for social and recrea tional trips by residents of cities in the million or more population group.

Average trips per city

Table 8 contains the number of interna trips made by residents by each mode of trave and for each trip purpose in the average cit within each population group. Although th figures are pure arithmetic means of the tota trips made in the cities within each popula tion group, the volumes are indicative of wha might be expected in other cities of simila size. Of special note is the regularly increas ing volume of trips for each trip purpose fron the smallest to the largest population grou for each mode of travel.

However, there appears to be a near maxi mum volume of automobile-driver trips fo shopping purposes when cities reach th 500,000-1,000,000 population size. In citie of 1 million population and over, trips made b automobile drivers for shopping purpose exceeded those in the 500,000-1,000,00 population group by less than 2 percent This is reflected in table 6 which shows tha automobile drivers made only 32 percent of th shopping trips in the largest cities as compare with 46 percent in the next smaller popula tion group. This difference may be explaine partly by the inability of the downtow shopping districts of very large cities t accommodate automobile drivers and partl by the increased availability of transit facilities and taxicabs, particularly around th densely populated areas in the vicinity of th central business district.

Table 8.—Average number of trips per city in each population group classified according to trip purpose by each mode of travel

Population group	Number of cities	Average number (in thousands) of trips per city made for purposes of—					
		Work and business	Social and recreation	Shop	Miscel-laneous	Home	Total
Automobile Drivers							
1,000,000 and over	4	286	75	50	104	291	806
500,000–1,000,000	6	185	52	49	73	228	587
250,000–500,000	3	78	24	20	28	81	231
100,000–250,000	20	44	14	14	22	52	146
50,000–100,000	12	20	7	5	10	25	67
Less than 50,000	5	12	5	4	7	14	42
All groups	50	74	22	18	30	84	228
Automobile and Taxi Passengers							
1,000,000 and over	4	86	105	29	38	192	450
500,000–1,000,000	6	48	67	24	26	126	291
250,000–500,000	3	24	37	12	10	57	140
100,000–250,000	20	13	22	7	6	35	83
50,000–100,000	12	7	10	3	2	16	38
Less than 50,000	5	3	8	2	1	10	24
All groups	50	21	30	10	10	53	124
Mass-Transit Passengers							
1,000,000 and over	4	350	86	77	221	507	1,241
500,000–1,000,000	6	164	31	34	32	236	497
250,000–500,000	3	59	17	14	20	84	194
100,000–250,000	20	17	6	5	5	30	63
50,000–100,000	12	9	3	2	2	14	30
Less than 50,000	5	3	1	1	1	4	10
All groups	50	60	15	14	25	90	204
All Modes of Travel							
1,000,000 and over	4	722	266	156	363	990	2,497
500,000–1,000,000	6	397	150	107	131	590	1,375
250,000–500,000	3	161	78	46	58	222	565
100,000–250,000	20	74	42	26	33	117	292
50,000–100,000	12	36	20	10	14	55	135
Less than 50,000	5	18	14	7	9	28	76
All groups	50	155	67	42	65	227	556

Distribution of Trips by Individual Cities

The number of trips by residents according to purpose in each of the 50 urban areas are presented in tables 9 and 10 for automobile drivers, automobile and taxi passengers, mass-transit passengers, and for all modes of travel. In these tables the cities are listed in descending order of population size at the time of the basic survey. The general tendency for a greater volume of trips in the more populous urban areas agrees with the same relationship already mentioned in the discussion of populaion groups, but in the case of individual cities several exceptions are apparent. The more obvious exceptions are readily noticed.

The residents of San Juan made far fewer automobile-driver and automobile- and taxi-passenger trips than persons living in mainland cities of the same size. This relatively small number of trips existed throughout all the major purposes, but applied particularly to shopping trips. The abnormally high number of trips made in Philadelphia for miscellaneous purposes may be related to the large number of mass-transit passenger trips for the intermediate purpose of changing mode of travel. In the St. Paul-Minneapolis area, an unusually large number of trips for social and recreational purposes were made by automobile.

The high volume of mass-transit passenger trips in Philadelphia, St. Louis, and Honolulu is noteworthy, and conversely the relatively small number of automobile-driver and automobile- and taxi-passenger trips in the same cities. In Houston there was an exceptionally large volume of trips by modes other than mass transit, particularly for shopping and miscellaneous purposes. A large number of automobile trips for all purposes is noted in Grand Rapids and Wichita. However, the relative stability of work and business trips and homeward-bound trips is significant throughout all cities.

Purpose distribution

The percentages of trips for each purpose in each of the 50 urban areas are presented in figure 5. Although generally displaying a pattern of uniformity in the percentage distribution of trip purposes within each city, this chart reveals several proportional trip variations which are not readily apparent in the tables of absolute trip volumes.

The large percentage of trips for miscellaneous purposes in Philadelphia again reflects the volume of trips made by mass-transit passengers for the purpose of changing mode of travel. In Wisconsin Rapids the high percentage of miscellaneous trips may be explained by the fact that over 90 percent of the miscellaneous transit trips in this small Wisconsin city were to school. Madison, Wis., a university city, also had a relatively large proportion of trips to school. The percentage of work and business trips is especially high in St. Louis, particularly among automobile and taxi passengers. This is undoubtedly due in part to the time of the survey which was begun just before the end of World War II. There are other extremes of more or less importance, such as the relatively small pro-

Table 9.—Number of trips by automobile drivers and automobile and taxi passengers in each of 50 cities in six population groups, classified according to trip purpose

City	Population group	Number of automobile-driver trips made for purposes of— Work and business	Social and recreation	Shop	Miscel-laneous	Home	Total	Number of automobile- and taxi-passenger trips made for purposes of— Work and business	Social and recreation	Shop	Miscel-laneous	Home	Total
Philadelphia, Pa	1,000,000 and over.	301,490	69,502	32,648	72,655	253,419	729,714	76,711	94.494	23,336	45,475	180,142	420,158
San Francisco, Calif		423,673	113,942	86,146	208,899	388,421	1,221,081	117,717	163.363	47,283	51.975	260,284	640.622
Newark, N. J		223,839	56,575	36,654	47,579	278,601	643,248	65,513	66,022	21,021	20,164	154,154	326,874
Washington, D. C		194,301	60,873	45,886	85,263	145,210	631,533	84,072	96.660	25,047	33,706	174,892	414,377
Total		1,143,303	300,892	201,334	414,396	1,165,651	3,225,576	344.013	420,539	116,687	151,320	769,472	1,802,031
St. Louis, Mo	500,000–1,000,000.	167,001	31,195	21,747	18,806	216,635	455,384	30,253	12.054	4,526	2,931	45,719	95,483
St. Paul-Minneapolis, Minn.		249,043	85,221	53,954	109,868	285,156	783,242	56,491	128,090	31,694	22,648	178,663	417,586
Baltimore, Md		138,682	30,395	21.055	22,263	136,185	348,580	44,871	35,016	13,278	18,835	91,386	203.386
Houston, Tex		283,079	82,573	114,278	161,984	388,703	1,030,617	83,945	112,089	60,187	69,110	242,110	567,441
Dallas, Tex		148,116	45.630	61,217	89,696	208,231	552,890	40,814	68,188	22,573	33,700	115,969	281,214
Seattle, Wash		124,257	34,461	24,318	35,910	135,261	354,207	33,336	46,603	12,901	9,224	79,670	181,734
Total		1,110,178	309,475	296,569	438,527	1,370,171	3,524,920	289,710	402,040	145,159	156,448	753,517	1,746,874
Portland, Oreg	250,000–500,000	143,170	41,536	37,772	55,454	140,772	418,704	34,619	69,522	20.424	9,722	89.206	223,493
Norfolk, Va		80,240	26,500	19,080	24,220	92,710	242,750	30,960	31,990	12,940	18,180	70,360	164,430
San Juan, P. R		10,948	4,098	1,389	5,004	9,384	30.823	5,305	8,639	1,411	3,554	12,630	31,539
Total		234,358	72,134	58,241	84,678	242,866	692.277	70,884	110,151	34,775	31,456	172,196	419,462
Wichita, Kans	100,000–250,000	109,142	26,936	37,051	67,088	131,879	372.096	41,478	32,520	19,857	21,355	84,004	199,214
Grand Rapids, Mich		89,493	34,859	34,889	39,578	111,094	309,913	22,531	57.674	18,282	9,177	77.351	185,015
Honolulu, T. H		40,100	29,282	14,118	27,995	63,209	174,704	15,335	43,022	9,644	11,707	64,443	144,151
Sacramento, Calif		67,802	16,968	21,702	38,760	69,840	215,072	18,328	21,922	10,078	6,801	41,130	98,259
Salt Lake City, Utah		44,212	15,343	8,499	13,073	51,126	132,253	15,728	23,765	5,590	3,173	37,338	85,594
Wilmington, Del		37,525	11,243	7,275	15.877	38,561	110,481	15,446	17,014	3,815	6,384	33,029	75,688
Phoenix, Ariz		62,481	21,784	32,252	42,374	78,069	236,960	17,834	31.533	16,397	12,997	49,599	128,360
Tacoma, Wash		37,948	11,381	8,118	14,595	40,429	112,471	8,843	13.892	3,986	3,294	21,744	51,759
Spokane, Wash		32,262	9,028	5.964	7,748	42.510	97,512	8,706	10.201	3,974	3,070	22,087	48,038
Scranton, Pa		17,326	5,278	2.817	4,422	21,926	51,769	5,795	10,249	3,430	962	18,151	38,587
Duluth, Minn., Superior, Wis.		34,449	10,559	7,424	13,089	31,458	96,979	9,230	23,006	5,183	2,582	26,015	66.016
Chester, Pa		15,279	4.860	4,023	4,843	21,601	50,606	6.694	6,057	3,029	1,243	15,022	32,045
Tucson, Ariz		45,830	14,340	17,110	23,720	53.510	154,510	11,565	20,942	9,387	8,144	31,832	81,870
Lansing, Mich		46,857	12,212	14,461	23,259	46,800	143,589	10,893	19,009	5,421	5,192	25,683	66,198
Reading, Pa		24,896	4,177	2,818	7.993	21,022	60,906	6,579	4,229	1,676	2,002	11,928	26,414
Albuquerque, N. Mex		38,940	14,575	10,769	19,888	45,287	129,459	11,258	27,045	4,753	4,085	33,137	80,278
Rockford, Ill		47,261	17,592	11,932	13,891	65,040	155,716	12,988	22,768	8,353	2,179	37.307	83,595
Saginaw, Mich		40,051	10,614	16,068	25,296	50,860	142,889	11,176	18,900	7,311	4,539	30,063	71,989
Madison, Wis		31,980	9,943	8,359	20,729	33,235	104,246	8,015	15,314	4,225	6,334	21,128	55,016
Harrisburg, Pa		25,130	6,057	5,121	9,474	25,130	70,912	6,222	9,757	2,405	1,527	15,804	35,715
Total		888,964	287,031	270.770	433,692	1,042,586	2,923,043	264,644	428,819	146,796	116.747	696,795	1,653,801
Johnstown, Pa	50,000–100,000	13,488	4,356	4,944	3,984	13,956	40,728	3,061	6,183	2,415	1,166	9,639	22,464
Altoona, Pa		16,224	6,296	5,423	6,186	20,940	55,069	3,936	9.054	3,512	856	13,811	31,169
Muskegon, Mich		24,158	12,721	6,969	11,359	32,209	87,416	8,898	21,526	3,975	2,109	25,787	62,295
Pontiac, Mich		22,089	5,809	5,582	13,195	27,648	74.323	9,690	9,669	3,162	2,603	19,326	44,450
Columbus, Ga		17,602	5,507	5,882	7,212	25,658	61,861	8.377	4,227	1,928	2,929	13,393	30,854
Racine, Wis		25,117	8,384	7,303	16,775	27.210	84.789	5,642	11,721	3,385	3,366	15,862	39,976
Macon, Ga		17,645	1,953	2,549	6,137	21,233	49,517	8,413	3,711	2.214	1,477	14,275	30.090
York, Pa		33,651	7,777	5,381	13,841	26,755	87,405	9,377	9,080	3,477	2,264	16,999	41,197
Charleston, S. C		13.227	5,957	3,718	4,222	18,720	45,844	6,203	8,662	2,435	1.071	15,493	33,864
Kalamazoo, Mich		24,162	10,237	5,329	10,141	29,911	79,780	6.424	11,464	3,223	2,757	17,568	41,436
Bay City, Mich		21,430	13,660	9,085	16,461	32,834	93,470	6,313	18,884	4,132	3,169	22,988	55,486
Williamsport, Pa		13,772	5,304	2,908	8,198	17,890	48.072	3,362	5,902	2.083	1,088	10,140	22,575
Total		242,565	87,961	65,073	117,711	294,964	808,274	79,696	120,083	35,941	24,855	195,281	455,856
Fargo, N. Dak., Moorhead, Minn.	Less than 50,000.	22,435	7,795	3,996	12,797	22,502	69,525	6,286	18,315	2,286	1,747	17,950	46,584
Sharon-Farrell, Pa		12,103	5,267	4,848	7,209	15,508	44,935	3,174	8,364	2,306	698	10,916	25,458
Norristown, Pa		7,097	3.168	1,754	3,310	11,949	27,308	3.046	2,927	886	801	6,464	14,124
Appleton, Wis		13,309	4,277	6,058	7,929	14,945	46.518	2.506	6,895	3,056	1,154	8,631	22,242
Wisconsin Rapids, Wis		5,536	1,912	2,188	4,124	6,776	20.536	1,402	2,249	906	1,320	3,407	9,284
Total		60,480	22,449	18,844	35,369	71,680	208,822	16,414	38,750	9,440	5,720	47,368	117,692
Grand total	All groups	3,679,848	1,079,942	910.831	1,524,373	4,187,918	11,382,912	1,065,361	1,520,382	488,798	486,546	2,634,629	6,195,716

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portion of work and business trips in Honolulu, Muskegon, and Bay City, which, in a sense, are somewhat offset by social and recreational trips. However, in spite of these variations among individual cities, the overall effect is to reemphasize the essentially uniform pattern of trip purposes among the population groups.

Though not shown in this article, similar data also were developed for each separate mode of travel. In most cities the combination of work-business and home trips accounted for about 70 percent of all automobile-driver trips as well as mass-transit passenger trips, with social-recreational and shopping trips each accounting for another 7 to 10 percent. On the other hand, trips by automobile and taxi passengers were more frequently made for a social or recreational purpose rather than work or business. Social and recreational trips generally amounted to one-fourth of the total trips by passengers in automobiles and taxis.

Among automobile drivers, trips to home comprised the major portion of the travel in 41 cities. Work and business trips ranked second in these cities and were foremost in the other nine cities.

Homeward-bound trips also ranked first among automobile and taxi passengers in all cities except one. In the Fargo-Moorhead area, social and recreational trips ranked first for this mode of travel. In all but 10 of the remaining 49 cities, social-recreational trips ranked second and were followed by work and business trips. This order was reversed in the remaining 10 cities.

The pattern of trip purposes for mass-transit passengers resembled the automobile-driver pattern more than that of automobile and taxi passengers, but among transit passengers, home trips predominated in all citie without exception. Work and business trip ranked second in all but two cities, Philade phia and Wisconsin Rapids, where changing mode-of-travel and school trips caused th miscellaneous group to exceed work and bus ness trips.

The composite of all modes of travel fol lowed the pattern of mass-transit passenger with home trips predominating in all cities followed by work and business trips in all bu Honolulu and Bay City, where social-recrea tional trips ranked second.

These consistencies in trip patterns sugges the possibility of utilizing the present dat in making estimates in cities where survey have not been completed. Although th ranking of trip purposes is fairly uniform, th limits of the individual percentages show wid variations not directly related to the size o

Table 10.—Number of trips by mass-transit passengers and by all modes of travel in each of 50 cities in six population groups, classifie according to trip purpose

City	Population group	Number of mass-transit passenger trips made for purposes of—						Number of trips by all modes of travel for purposes of—					
		Work and business	Social and recreation	Shop	Miscellaneous	Home	Total	Work and business	Social and recreation	Shop	Miscellaneous	Home	Total
Philadelphia, Pa.	1,000,000 and over.	583, 557	135, 154	126, 102	692, 382	861, 013	2, 398, 208	961, 758	299, 150	182, 086	810, 512	1, 294, 574	3, 548, 080
San Francisco, Calif.		296, 825	79, 652	66, 397	86, 241	414, 667	943, 782	838, 215	356, 957	199, 826	347, 115	1, 063, 372	2, 805, 485
Newark, N. J.		284, 434	78, 023	78, 313	54, 244	453, 361	948, 375	573, 786	200, 620	135, 988	121, 987	886, 116	1, 918, 497
Washington, D. C.		237, 164	52, 699	38, 872	51, 167	298, 058	677, 960	515, 537	210, 232	109, 805	170, 136	718, 160	1, 723, 870
Total		1, 401, 980	345, 528	309, 684	884, 034	2, 027, 099	4, 968, 325	2, 889, 296	1, 066, 959	627, 705	1, 449, 750	3, 962, 222	9, 995, 932
St. Louis, Mo.	500,000–1,000,000.	428, 806	69, 134	70, 793	30, 495	562, 209	1, 161, 437	626, 060	112, 383	97, 066	52, 232	824, 563	1, 712, 304
St. Paul-Minneapolis, Minn.		137, 017	29, 327	33, 728	30, 394	201, 235	431, 701	442, 551	242, 638	119, 376	162, 910	665, 054	1, 632, 529
Baltimore, Md.		201, 560	44, 773	42, 922	46, 233	307, 263	642, 751	385, 113	110, 184	77, 255	87, 331	534, 834	1, 194, 717
Houston, Tex.		66, 022	8, 630	14, 227	44, 125	119, 265	252, 269	433, 046	203, 292	188, 692	275, 219	750, 078	1, 850, 327
Dallas, Tex.		68, 066	7, 421	12, 317	22, 299	95, 968	206, 071	256, 996	121, 239	96, 107	145, 695	420, 168	1, 040, 205
Seattle, Wash.		81, 675	25, 713	27, 015	16, 532	132, 308	283, 243	239, 268	106, 777	64, 234	61, 666	347, 239	819, 184
Total		983, 146	184, 998	201, 002	190, 078	1, 418, 248	2, 977, 472	2, 383, 034	896, 513	642, 730	785, 053	3, 541, 936	8, 249, 266
Portland, Oreg.	250, 000–500, 000	75, 407	27, 190	24, 837	10, 838	110, 779	249, 051	253, 196	138, 248	83, 033	76, 014	340, 757	891, 248
Norfolk, Va.		40, 920	8, 230	7, 180	6, 060	55, 350	117, 740	152, 120	66, 720	39, 200	48, 460	218, 420	524, 920
San Juan, P. R.		59, 449	16, 889	10, 040	43, 450	85, 142	214, 970	75, 702	29, 626	12, 840	52, 008	107, 156	277, 332
Total		175, 776	52, 309	42, 057	60, 348	251, 271	581, 761	481, 018	234, 594	135, 073	176, 482	666, 333	1, 693, 500
Wichita, Kans.	100,000–250,000	18, 508	3, 484	5, 349	8, 927	31, 441	67, 709	169, 128	62, 940	62, 257	97, 370	247, 324	639, 019
Grand Rapids, Mich.		23, 407	6, 942	5, 704	3, 331	34, 176	73, 560	135, 431	99, 475	58, 875	52, 086	222, 621	568, 488
Honolulu, T. H.		34, 179	18, 845	9, 064	17, 751	82, 366	162, 205	89, 614	91, 149	32, 826	57, 453	210, 018	481, 060
Sacramento, Calif.		14, 517	3, 708	3, 917	8, 770	27, 344	58, 256	100, 647	42, 598	35, 697	54, 331	138, 314	371, 587
Salt Lake City, Utah		21, 079	7, 642	6, 332	3, 735	35, 060	73, 848	81, 019	46, 750	20, 421	19, 981	123, 524	291, 695
Wilmington, Del.		28, 532	9, 317	6, 551	7, 244	46, 242	97, 886	81, 503	37, 574	17, 641	29, 505	117, 832	284, 055
Phoenix, Ariz.		15, 863	5, 046	5, 484	10, 897	34, 028	71, 318	96, 178	58, 363	54, 133	66, 268	161, 696	436, 638
Tacoma, Wash.		14, 967	4, 724	4, 742	5, 340	25, 400	55, 173	61, 758	29, 997	16, 846	23, 229	87, 573	219, 403
Spokane, Wash.		14, 915	4, 979	6, 177	5, 057	32, 090	63, 218	55, 883	24, 208	16, 115	15, 875	96, 687	208, 768
Scranton, Pa.		15, 765	9, 282	14, 017	1, 960	40, 238	81, 262	38, 886	24, 809	20, 264	7, 344	80, 315	171, 618
Duluth, Minn., Superior, Wis.		17, 648	7, 244	4, 953	2, 468	27, 658	59, 971	61, 327	40, 809	17, 560	18, 139	85, 131	222, 966
Chester, Pa.		8, 197	1, 922	2, 311	3, 057	12, 680	28, 167	30, 170	12, 839	9, 363	9, 143	49, 303	110, 818
Tucson, Ariz.		7, 310	2, 490	2, 640	5, 590	16, 290	34, 320	64, 705	37, 772	29, 137	37, 454	101, 632	270, 700
Lansing, Mich.		8, 543	2, 719	2, 583	3, 797	14, 478	32, 120	66, 293	33, 940	22, 465	32, 248	86, 961	241, 907
Reading, Pa.		23, 717	4, 907	4, 731	3, 552	32, 885	69, 792	55, 192	13, 313	9, 225	13, 547	65, 835	157, 112
Albuquerque, N. Mex.		8, 668	3, 597	3, 069	2, 266	15, 290	32, 890	58, 866	45, 217	18, 591	26, 239	93, 714	242, 627
Rockford, Ill.		10, 911	3, 059	6, 749	1, 354	20, 484	42, 557	71, 160	43, 419	27, 034	17, 424	122, 831	281, 868
Saginaw, Mich.		6, 217	2, 074	1, 427	871	9, 471	20, 060	57, 444	31, 588	24, 806	30, 706	90, 394	234, 938
Madison, Wis.		10, 495	4, 008	2, 500	8, 785	20, 051	45, 839	50, 490	29, 265	15, 084	35, 848	74, 414	205, 101
Harrisburg, Pa.		26, 782	9, 578	5, 861	3, 299	38, 592	84, 112	58, 134	25, 392	13, 387	14, 300	79, 526	190, 739
Total		330, 220	115, 567	104, 161	108, 051	596, 264	1, 254, 263	1, 483, 828	831, 417	521, 727	658, 490	2, 335, 645	5, 831, 107
Johnstown, Pa.	50,000–100,000	11, 424	3, 924	3, 132	1, 176	17, 940	37, 596	27, 973	14, 463	10, 491	6, 326	41, 535	100, 788
Altoona, Pa.		6, 107	1, 823	2, 391	946	10, 300	21, 567	26, 267	17, 173	11, 326	7, 988	45, 051	107, 805
Muskegon, Mich.		6, 373	4, 022	2, 307	574	11, 360	24, 636	39, 429	38, 269	13, 251	14, 042	69, 356	174, 347
Pontiac, Mich.		7, 122	1, 949	1, 648	4, 813	12, 768	28, 300	38, 901	17, 427	10, 392	20, 611	59, 742	147, 073
Columbus, Ga.		21, 645	2, 894	3, 765	4, 024	30, 903	63, 231	47, 624	12, 628	11, 575	14, 165	69, 954	155, 946
Racine, Wis.		7, 653	2, 916	2, 390	2, 832	11, 257	27, 048	38, 412	23, 021	13, 078	22, 973	54, 329	151, 813
Macon, Ga.		20, 549	4, 418	5, 006	2, 915	33, 154	66, 042	46, 607	10, 082	9, 769	10, 529	68, 662	145, 649
York, Pa.		4, 281	1, 377	1, 496	1, 345	6, 537	15, 036	47, 309	18, 234	10, 354	17, 450	50, 291	143, 638
Charleston, S. C.		10, 498	5, 068	2, 261	789	15, 885	34, 501	29, 928	19, 687	8, 414	6, 082	50, 098	114, 209
Kalamazoo, Mich.		7, 189	2, 546	2, 247	3, 031	11, 144	26, 157	37, 775	24, 247	10, 799	15, 929	58, 623	147, 373
Bay City, Mich.		4, 955	1, 978	1, 239	1, 337	7, 017	16, 526	32, 698	34, 522	14, 456	20, 967	62, 839	165, 482
Williamsport, Pa.		2, 401	781	896	498	3, 971	8, 547	19, 535	11, 987	5, 887	9, 784	32, 001	79, 194
Total		110, 197	33, 696	28, 778	24, 280	172, 236	369, 187	432, 458	241, 740	129, 792	166, 846	662, 481	1, 633, 317
Fargo, N. Dak., Moorhead, Minn.	Less than 50,000.	3, 543	1, 690	1, 310	885	5, 994	13, 422	32, 264	27, 800	7, 592	15, 429	46, 446	129, 531
Sharon-Farrell, Pa.		4, 229	1, 489	2, 021	585	7, 688	16, 012	19, 506	15, 120	9, 175	8, 492	34, 112	86, 405
Norristown, Pa.		3, 908	842	973	1, 759	6, 527	14, 009	14, 051	6, 967	3, 613	5, 870	24, 940	55, 441
Appleton, Wis.		1, 052	356	445	325	1, 994	4, 172	16, 867	11, 528	9, 559	9, 408	25, 570	72, 932
Wisconsin Rapids, Wis.		52	12	4	116	220	404	6, 990	4, 173	3, 098	5, 560	10, 403	30, 224
Total		12, 784	4, 389	4, 753	3, 670	22, 423	48, 019	89, 678	65, 588	33, 037	44, 759	141, 471	374, 533
Grand total	All groups	3, 014, 103	736, 487	690, 435	1, 270, 461	4, 487, 541	10, 199, 027	7, 759, 312	3, 336, 811	2, 090, 064	3, 281, 380	11, 310, 088	27,777,655

ity and indicate that such a basis would provide only a rude forecast at best.

The ranges in percentages of trips for each trip purpose by each mode of travel are shown in table 11. Despite the wide range between the maximum and minimum percentages, it is seen later that for any particular urban area it is possible to make a fairly reasonable forecast of the absolute volume of trips from which percentages may be computed.

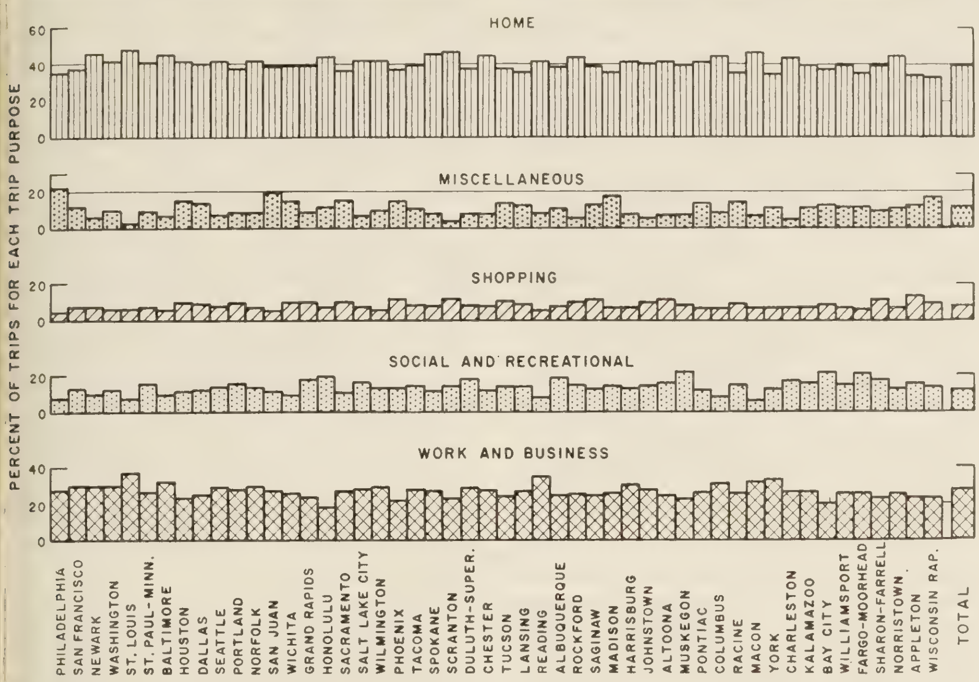

Figure 5.—Percentage distribution of trips in each city, according to purpose.

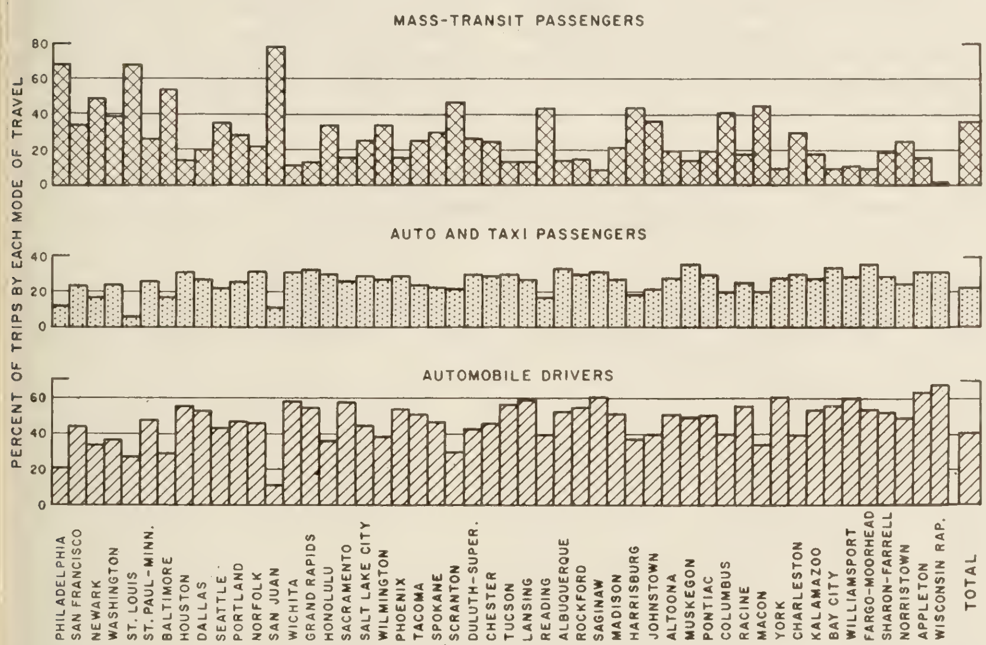

Figure 6.—Percentage distribution of trips in each city, according to mode of travel.

Table 11.—Range in percentage of trips for each trip purpose by each mode of travel in 50 cities

Mode of travel	Percentage range, by mode of travel, in trips made for purposes of—				
	Work and business	Social and recreation	Shop	Miscel-laneous	Home
Automobile drivers:					
Maximum	41.3	16.8	13.6	20.1	47.6
Minimum	22.9	4.0	4.5	4.1	30.4
Automobile and taxi passengers:					
Maximum	31.7	39.3	13.7	12.2	47.9
Minimum	10.6	12.3	4.5	2.5	36.7
Mass-transit passengers:					
Maximum	36.9	16.3	17.3	28.9	54.5
Minimum	12.9	3.0	1.0	2.3	35.9
All modes of travel:					
Maximum	36.6	22.0	13.1	22.8	48.2
Minimum	18.6	6.9	4.6	3.1	34.4

Mode distribution

The percentage distribution of trips in the 50 individual cities by mode of travel is presented in figure 6. The most noticeable difference from the previous distribution by trip purpose is the relative lack of uniformity among the several cities when considering travel mode. While not included in this article, similar percentages were developed for each trip purpose and a variable pattern was found in each case. The ranges in the percentage of trips by each mode of travel for each trip purpose and for all purposes are shown in table 12.

Besides being small in absolute volumes, trips by automobile drivers and automobile and taxi passengers were also few on a relative basis in San Juan, where 7 out of 9 persons making trips traveled as mass-transit passengers, largely in "publicos" (privately owned public conveyances, usually station wagons, which generally operate over established routes but with no fixed schedule). On the other hand, exceptionally high percentages of automobile trips were observed for each trip purpose in cities of Texas, New Mexico, Arizona, California, Washington, Michigan, and Wisconsin.

It may be that these variations are related to the period during which the basic studies were made or to the geographical area in which the cities are located. Some of the studies where mass-transit facilities played an important role were made during or shortly after World War II when automobile driving was restricted. Also, other evidence indicates that the preference for automobile travel has increased progressively over the decade during which the studies were made in the various cities. Insofar as location is concerned, it is not unusual to find a particularly high proportion of automobile-driver trips in the Southwestern and Pacific States, and certain States in the Great Lakes region where automobile ownership and travel are relatively high.

Table 12.—Range in percentage of trips by each mode of travel for each trip purpose in 50 cities

Purpose of trip	Percentage range, by purpose of trip, in trips made by—		
	Automobile drivers	Automobile and taxi passengers	Mass-transit passengers
Work and business:			
Maximum	79.2	24.9	78.5
Minimum	14.5	4.8	.7
Social and recreation:			
Maximum	45.9	65.9	61.5
Minimum	13.8	10.7	.3
Shop:			
Maximum	70.6	35.4	78.2
Minimum	10.8	4.7	.1
Miscellaneous:			
Maximum	84.9	37.5	85.4
Minimum	9.0	5.6	2.1
Home:			
Maximum	65.1	38.7	79.5
Minimum	8.8	5.6	2.1
All purposes:			
Maximum	67.9	35.7	77.5
Minimum	11.1	5.6	1.3

In spite of the noticeable lack of uniformity as far as mode of travel for each trip purpose is concerned, there was an overall trend for a larger percentage of automobile trips in smaller cities as would be expected. Conversely, there seemed to be a general trend toward a larger percentage of mass-transit passenger trips in the larger cities. Mass transit was the predominant mode of travel in the largest cities, but automobile drivers comprised over half of the vehicular trips by residents in most of the medium-size and smaller cities. These trends appeared among trips for each purpose.

Trips from Purpose to Purpose

All of the previous discussion has dealt with the purpose of trips in connection with their point of destination. This section considers the purpose from which the trips were made at points of origin, as related to the destination purpose. This type of information is presented only in summary form for all 50 urban areas, although detailed data are available from individual city reports. The number of trips made by persons "from" a purpose "to" a purpose are included. This somewhat unusual phraseology is used to express an idea that could not otherwise be expressed precisely in so few words. It describes not only why a person made a trip to his destination, but why he was at the place he left.

Table 13 shows the volume of trips in all 50 urban areas from each purpose to each purpose for each mode of travel. The predominant purposes of trips by all modes of travel were from home to work and business, followed closely by trips from work and business to home. These same trips were dominant among mass-transit passengers and automobile drivers, but ranked second among automobile and taxi passengers. The trips from work or business to home did not quite equal the volume of trips in the reverse direction because of the intermediate trips from work or business for some other purpose prior to returning home. For instance, some of this difference was accounted for by the excess of trips from social-recreational purposes to home, over and above the number of trips from home for social and recreational purposes. Also pedestrian trips, not included in the basic surveys, could have accounted for some of the apparent discrepancies.

Trips between home and social-recreational activities were the next most important category (after the home and work-business cycle) among the trips by all modes of travel combined, but they were the most important purpose-to-purpose category among automobile and taxi passengers. Trips between home and miscellaneous purposes ranked second for automobile drivers and mass-transit passengers, third for all modes of travel combined, and fourth for automobile and taxi passengers. The third ranking category among automobile drivers and mass-transit passengers was home trips to and from social-recreational purposes. Trips between home and shopping ranked third with automobile and taxi passengers and fourth with each of the other modes of travel and with all modes combined. The only other significant purpose-to-purpose categories were the automobile- and taxi-passenger trips from one social or recreational purpose to another, trips from work or business to work or business by automobile drivers, and trips between work or business and miscellaneous purposes by each mode of travel.

Table 13 also shows the percentage distribution of trips from each purpose to each purpose for all travel modes. Trips from home to work and business by mass-transit passengers were the foremost type of internal trips by residents of the 50 urban areas. These trips accounted for nearly 10 percent of the total trips by all modes for all purposes. Trips either to or from home were the most numerous of all. The only other categories of trips accounting for 1 percent or more of the total were trips by automobile drivers for work or business and miscellaneous purposes, and social-recreational trips by automobile and taxi passengers.

Table 13 is the basis for figure 7 which presents the percentage distribution of trips from each purpose to each purpose, and that proportion attributable to each mode of travel. Since trips are grouped first by trip purpose and then by all purposes, each trip is represented at least twice in this chart. The arrows indicate the direction of trip purpose. In the upper left-hand corner of the chart, for instance, under the home category, it may be

Table 13.—Number and percentage of trips by each mode of travel in 50 cities from each purpose to each purpose

Trips from—	Trips to—											
	Work and business		Social and recreation		Shop		Miscellaneous		Home		Total	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Automobile Drivers												
Work and business	1,137,747	4.1	69,070	0.2	103,456	0.4	338,619	1.2	2,042,942	7.4	3,691,834	13.3
Social and recreation	31,001	.1	135,366	.5	43,584	.2	93,036	.3	774,933	2.8	1,077,920	3.9
Shop	43,624	.2	46,590	.2	138,449	.5	43,602	.2	628,494	2.2	900,759	3.3
Miscellaneous	340,199	1.2	93,187	.3	74,324	.2	237,668	.9	741,549	2.7	1,486,927	5.3
Home	2,127,277	7.6	735,729	2.7	551,018	2.0	811,448	2.9	----------	------	4,225,472	15.2
Total	3,679,848	13.2	1,079,942	3.9	910,831	3.3	1,524,373	5.5	4,187,918	15.1	11,382,912	41.0
Automobile and Taxi Passengers												
Work and business	117,942	0.4	42,639	0.2	36,541	0.1	61,531	0.2	837,854	3.0	1,096,507	3.9
Social and recreation	21,597	.1	305,659	1.1	40,438	.1	38,734	.1	1,159,437	4.2	1,565,865	5.6
Shop	12,575	.1	41,213	.1	73,229	.2	9,402	------	351,404	1.3	487,823	1.7
Miscellaneous	48,862	.2	51,781	.2	17,394	.1	26,310	.1	285,934	1.0	430,281	1.6
Home	864,385	3.1	1,079,090	3.9	321,196	1.1	350,569	1.3	----------	------	2,615,240	9.4
Total	1,065,361	3.9	1,520,382	5.5	488,798	1.6	486,546	1.7	2,634,629	9.5	6,195,716	22.2
Mass-Transit Passengers												
Work and business	118,402	0.4	35,234	0.1	38,464	0.2	233,567	0.9	2,533,978	9.1	2,959,645	10.7
Social and recreation	9,086	------	35,688	.1	12,208	------	39,639	.2	598,636	2.2	695,257	2.5
Shop	13,399	------	21,087	.1	23,085	.1	44,347	.2	590,706	2.1	692,624	2.5
Miscellaneous	237,287	.9	52,453	.2	53,753	.2	189,914	.6	764,221	2.8	1,297,628	4.7
Home	2,635,929	9.5	592,025	2.1	562,925	2.1	762,994	2.7	----------	------	4,553,873	16.4
Total	3,014,103	10.8	736,487	2.6	690,435	2.6	1,270,461	4.6	4,487,541	16.2	10,199,027	36.8
All Modes of Travel												
Work and business	1,374,091	4.9	146,943	0.5	178,461	0.7	633,717	2.3	5,414,774	19.5	7,747,986	27.9
Social and recreation	61,684	.2	476,713	1.7	96,230	.3	171,409	.6	2,533,006	9.2	3,339,042	12.0
Shop	69,598	.3	108,890	.4	234,763	.8	97,351	.4	1,570,604	5.6	2,081,206	7.5
Miscellaneous	626,348	2.3	197,421	.7	145,471	.5	453,892	1.6	1,791,704	6.5	3,214,836	11.6
Home	5,627,591	20.2	2,406,844	8.7	1,435,139	5.2	1,925,011	6.9	----------	------	11,394,585	41.0
Total	7,759,312	27.9	3,336,811	12.0	2,090,064	7.5	3,281,380	11.8	11,310,088	40.8	27,777,655	100.0

seen that trips in connection with work and business accounted for the largest proportion of home trips. Trips from home to work and business slightly exceeded those in the reverse direction (20.3 percent as compared with 19.5 percent). Mass-transit passengers ranked first in these trips, and automobile and taxi passengers ranked third behind automobile drivers.

Home trips that were linked with social and recreational purposes were fewer than those involving work and business. Their pattern differed from the latter in that trips from home to social-recreational activities were fewer than the reverse trips. Also, in this case, automobile- and taxi-passenger trips were the most numerous, and were followed by automobile-driver and mass-transit passenger trips. As a matter of fact, home trips linked with work and business were made less often by automobile and taxi passengers than home trips linked with a social-recreational purpose. Figure 7 is adaptable similarly to an analysis of trips associated with other or with all to and from purposes.

Table 14 shows the percentage of trips made both to and from each purpose for each mode of travel. Since for each single trip there are two purposes, one from and one to, the totals add to 200 percent. This table formed the basis for figure 8, from which it is apparent that first home and then work and business were the top-ranking purposes among all modes except one. Automobile and taxi passengers traveled more frequently from or to a social-recreational purpose (50 percent) than a work or business purpose (35 percent). Work and business trips were relatively more significant among the automobile drivers, since 65 percent of their trips were for that purpose. Mass-transit passengers were the group most likely to be traveling from or to home. The fact that this purpose accounted for almost 89 percent of their trips may be related to the greater possibility that intermediate trips by these persons were made by walking than in the case of automobile drivers and automobile and taxi passengers. Miscellaneous trips accounted for about

Table 14.—Percentage of trips for each mode of travel in 50 cities, classified according to purpose at both origin and destination

Purpose	Mode of travel [1]			
	Automobile drivers	Automobile and taxi passengers	Mass-transit passengers	All modes of travel
Home	73.9	84.7	88.6	81.8
Work and business	64.8	34.9	58.6	55.8
Social-recreation	19.0	49.8	14.0	24.0
Miscellaneous	26.4	14.8	25.2	23.4
Shopping	15.9	15.8	13.6	15.0
Total	200.0	200.0	200.0	200.0

[1] Percentages add to 200 for each mode of travel because the purpose of each trip is considered twice, at place of origin (purpose from) and at place of destination (purpose to).

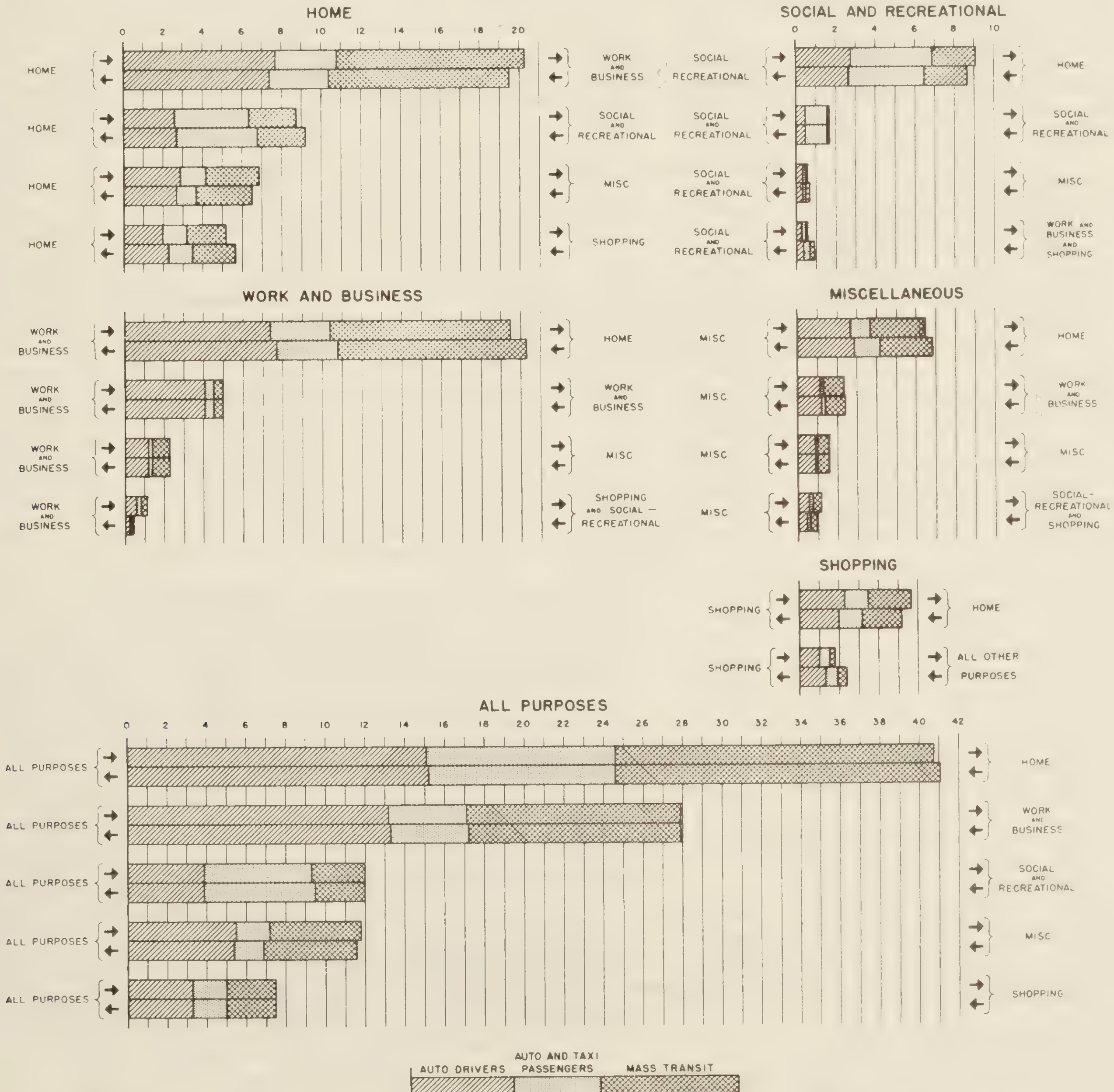

Figure 7.—Percentage distribution of trips from each purpose to each purpose, by mode of travel.

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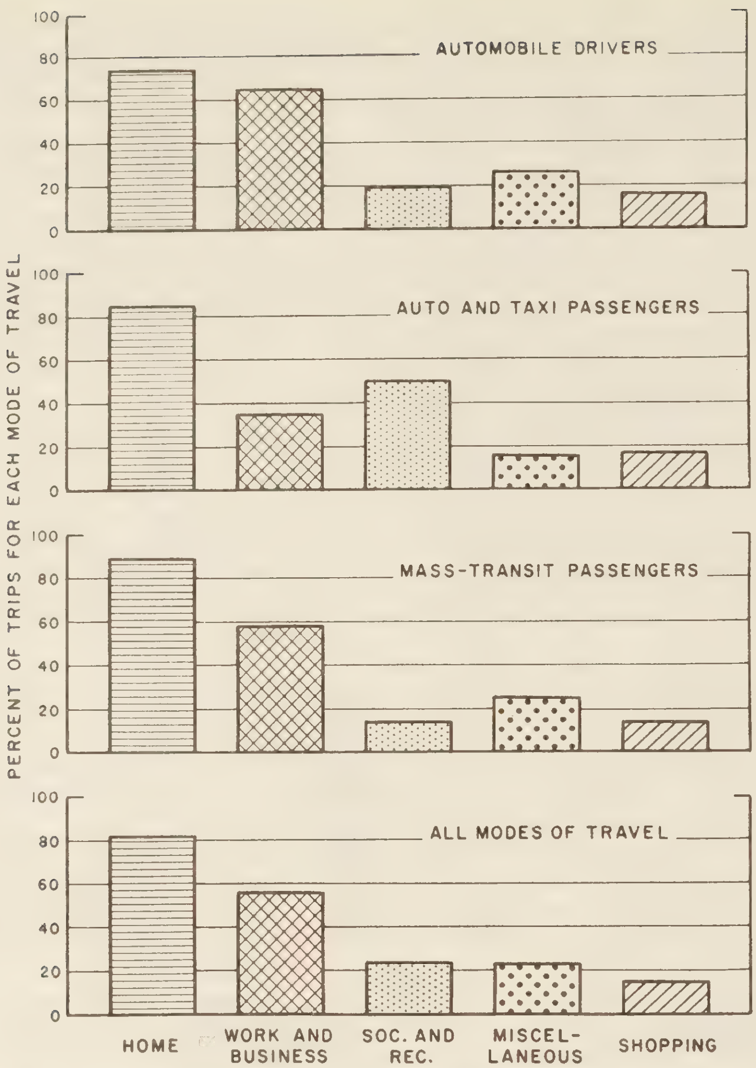

Figure 8.—Percentage distribution of trips, both from and to each purpose, by mode of travel.

one-fourth of the trips by both mass-transit passengers and by automobile drivers. Trips to or from shopping amounted to approximately 15 percent of the trips by each mode of travel.

The percentage distribution of trips from each purpose to each purpose is presented in figure 9 for all modes of travel combined. This chart was constructed in a manner similar to figure 2. It shows, for instance, that trips from home to work and business predominated, accounting for almost 50 percent of the trips from home and over 20 percent of all trips. The reverse trips from work and business to home also accounted for about one-fifth of all trips, but they comprised 70 percent of the trips from work and business. Trips to home accounted for three-fourths of the trips from social-recreational and from shopping purposes, but in comparison with total trips, they represented only 9 and 6 percent, respectively. The large proportion of trips both to and from home, 82 percent, is particularly apparent in figure 9.

Household Characteristics

In addition to data concerning the daily trips of residents, the basic origin and destination surveys of the home-interview type provided information concerning the numbers of dwelling units, automobiles owned, residents, and persons 5 years of age and older. Some of these household characteristics for the 50 urban areas are recorded in table 15. By and large they varied directly with popu- lation. This pattern is more apparent i table 16, which compares the mean averag for each of six population groups. In th table and in all of the following analyses Sa Juan, Puerto Rico, was omitted because the significant differences from the pattern travel in the continental United States.

Trips Related to Household Characteristics

The ratios of trips by each travel mode t household characteristics are shown in tabl 17 for the average city in each populatio group. The ratios of total trips and automo bile trips tended to vary inversely wit population, while mass-transit trip ratic varied directly with population, as seen i figure 10. The sharp upturn in the patter for total trips per automobile owned in th highest population group was due to th relatively low automobile ownership ratic in cities of the 1 million or more populatio group and the greater incidence of mass-transi trips in these cities. The reverse situatio caused the low point in this pattern for citie of less than 50,000 population. Some of th other variations of the patterns in the 500,00 to 1,000,000 and 50,000 to 100,000 populatio groups would be smoothed out by eliminatin surveys conducted during World War II.

The basic tables 9 and 10, giving trip pur pose and mode of travel in each of the 5 cities, and the household characteristic shown in table 15 may be used to develo similar individual city ratios for each mode o travel and each trip purpose. For each tri purpose there appears to be an inverse linea correlation between population and trips pe dwelling unit or trips per person for the auto mobile travel modes; that is, the larger citie have smaller trip ratios. In the case o trips by mass-transit passengers, the corre lations generally appear to be direct for eacl trip purpose.

The relations existing between a few of thes trip ratios and the number of automobile

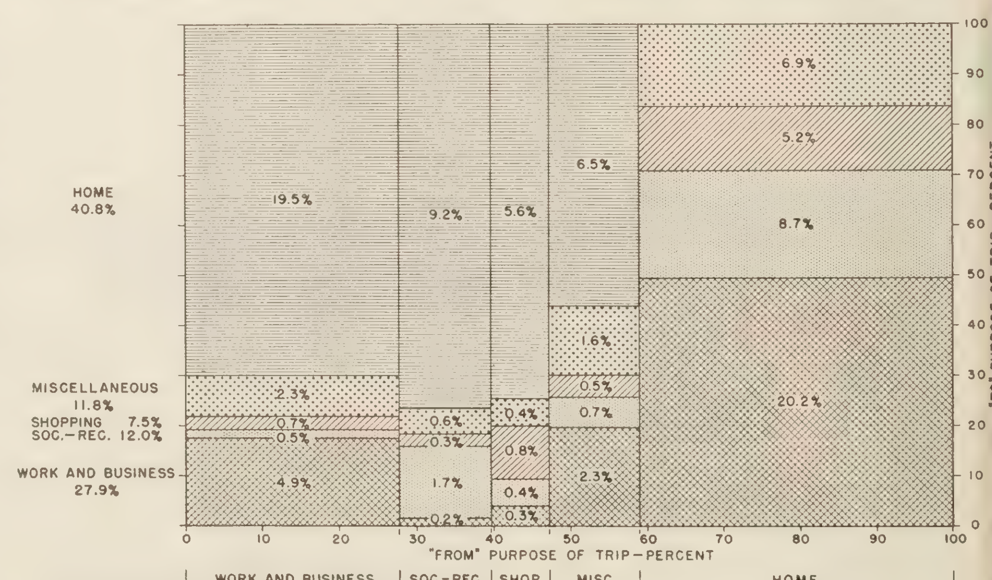

Figure 9.—Percentage distribution of trips from each purpose to each purpose.

Table 15.—Selected household characteristics in each of 50 cities in 6 population groups

City	Population group	Number of dwelling units	Number of passenger cars owned	Number of persons, all ages	Number of persons, 5 years of age and older
Philadelphia, Pa	1,000,000 and over	659, 165	257, 907	2, 233, 531	2, 048, 388
San Francisco, Calif		554, 200	317, 400	1, 468, 933	1, 348, 835
Newark, N. J		436, 886	245, 151	1, 456, 947	1, 345, 138
Washington, D. C		336, 181	203, 464	1, 109, 860	992, 644
Total		1, 986, 432	1, 023, 922	6, 269, 271	5, 735, 005
St. Louis, Mo	500,000–1,000,000	294, 757	143, 415	974, 545	878, 377
St. Paul-Minneapolis, Minn		299, 510	226, 815	915, 960	825, 625
Baltimore, Md		275, 778	123, 998	912, 809	830, 909
Houston, Tex		272, 722	256, 300	878, 629	765, 942
Dallas, Tex		168, 066	153, 777	533, 606	471, 064
Seattle, Wash		188, 732	118, 622	518, 563	471, 911
Total		1, 499, 565	1, 022, 927	4, 734, 112	4, 243, 828
Portland, Oreg	250,000–500,000	152, 586	103, 245	453, 128	412, 358
Norfolk, Va		108, 000	61, 480	335, 910	293, 270
San Juan, P. R		63, 131	8, 011	312, 069	267, 726
Total		323, 717	172, 736	1, 101, 107	973, 354
Wichita, Kans	100,000–250,000	79, 534	75, 888	238, 302	206, 529
Grand Rapids, Mich		65, 170	52, 795	220, 977	199, 209
Honolulu, T. H		51, 422	32, 692	214, 236	184, 141
Sacramento, Calif		79, 100	53, 900	201, 345	179, 778
Salt Lake City, Utah		57, 103	38, 851	196, 571	172, 557
Wilmington, Del		49, 903	30, 190	181, 445	162, 503
Phoenix, Ariz		48, 221	36, 372	161, 567	145, 198
Tacoma, Wash		48, 008	35, 175	138, 700	125, 002
Spokane, Wash		48, 517	29, 644	138, 381	124, 952
Scranton, Pa		41, 362	22, 093	137, 089	126, 541
Duluth, Minn., Superior, Wis		42, 550	25, 596	130, 847	119, 056
Chester, Pa		35, 206	24, 449	127, 408	114, 709
Tucson, Ariz		38, 690	32, 910	126, 900	113, 730
Lansing, Mich		35, 821	30, 252	122, 776	110, 269
Reading, Pa		37, 910	17, 184	119, 850	112, 504
Albuquerque, N. Mex		34, 884	27, 469	116, 056	100, 817
Rockford, Ill.		36, 200	33, 100	116, 000	102, 500
Saginaw, Mich		31, 915	27, 028	112, 902	101, 438
Madison, Wis		33, 365	25, 328	104, 074	94, 300
Harrisburg, Pa		31, 599	16, 363	103, 303	96, 100
Total		926, 480	667, 279	3, 008, 729	2, 691, 833
Johnstown, Pa	50,000–100,000	23, 130	13, 828	87, 509	80, 351
Altoona, Pa		24, 060	16, 758	85, 347	77, 477
Muskegon, Mich		23, 507	18, 941	83, 724	75, 099
Pontiac, Mich		22, 251	17, 808	79, 431	71, 851
Columbus, Ga		20, 307	8, 808	79, 192	70, 621
Racine, Wis		23, 280	18, 483	78, 033	69, 508
Macon, Ga		20, 089	9, 529	77, 665	69, 966
York, Pa		25, 310	20, 473	77, 350	69, 387
Charleston, S. C		20, 258	7, 179	73, 205	65, 390
Kalamazoo, Mich		22, 645	17, 198	72, 024	65, 945
Bay City, Mich		19, 561	15, 927	69, 231	61, 454
Williamsport, Pa		17, 016	14, 715	55, 216	48, 675
Total		261, 414	179, 647	917, 927	825, 724
Fargo, N. Dak., Moorhead, Minn.	Less than 50,000	15, 617	12, 688	49, 852	44, 030
Sharon-Farrell, Pa		13, 657	9, 442	48, 432	44, 310
Norristown, Pa		10, 282	7, 466	39, 485	36, 106
Appleton, Wis		11, 769	11, 073	39, 172	33, 923
Wisconsin Rapids, Wis		4, 700	4, 660	16, 504	14, 428
Total		56, 025	45, 329	193, 445	172, 797
Grand total		5, 053, 633	3, 111, 840	16, 224, 591	14, 642, 541

per dwelling unit are shown in figure 11. It is noted that in areas of high automobile-ownership ratios, the total trips per person and the automobile trips per person were greater. Also, since automobile-driver trips per automobile tended to increase as automobile ownership increased, the number of trips per vehicle may be expected to increase as the ownership ratio of automobiles per family continues to grow. Whether mileage traveled per vehicle follows the same trend depends upon trip lengths. As in the case of figure 10, these curves are also affected by the data from older studies and by the economic as well as the population characteristics of the cities studied.

Volume of trips and percentage of trips by individual purposes and modes of travel were associated with the ratios of automobiles per dwelling unit and persons per automobile. Although there was fairly good linear correlation between percentage of trips (by purpose and mode) and automobiles per dwelling unit, these correlations were not as high as others relating trips to the absolute household data in each urban area. In the latter case, better correlations were found between volume of trips (by purpose and mode) and the numbers of persons over 5 years of age, automobiles or dwelling units, than between percentage of trips (for a particular purpose or mode of travel) and any one of these variables.

The household characteristic which was most closely related to volume of trips varied, depending upon the mode of travel or purpose of trip. These relations are shown in table 18, together with their respective correlation coefficients. These two-variable, linear correlations were deemed to be sufficiently high to forgo the need for testing correlations based upon second-degree equations or logarithms. However, for convenience of presentation the related scatter diagrams shown in figures 12–16 have been plotted on logarithmic scales.

No attempt was made to associate all household characteristics with the volume of automobile- and taxi-passenger trips, but the scatter diagram in figure 17 suggests that the number of automobiles owned in the area is a good factor.

The relatively low correlation for trips with miscellaneous purposes is not unusual because of the varying nature of such trips. A better correlation factor is hardly required, however, since there is less cause for estimating these miscellaneous trips due to their relatively small number—less than 12 percent of the total. More favorable multiple correlations might be developed if required. For instance, the addition of the factor automobiles owned to the number of persons over 5 years of age raised the correlation with mass-transit passengers from +0.941 to +0.987.

In view of the large number of automobile-driver trips made for the purpose of going to work and for transacting business, these particular trips were also associated with the several household factors. Although total work and business trips in an area were more closely related to dwelling units (a higher correlation coefficient) than total automobile-driver trips were related to automobiles owned, it was found that work and business trips made by automobile drivers were more closely associated to automobiles owned. In the latter comparison, which is illustrated in figure 18, the correlation coefficient was +0.984.

In order to more precisely estimate the volume of trips by each mode of travel for each individual purpose, it would be necessary to determine by means of correlation techniques similar maximum coefficients for the other modes and purposes. Of course, any application of estimates must be consistent with the resulting standard error. Further development is not attempted here, since this article is primarily concerned with existing conditions within the 50 urban areas. However, this discussion should be sufficiently indicative of the types of analysis which may be continued and expanded in an effort to

Table 16.—Average number of dwelling units, passenger cars owned, and residents per city for each of six population groups

Population group	Number of cities	Average number (in thousands) of— Dwelling units	Passenger cars owned	Persons, all ages	Persons, 5 years of age and older
1,000,000 and over	4	497	256	1, 567	1, 434
500,000–1,000,000	6	250	170	789	707
250,000–500,000	2	130	82	395	353
100,000–250,000	20	46	33	150	135
50,000–100,000	12	22	15	76	69
Less than 50,000	5	11	9	39	35
All groups	49	102	64	325	294

Table 17.—Average ratios per city between number of trips by each mode of travel and selected household characteristics in six populatio groups

Population group	Trips per dwelling unit by mode of travel				Trips per automobile owned by mode of travel				Trips per person by mode of travel			
	Automobile driver	Automobile and taxi passenger	Mass-transit passenger	Total	Automobile driver	Automobile and taxi passenger	Mass-transit passenger	Total	Automobile driver	Automobile and taxi passenger	Mass-transit passenger	Total
1,000,000 and over	1. 62	0. 91	2. 50	5. 03	3. 15	1. 76	4. 85	9. 76	0. 51	0. 29	0. 79	1. 59
500,000–1,000,000	2. 35	1. 16	1. 99	5. 50	3. 45	1. 70	2. 91	8. 06	. 74	. 37	. 63	1. 74
250,000–500,000	2. 54	1. 49	1. 41	5. 44	4. 02	2. 35	2. 22	8. 59	. 84	. 49	. 46	1. 79
100,000–250,000	3. 15	1. 79	1. 35	6. 29	4. 38	2. 48	1. 88	8. 74	. 97	. 55	. 42	1. 94
50,000–100,000	3. 09	1. 75	1. 41	6. 25	4. 50	2. 54	2. 05	9. 09	. 88	. 50	. 40	1. 78
Less than 50,000	3. 73	2. 10	. 85	6. 60	4. 61	2. 60	1. 06	8. 27	1. 08	. 61	. 25	1. 94

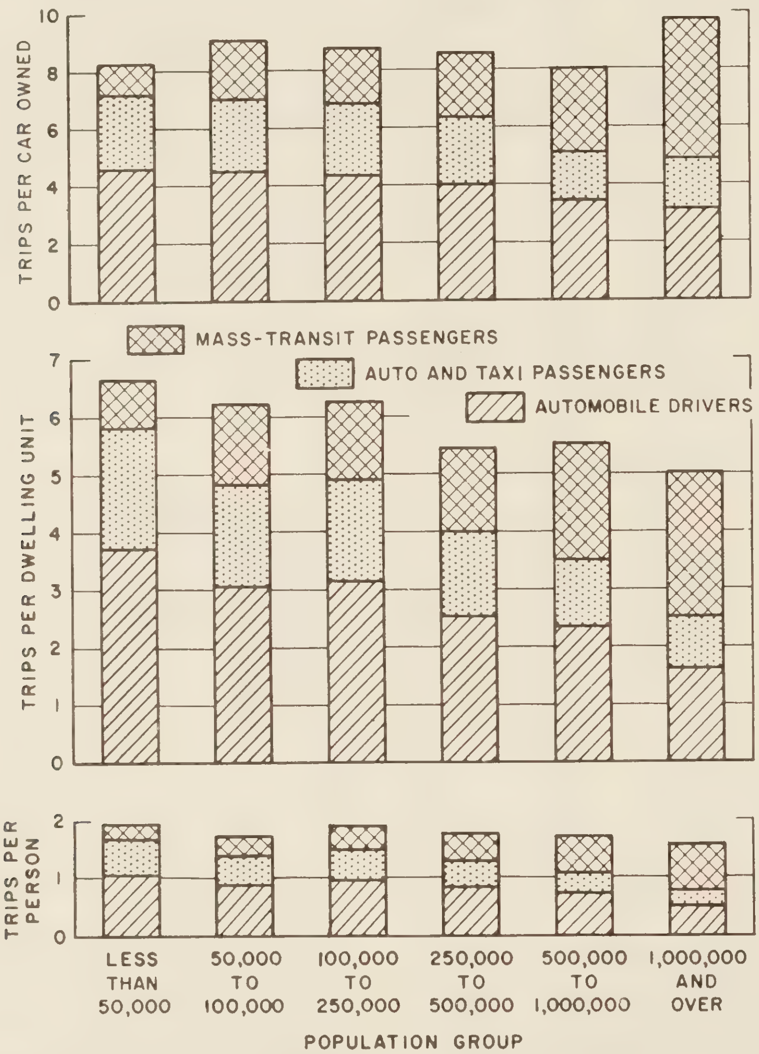

Figure 10.—Relation of trips per person, trips per dwelling unit, and trips per automobile to population size of cities.

develop predictive factors representative of local travel in typical urban areas.

Appendix

Up to this point, the discussion has dealt with several aspects of the travel pattern in 50 urban areas with regard to the 5 major trip purposes and the 3 most important modes of travel. It was mentioned, however, that the basic origin and destination surveys, which provided the data for these analyses, included information with respect to 7 possible travel modes and 10 trip purposes; and in certain cases some rather interesting and significant facets of the total urban travel complex wer obscured as a result of the combining pro cesses. Several of the more notable individu aspects are included here.

For all cities, medical-dental trips accounte for 5.5 percent of the trips by taxi passenger and, conversely, taxi-passenger trips accounte for 4.2 percent of the trips for medical c dental purposes. Changing of mode accounte for 10 percent of the train-passenger trips an train passengers accounted for 2.2 percent c the trips to change mode of travel. Also, i is significant that 8.9 percent of the auto mobile drivers made trips for the purpose c serving passengers. All of the serve-passenge trips were made by drivers of automobiles

In addition to the cases just cited, there ar several interesting facts regarding individua cities, which were concealed when trip pur poses and modes of travel were grouped. Fo example, in Columbus, Ga., Baltimore, Md. Charleston, S. C., Reading, Pa., and Gran Rapids, Mich., over 10 percent of the auto mobile-driver trips were for the purpose o transacting business. In Pontiac, Mich., an Sacramento, Calif., 14 percent of the auto mobile-driver trips were to serve passengers The fact that 11 percent of the automobile driver trips and 9 percent of the mass-transi trips in San Juan, P. R., were for the purpos of eating is due largely to the prevalent loca custom of returning home for lunch at midday

In the category of trips for the purpose o changing mode of travel, several unusual situ ations occurred in individual urban areas These trips accounted for 10 and 25 percen of the total streetcar- and bus-passenger trip in Norristown and Philadelphia, Pa., respec tively. Also, in Philadelphia, change-mod trips amounted to 60 percent of the subway- o elevated-railway passenger trips and 24 per cent of the train-passenger trips.

Over 12 percent of the streetcar- and bus passenger trips were to school in Madison

Table 18.—Correlation coefficients computed for certain types of trips and related household characteristics in 49 cities [1]

Mode of travel or purpose of trip	Household characteristic	Correlation coefficient
Mode of travel:		
All modes	Dwelling units	0. 987
Automobile driver	Automobiles owned	. 975
Mass-transit passenger	Persons 5 years of age and over	. 941
Purpose of trip:		
Work and business	Dwelling units	. 989
Social and recreation	Automobiles owned	. 968
Shop	do	. 979
Miscellaneous	Persons 5 years of age and over	. 916
Home	Dwelling units	. 985

[1] Scatter diagrams, except for social-recreational, miscellaneous, and home trip purposes, are presented in figures 12-16.

Wis., Pontiac, Mich., Sacramento, Calif., and in Phoenix and Tucson, Ariz. Trips to transact business accounted for 11 percent of all taxi-passenger trips in Charleston, S. C., and in Salt Lake City, Utah, and 13 percent in Seattle, Wash.

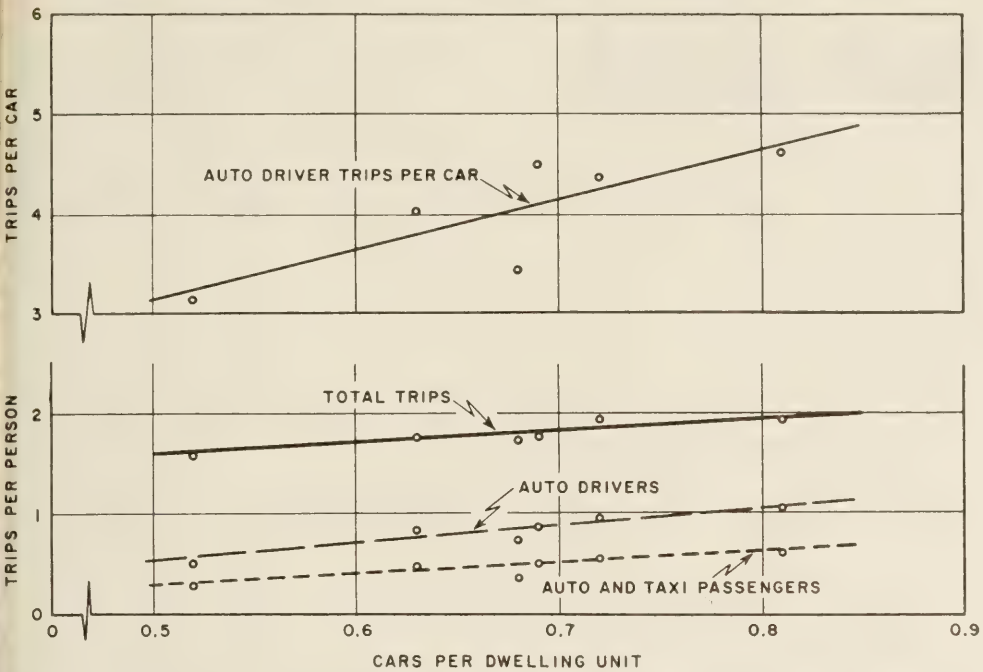

Figure 11.—Trips per person and trips per automobile related to automobiles owned per dwelling unit.

With regard to modes of travel, again there are individual city exceptions, which were absorbed in the grouping procedure. Among the more important variations which should be mentioned is the case of Washington, D. C., where taxi passengers accounted for almost 3 percent of all trips. Also truck and taxi passengers combined accounted for over 3 percent of the total trips in Baltimore, Md., and Macon, Ga. Finally, train-passenger trips amounted to 5 percent of the total trips in Newark, N. J., and 2 percent in Philadelphia.

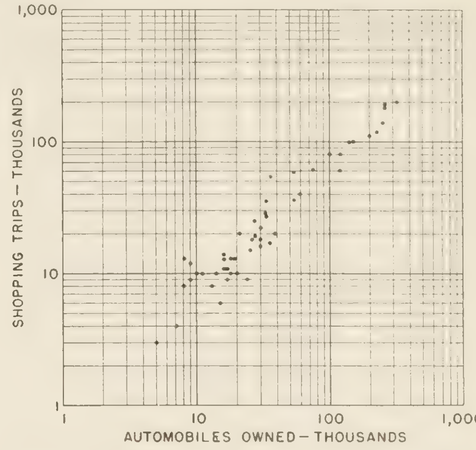

Figure 16.—Number of shopping trips related to number of automobiles owned.

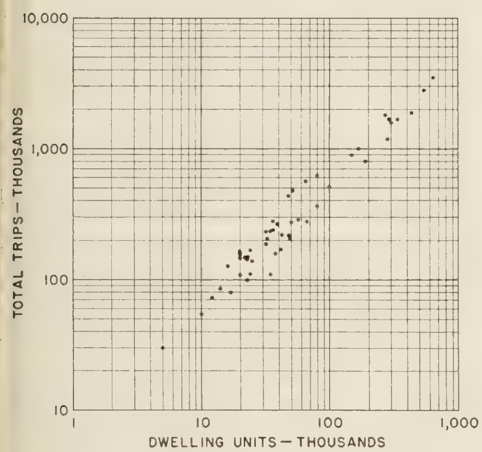

Figure 12.—Number of trips related to number of dwelling units.

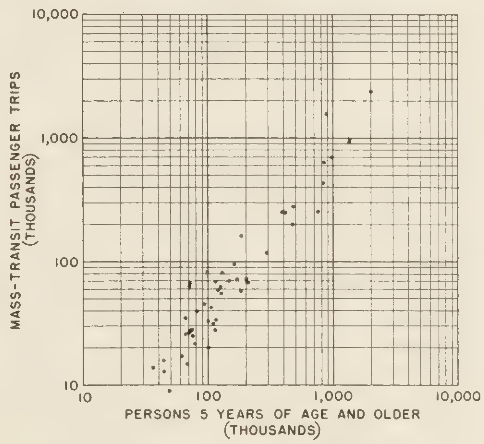

Figure 14.—Number of mass-transit passenger trips related to number of persons 5 years of age and over.

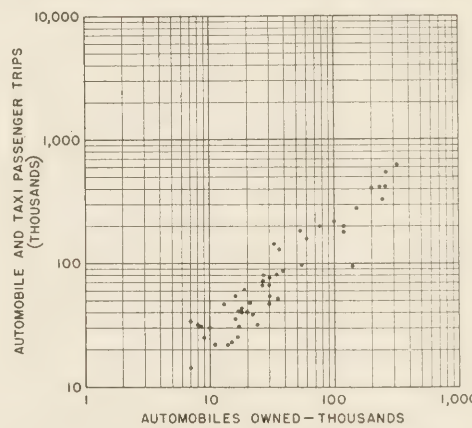

Figure 17.—Number of automobile- and taxi-passenger trips related to number of automobiles owned.

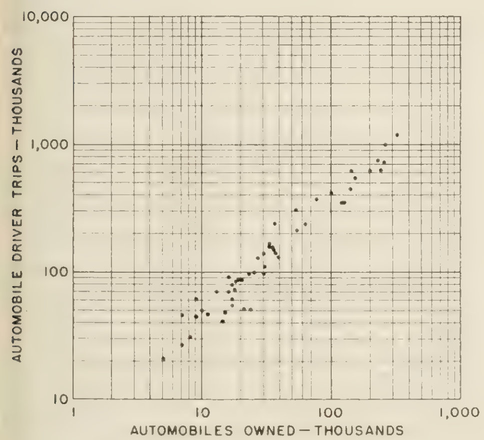

Figure 13.—Number of automobile-driver trips related to number of automobiles owned.

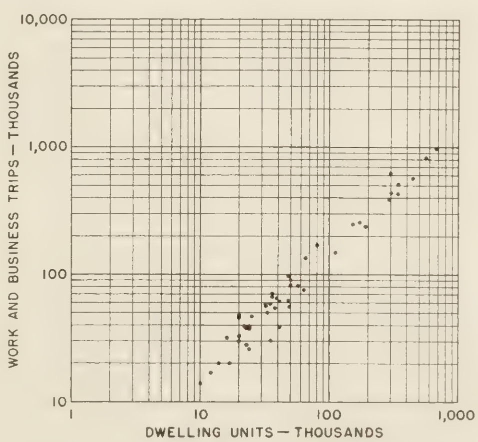

Figure 15.—Number of work and business trips related to number of dwelling units.

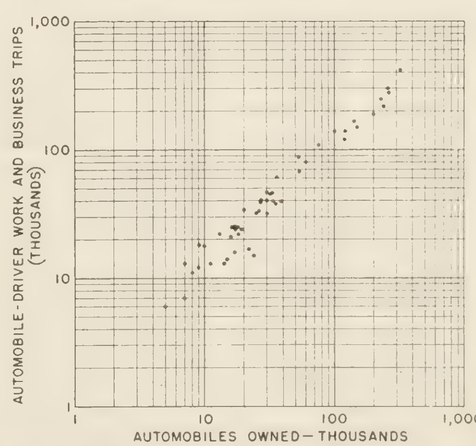

Figure 18.—Number of automobile-driver work and business trips related to number of automobiles owned.

Observations Concerning Urban Traffic Volume Patterns in Tennessee

BY THE DIVISION OF HIGHWAY PLANNING
BUREAU OF PUBLIC ROADS

Reported [1] by BORIS B. PETROFF, Head, Traffic Inventory Section, and ANTHONY P. KANCLER, Statistician

The accuracy of estimates of traffic volumes on rural roads in 28 States has been determined in previous studies by probability measures. The production characteristics of the various traffic-counting methods were evaluated, and in the majority of these States efficiency was improved by appropriate changes in procedures. An important conclusion drawn from the rural studies was that traffic-volume sampling variations were relatively small and could be effectively controlled.

Intuitively it has been recognized that in some aspects of traffic volume patterns on city streets a greater uniformity exists than on rural roads, and traffic volumes can be effectively sampled and accurately interpreted by even simpler statistical control devices. It was not, however, until the State of Tennessee had undertaken comprehensive urban traffic volume research that facts began to replace opinions.

The findings of the present study support the judgment previously exercised in Tennessee in the use of some of the procedures and indicate the possibility of improving others. But in addition to the local benefits, the Tennessee studies provide an invaluable background upon which other States and cities can develop efficient urban traffic-counting procedures.

SINCE 1954, 55 continuous-count traffic recorders at 52 locations have been installed in Tennessee cities in order to study the characteristics of urban traffic volumes. The recommendations of the Highway Research Board Committee on Urban Volume Characteristics were used as guides for the selection of locations for these recorders. The 1956 data at 30 locations in 13 cities were analyzed in studies for machine counts, and 1955 data at 33 locations were used in the analysis for manual counts.

To determine the actual annual average daily number of vehicles, hereinafter called ADT, at a particular point on a road or street would require continuous counting for 365 days. On the other extreme, a qualified person could make an estimate without counting, just from general knowledge of the situation. The latter method usually would not be considered acceptable because of the suspected lack of accuracy. Since an exact determination is seldom possible, it becomes axiomatic that the ADT estimates are based on sampling, and the cost of obtaining these estimates must be related to their accuracy. The problem therefore is to find means of measuring the accuracy of ADT estimates obtained by various methods of sampling traffic volumes. The measures employed in the Tennessee studies made use of the configuration of similar patterns of repetition in the mass movement of people and the concepts of probability of these repetitions.

At the present time, only a few basic analyses have been undertaken to aid in the evaluation of existing sampling procedures and to provide essential measures in the development of new traffic-counting schedules. The present as well as other possible schedules were presumed to be based on the assumption that a sample weekday count is representative of the average weekday volume of traffic during the month of the sample count. Therefore, this basic assumption was evaluated and the size of the standard error was estimated. The standard error is a measure of the dispersion about their averages of all possible estimates which are based on samples of a given size. Although the mathematics of probability do not require the knowledge of the true values in these studies, the true (or practically true) values are available at the continuous-count recorders and are therefore used as the basis for measuring errors of estimates developed by sampling.

Conclusions

The following conclusions were reached regarding the observations of 30 urban traffic-counting stations in 13 Tennessee cities:

1. Traffic counts of 24-hour duration on weekdays may be assumed to represent the annual average daily traffic volumes with certain limitations, some of which are subsequently referred to in the discussion of the St. Louis and Detroit studies. Although previous studies have indicated that this assumption may result in an overestimate, the error is within practical limits of acceptance.

2. The monthly variations of traffic are very uniform for the 30 continuous-count stations. The predominant majority of the ratios of ADT to the daily averages at individual stations fall within the ± 10-percent range from the respective monthly means. The standard deviation for the Tennessee urban stations was ± 5.2 percent. Earlier studies in St. Louis and Detroit showed standard deviations of approximately ± 6.0 percent. It appears that confidence limits could be set so that a range lower than ± 10 percent could be achieved if populations could be identified in urban areas. Heterogeneous populations can be separated on the basis of parameters showing similar configurative patterns or selected maximum ranges of deviation.

3. The goodness-of-fit tests as applied to the Gaussian or normal curve can be used to detect heterogeneous populations. These tests include the chi-square and Fisher's g_1 and g_2 statistics. Samples may be taken from heterogeneous populations, and with proper statistical safeguards that samples are representative of the original population they will give satisfactory results. The statistical safeguards are the *F*- and *T*-tests.

4. It can be stated from the studies that the 30-station mean monthly adjustment factors could be satisfactorily used. Furthermore, practically the same factors could be obtained from the data for 6 or 7 stations randomly selected. The tests indicate the possibility of refinements in the accuracy of adjustments for monthly variations. Such refinements would require identification of populations which is a costly operation. Even if this were accomplished, the study of Nashville which is subsequently described would indicate that the improvement in the accuracy of estimates of ADT, when based on 24-hour weekday samples, could hardly be expected to reduce the value of the standard deviation by more than 1 percent.

5. Satisfactory estimates of 24-hour weekday traffic volumes can be obtained from weekday counts of 4-hour duration which include either the morning or afternoon hour of peak traffic volume.

6. Differences in social and economic characteristics, upon which the selection of the locations of continuous-count recorders was

[1] This article was presented at the 37th Annual Meeting of the Highway Research Board, Washington, D. C., January 1958.

based, did not seem to influence to any great extent the monthly variations of traffic volumes. However these characteristics should not be disregarded in future studies as they may be found to be significant in other measures of traffic.

Selection of Traffic Stations

In the selection of locations for the 55 continuous-count traffic recorders, State officials have followed in general the recommendations developed by the Committee on Urban Volume Characteristics of the Highway Research Board. These committee suggestions as interpreted by code for Tennessee are as follows:

A. Distribution by city characteristics:
- I. By dominant economic base (as described on pages 37 and 48 of the 1950 Municipal Yearbook):
  - (a) Manufacturing and industrial, including diversified manufacturing, mining, and transportation.
  - (b) Retail, including diversified retail.
  - (c) Wholesale.
  - (d) Resort.
  - (e) Education.
  - (f) Government.
  - (g) Dormitory.
- II. By population size (1950 census):
  - (a) 1,000,000 and over
  - (b) 500,000–1,000,000
  - (c) 250,000–500,000
  - (d) 100,000–250,000
  - (e) 50,000–100,000
  - (f) 25,000–50,000
  - (g) 10,000–25,000
  - (h) Under 10,000

B. Location by street classification:
- I. By traffic function:
  - (a) Major or arterial streets:
    1. Radials that are part of primary State highways.
    2. Radials that are not part of primary State highways.
    3. Crosstown (or rings) connecting two or more major radials.
  - (b) Secondary streets:
    1. Radials and crosstowns.
    2. Local, commercial, and industrial.
    3. Local and residential.
- II. By average overall speed range in peak period:
  - (a) 5–15 miles per hour.
  - (b) 15–25 miles per hour.
  - (c) 25–35 miles per hour.
  - (d) 35–45 miles per hour.

The coding of urban continuous-count stations according to these classifications is shown in table 1.

Data for one complete year of operations, 1956, were available for 30 locations scattered throughout 13 cities. Table 2 shows the distribution of these stations by cities. It is noted in table 1 that these cities vary in population from 514 in Decaturville to over 400,000 in Memphis.

For the purpose of statistical analysis three tabulating cards were developed: Nos. 21 and 31 as shown in figure 1, and the general card, the code sheet of which is shown as figure 2.

Table 1.—Tennessee cities in which continuous-count traffic stations were located

City	Population	City characteristics [1]	Station No.	City street classification [2]
Nashville	176,170	A–I (a) (b) (c) (e) (f), A–II (d)	500	B–I (a) 1, B–II (c).
			501	B–I (b) 3, B–II (b).
			502	B–I (a) 1, B–II (c).
			503	B–I (b) 1, B–II (c).
			504	B–I (a) 2, B–II (b).
			505	B–I (a) 2, B–II (c).
Memphis	407,439	A–I (a) (b) (c) (e), A–II (c)	506	B–I (a) 1, B–II (c).
			507	B–I (b) 2, B–II (a).
			508	B–I (b) 1, B–II (b).
			509	B–I (a) 2, B–II (c).
			510	B–I (b) 3, B–II (b).
			511	B–I (a) 3, B–II (c).
Knoxville	124,769	A–I (a) (b) (c) (e), A–II (d)	512	B–I (b) 1, B–II (b).
			513	B–I (b) 2, B–II (a).
			514	B–I (a) 1, B–II (c).
			515	B–I (a) 1, B–II (c).
			516	B–I (b) 3, B–II (b).
			551	B–I (a) 1, B–II (d).
Johnson City	28,337	A–I (b) (c) (e), A–II (f)	517	B–I (a) 2, B–II (c).
			518	B–I (b) 3, B–II (b).
Morristown	13,151	A–I (a) (b) (c), A–II (g)	519	B–I (b) 2, B–II (a).
			520	B–I (a) 1, B–II (c).
Crossville	2,291	A–I (b) (c), A–II (h)	521	B–I (a) 1, B–II (c).
Rockwood	4,272	A–I (a) (b) (c), A–II (h)	522	B–I (b) 1, B–II (a).
McMinnville	7,577	A–I (a) (b) (c), A–II (h)	523	B–I (b) 1, B–II (a).
Columbia	10,911	A–I (a) (b) (c), A–II (g)	524	B–I (b) 1, B–II (b).
			525	B–I (a) 1, B–II (c).
Jackson	33,354	A–I (a) (b) (c) (e), A–II (f)	526	B–I (a) 1, B–II (c).
			527	B–I (a) 3, B–II (b).
Dyersburg	12,063	A–I (b) (c), A–II (g)	528	B–I (b) 1, B–II (a).
			529	B–I (b) 1, B–II (b).
Dresden	1,509	A–I (b), A–II (h)	530	B–I (a) 1, B–II (c).
Waverly	2,410	A–I (b), A–II (h)	531	B–I (b) 3, B–II (b).
Decaturville	514	A–I (b), A–II (h)	532	B–I (b) 1, B–II (b).
Rogersville	2,670	A–I (b) (c), A–II (h)	533	B–I (a) 1, B–II (c).
Kingsport	19,609	A–I (a) (b) (c), A–II (g)	534	B–I (b) 3, B–II (b).
			535	B–I (b) 2, B–II (a).
Athens	10,103	A–I (b) (c), A–II (g)	536	B–I (b) 3, B–II (b).
			537	B–I (b) 1, B–II (b).
Chattanooga	131,041	A–I (a) (b) (c), A–II (d)	538	B–I (a) 2, B–II (c).
			539	B–I (b) 3, B–II (b).
			540	B–I (a) 3, B–II (b).
			541	B–I (a) 1, B–II (c).
			542	B–I (b) 2, B–II (b).
Bolivar	2,429	A–I (b) (c), A–II (h)	543	B–I (a) 1, B–II (c).
Humboldt	7,426	A–I (b) (c), A–II (h)	544	B–I (a) 1, B–II (c).
			545	B–I (a) 3, B–II (c).
Union City	7,665	A–I (b) (c), A–II (h)	546	B–I (b) 1, B–II (b).
			547	B–I (a) 1, B–II (c).
Shelbyville	9,847	A–I (b) (c), A–II (h)	548	B–I (a) 1, B–II (c).
			549	B–I (a) 2, B–II (c).
Lewisburg	5,312	A–I (b) (c), A–II (h)	550	B–I (a) 1, B–II (b).

[1] Economic characteristics and population groups. Explanation of codes is given in the text on the left.
[2] Traffic functions of streets and average speeds. See codes given in the text on the left.

Procedure

The sampling error of 24-hour weekday (Monday through Friday) counts, which were distributed throughout all months of the year, was computed for the six stations in Memphis as shown in table 3. The mean coefficient of variation of ±5.9 percent denotes that when the traffic volume for a 24-hour period on a given weekday was compared with the average 24-hour weekday traffic during that month at that point, then, based on a normal distribution, it could be expected that approximately two-thirds of such 24-hour weekday counts would not differ by more than ±5.9 percent from the respective monthly means, and 95 percent of such counts should not differ from their respective monthly means by more than twice the value of the coefficient of variation, or ±11.8 percent. It is noteworthy that similar tests conducted by the Bureau of Public Roads during 1957 on the 1954 data for 12 stations in St. Louis, Mo., resulted in a standard deviation of ±5.4 percent; and studies made on 1954–55 data (April through November) at 10 stations in Detroit, Mich., indicated a standard deviation of ±6.3 percent.

If the truest adjustment ratio of ADT to the average weekday of the month (the ratio derived from the same station from which the sample was taken) were applied to the sample to estimate the ADT, the measure of error in such estimates would still be expressed by the coefficient of variation of ±5.9 percent. Since the mean ratio value of the various tests based on ADT is unity (1.00), the coefficient of variation is equal to the standard deviation. The significance of the measure of standard deviation in these cases is practically synonymous with that of the coefficient of variation. Thus, the ±5.9-percent measure of the

Table 2.—Ratios of annual average daily traffic to average daily traffic volumes for 30 stations in 13 Tennessee cities during 1956

City	Station number	January		February		March		April		May		June		July		August		September		October		November		December	
		Ratio	Deviation	Ratio	Deviation	Ratio	Deviation	Ratio	Deviation	Ratio	Deviation	Ratio	Deviation	Ratio	Deviation	Ratio	Deviation	Ratio	Deviation	Ratio	Deviation	Ratio	Deviation	Ratio	Deviation
Nashville	500	1.10	−1	1.02	−4	1.01	−1	0.97	−3	0.97	0	0.99	3	0.96	−1	0.98	2	1.02	4	1.01	2	1.02	2	0.97	−2
	501	1.11	0	.99	−7	.99	−3	1.01	1	.96	−1	1.05	9	1.02	5	1.02	6	1.01	3	.97	−2	.97	−3	.93	−6
	502	(2)		(2)		1.01	−1	.95	−5	.97	0	.94	−2	.88	−9	.87	−9	1.00	2	1.03	4	1.05	5	.99	0
	503	1.22	11	1.01	0	.99	−3	.95	−5	.95	−2	.94	−2	.98	1	.98	2	.98	0	.99	0	1.01	1	1.00	1
	504	1.07	−4	1.04	−2	1.03	1	1.00	0	.99	2	1.01	5	1.03	6	.95	−1	.94	−4	.95	−4	1.01	1	1.00	1
	505	1.09	−2	1.04	−2	1.03	1	1.03	3	.97	0	.93	−3	.94	−3	.94	−2	.99	1	1.05	6	1.03	3	1.00	1
Memphis	506	1.09	−2	1.13	7	1.06	4	1.05	5	.95	−2	.91	−5	.90	−7	.87	−9	.87	−11	.87	−12	.91	−9	1.02	3
	507	1.00	−11	1.06	0	1.05	3	1.02	2	1.00	3	.92	−4	.93	−4	.98	2	1.00	2	1.01	2	1.01	1	1.04	5
	508	1.05	−6	1.07	1	1.02	0	.97	−3	.95	−2	.97	1	.99	2	.98	2	(2)		.97	−2	.98	−2	.93	−6
	509	1.02	−9	.96	−10	.98	−4	.94	−6	.93	−4	.94	−2	1.08	11	1.05	9	1.05	7	1.04	5	1.05	5	(2)	
	510	1.08	−3	1.03	−3	1.00	−2	1.03	3	1.02	5	.99	3	1.01	4	.96	3	.96	−2	.97	−2	.97	−3	.95	−4
	511	1.19	8	1.06	0	1.05	3	1.11	11	.96	−1	.92	−4	.95	−2	.89	−7	.89	−9	.99	0	.95	−5	1.13	14
Knoxville	512	1.07	−4	1.05	−1	1.03	1	1.01	1	1.03	6	1.05	9	.86	−11	1.00	4	1.02	4	.93	−6	.96	−4	1.04	5
	513	1.24	13	1.15	9	1.11	9	1.04	4	.95	−2	.90	−6	.91	−6	.88	−8	.99	1	.99	0	.96	−4	1.00	1
	515	1.11	0	1.04	−2	.96	−6	.98	−2	.98	1	.94	−2	.93	−4	.94	−2	1.02	4	1.03	4	1.08	8	1.03	4
Johnson City	517	1.15	4	1.05	−1	1.02	0	1.00	0	.96	−1	.98	2	.96	−1	.94	−2	.96	−2	.98	−1	1.02	2	1.00	1
	518	1.28	17	1.11	5	1.05	3	.98	−2	.95	−2	.95	−1	.93	−4	.80	−16	.86	−12	.99	0	(2)		1.05	6
Morristown	519	1.09	−2	1.08	2	1.03	1	1.01	1	.98	1	.95	−1	.95	−2	.94	−2	.97	−1	1.00	1	1.01	1	1.03	4
	520	1.13	2	1.14	8	1.10	8	1.03	3	1.00	3	.97	1	1.06	9	.99	3	1.01	3	.89	−10	.85	−15	.93	−6
Crossville	521	1.21	10	1.16	10	1.08	6	1.05	5	.96	−1	.86	−10	.88	−9	.84	−12	.91	−7	1.01	2	1.11	11	1.11	12
Rockwood	522	1.03	−8	1.02	−4	1.00	−2	1.00	0	.99	2	.94	−2	1.00	3	.98	2	.99	1	1.03	4	1.05	5	.98	−1
McMinnville	523	1.13	2	1.10	4	1.03	1	1.03	3	1.00	3	1.03	7	.97	0	.97	1	.99	1	.96	−3	.94	−6	.91	−8
Columbia	524	1.08	−3	1.01	−5	.97	−5	1.00	0	.96	−1	1.04	8	1.07	10	1.04	8	.94	−4	.97	−2	.97	−3	.98	−1
	525	1.12	1	1.06	0	1.00	−2	1.00	0	.96	−1	.99	3	.99	2	.97	1	.95	−3	.98	−1	.99	−1	1.01	2
Jackson	526	1.03	−8	.99	−7	.95	−7	.97	−3	1.01	4	1.01	5	1.00	3	(2)		.99	1	.99	0	1.00	0	.96	−3
	527	1.05	−6	1.03	−3	1.01	−1	.98	−2	.97	0	.99	3	1.04	7	1.03	7	.99	1	.97	−2	.98	−2	.97	−2
Dyersburg	528	1.09	−2	1.02	−4	.97	−5	1.00	0	.97	0	.94	−2	.94	−3	.96	0	1.00	2	1.03	4	1.07	7	1.03	4
	529	1.07	−4	.97	−9	.93	−9	.96	−4	.88	−9	.89	−7	1.06	9	1.05	9	1.00	2	1.06	7	1.11	11	1.11	12
Dresden	530	1.15	4	1.10	4	.93	−9	.93	−7	.99	2	.98	2	.98	1	1.00	4	1.02	4	1.09	10	1.05	5	.86	−13
Decaturville	532	1.17	6	1.10	4	1.14	12	1.12	12	.95	−2	.97	1	.94	−3	.90	−6	1.04	6	1.00	1	.94	−6	.86	−13
Mean monthly ratio		1.11		1.06		1.02		1.00		.97		.96		.97		.96		.98		.99		1.00		.99	
Σd (net)			3		10		−7		12		1		9		4		−11		−6		5		5		11
Σd² (total)			1,305		756		719		564		245		649		990		1,111		634		615		947		1,181

Ratios of annual average daily traffic to average daily traffic volumes and deviations [1] of each ratio from the mean monthly ratio.

[1] Deviation $(d)=(X_1-X)100$, where X_1 is the ratio of the station's annual ADT to the average daily traffic of the month and X is the mean monthly ratio for all stations.
[2] Values were unacceptable for various reasons.

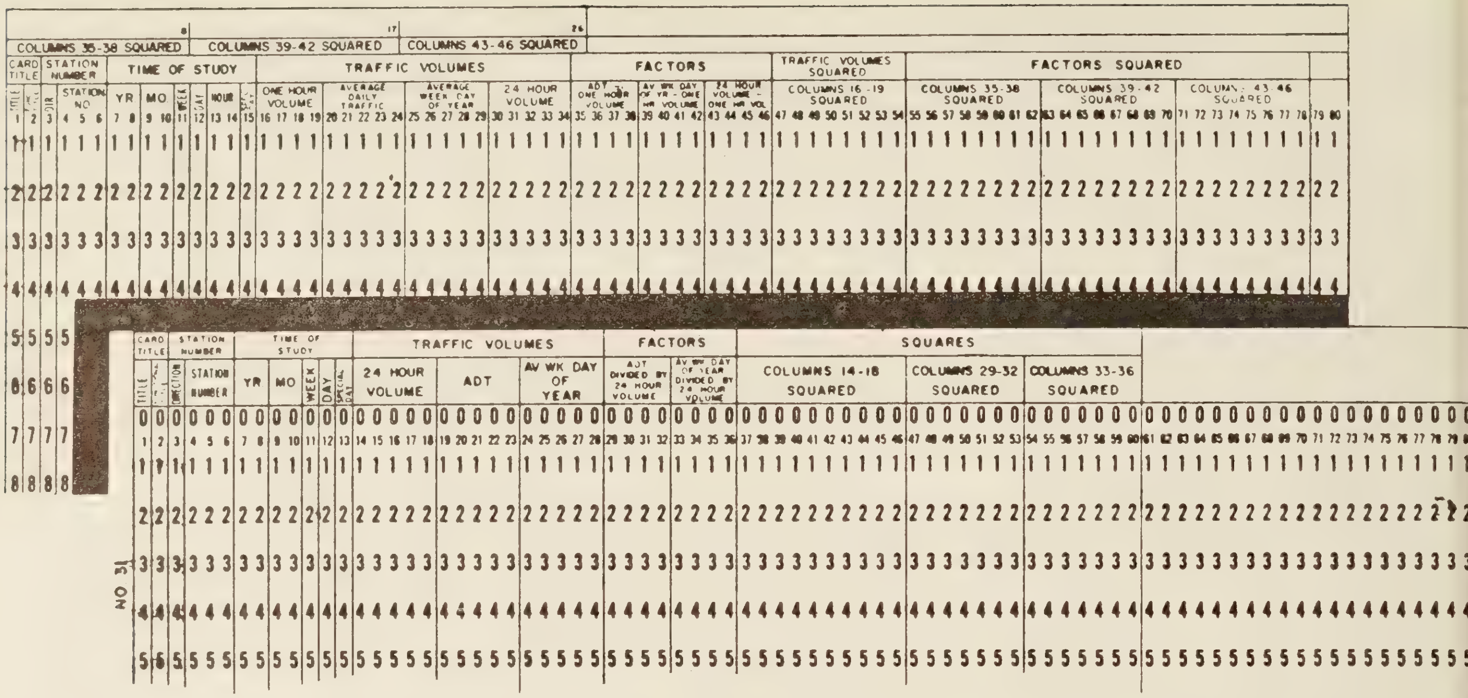

Figure 1.—Tabulating cards used by the Tennessee Department of Highways and Public Works for summarizing urban traffic data.

sampling error is the minimum that can be expected in the distribution of errors in ADT estimates in this particular study; that is, when these estimates are based on adjustment ratios computed in terms of ADT to the average weekday of the month from any other source, it generally can be expected that the measure of the error in ADT estimates will be greater than the measure of the sampling error.

	Card Column Number	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Station Number	1 - 2 - 3 - 4							
Day Of Week	5	7	1	2	3	4	5	6
Month Of Count	6 - 7							
Day Of Month	8 - 9							
Year	10 - 11							
Traffic Volume 6 A.M. - 7 A.M.	12 - 15							
7 - 8	16 - 19							
8 - 9	20 - 23							
9 - 10	24 - 27							
10 - 11	28 - 31							
11 - 12 Noon	32 - 35							
12 Noon - 1 P.M.	36 - 39							
1 - 2	40 - 43							
2 - 3	44 - 47							
3 - 4	48 - 51							
4 - 5	52 - 55							
5 - 6	56 - 59							
6 - 7	60 - 63							
7 - 8	64 - 67							
8 - 9	68 - 71							
Total 24 Hour Volume	72 - 76							
Peak Hour Volume	77 - 80							

Figure 2.—Coding sheet for automatic traffic recorder data.

The 24-hour weekday counts were adjusted to the ADT by application of appropriate factors. These factors were obtained from a group of stations having similar patterns of monthly variations of traffic volumes. They should be in terms of ratios of ADT to the weekday traffic of the respective months. Since the factors were based on group values, the resulting group mean values are characterized by differences between the individual station data and the group mean data. Thus, factors were another source of error contributing to the error in the ADT estimates. The material readily available did not permit the evaluation of the error in such factors. However, a reasonable approximation was available in terms of the ratios of ADT to the average daily volume for each month for the 30 stations in 13 cities. These ratios permitted the measurement of monthly variations and the comparisons of these variations among stations. The ratios and comparisons are shown in table 2. It is noted that the overwhelming majority of the monthly ratios vary from the respective means of the 30 stations by ± 10 percent or less, and the standard deviation of these differences is ± 5.2 percent.

$$S=\sqrt{\frac{1}{N-1}\left[\Sigma d^2-\frac{1}{N}\,(\Sigma d)^2\right]}=$$

$$\sqrt{\frac{1}{354-1}\left[9{,}716-\frac{1}{354}\,(16)^2\right]}=\sqrt{27.52}=\pm 5.2$$

By comparison with the spread of seasonal variation usually encountered on rural roads, the extremely narrow range observed in this study and the implications of these observations as regards traffic survey costs were given special attention in the analysis.

Table 3.—Errors in sampling of Memphis traffic volumes for 24-hour periods on weekdays in 1955 [1]

Station number and item	January	February	March	April	May	June	July	August	September	October	November	December
Station No. 506:												
Number of weekdays	12	19	18	24	21	20	20	17	19	22	21	22
Average weekday volume	17, 668	18, 703	20, 402	21, 684	22, 061	23, 836	24, 378	24, 174	23, 712	24, 115	22, 297	22, 831
Coefficient of variation	10. 8	3. 3	3. 9	3. 9	3. 1	2. 4	2. 8	3. 2	8. 4	2. 7	3. 5	8. 8
Station No. 507:												
Number of weekdays	17	20	16	10	20	8	24	20	19	22	19	24
Average weekday volume	9, 172	9, 049	9, 660	10, 203	11, 429	10, 695	10, 608	10, 221	10, 606	12, 331	11, 714	11, 475
Coefficient of variation	4. 8	4. 5	3. 8	5. 3	12. 6	3. 9	4. 6	4. 7	4. 4	7. 9	4. 2	6. 2
Station No. 508:												
Number of weekdays	10	17	16	22	20	11	24	15	19	25	19	24
Average weekday volume	15, 014	11, 777	12. 355	12, 478	12, 607	13, 009	12, 694	12, 643	13, 339	12, 506	13, 198	13, 040
Coefficient of variation	20. 7	3. 8	3. 6	5. 6	7. 2	4. 3	3. 9	3. 6	7. 1	11. 2	5. 6	6. 4
Station No. 509:												
Number of weekdays	16	20	16	20	14	16	24	17	15	23	16	20
Average weekday volume	18, 095	17, 984	18. 222	18, 188	18, 772	19, 366	18, 741	18, 585	19, 475	22. 731	23, 292	23, 550
Coefficient of variation	2. 2	4. 7	3. 6	6. 7	10. 8	3. 5	3. 7	4. 2	14. 4	1. 7	4. 3	8. 0
Station No. 510:												
Number of weekdays	19	20	14	23	20	20	24	19	12	23	19	24
Average weekday volume	8, 385	7, 527	7, 903	7, 942	7, 559	7, 383	8, 173	7, 598	7, 962	7, 242	7, 232	7, 280
Coefficient of variation	1. 8	5. 1	4. 9	4. 2	4. 9	3. 8	10. 6	5. 9	4. 4	7. 2	2. 6	7. 3
Station No. 511:												
Number of weekdays	15	18	18	23	13	12	18	20	16	14	13	24
Average weekday volume	29, 575	24, 549	25, 333	27, 038	25, 106	27, 775	27, 375	25, 410	25, 578	28, 721	26, 624	25, 940
Coefficient of variation	8. 9	4. 6	4. 2	4. 0	8. 5	7. 9	9. 8	5. 9	11. 7	5. 6	10. 0	7. 9

[1] Mean coefficient of variation=426.2/72=±5.9 percent.

Monthly Expansion Factors

Experience with rural traffic counts [2] indi-ates that when monthly factors fall within he ±10-percent range of the group mean, then he effect of added amount of error to the sam-pling error of the 24-hour sample in the esti-nates of ADT is very small. Thus, it ap-peared that single monthly expansion factors, which are the means of the 30 stations, could be used in Tennessee for the expansion of 24-hour weekday sample counts so that the re-sulting errors in ADT estimates would not be much larger than those which are expressed by the standard deviation of ±5.9 percent.

[2] *Experience in application of statistical method to traffic counting*, by Boris B. Petroff. PUBLIC ROADS, vol. 29, No. 5, Dec. 1956.

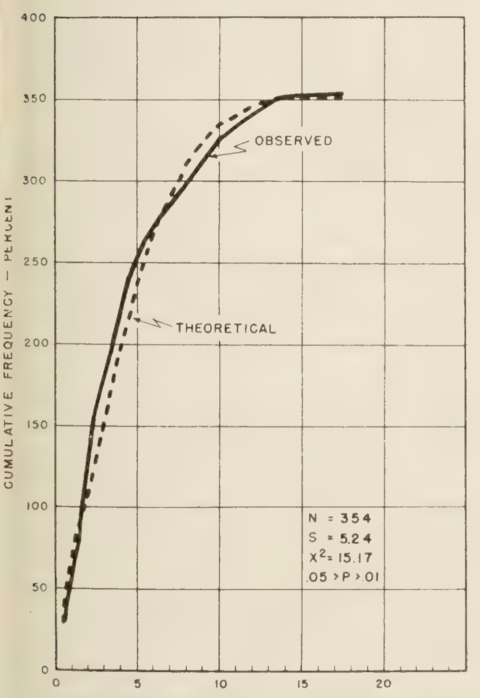

Figure 3.—Comparison of observed and theoretical distributions of deviations of individual ratios of ADT from the mean monthly ratios.

The chi-square test of these data (standard deviation ±5.2 percent) showed a probability level between 5 and 1 percent. Considering "good fit" within the range from 5 to 95 percent, the goodness of fit was not quite acceptable. The normal distribution is applicable only when chance forces are in operation. In this instance the normal distribution of the observed values is borderline, which indicates the possibility of forces or heterogeneous populations causing results not due to chance alone.

The computation of chi square given in table 4 and the values obtained are presented in figure 3. The tendency for the traffic observations to concentrate bimodally on either side of the mean contributes to the low chi-square probability level.

Three random samples of 6, 5, and 4 stations were taken from the data for 30 stations; the respective standard deviations (S) were ±5.93, ±4.70, and ±2.53. The F-test related the variance (S^2) of each of the three random samples to the variance of the 30-station data and expressed the probability level of the relation. The test showed that the 5- and 6-station random samples yielded stable results, whereas variations for the 4-station random sample were so much greater as to be unreliable. The formula for the F-test is as follows:

$$F=\frac{S_1^2}{S_2^2}$$

Where:

S_1^2 = The larger variance.

S_2^2 = The smaller variance.

Another test for conformity, the T-test, related the significance of the differences in the monthly means of each of the three random samples to the monthly means of the 30-station data, but here the differences were not significant for all three.

$$T=\frac{\overline{X}_1-\overline{X}_2}{S_{(\overline{X}_1-\overline{X}_2)}}$$

Where:

$$S_{(\overline{X}_1-\overline{X}_2)}=\sqrt{\frac{(N_1+N_2)(\Sigma d_1^2+\Sigma d_2^2)}{N_1N_2[(N_1-1)+(N_2-1)]}}$$

$\overline{X}_1$ = Monthly mean of sample having N_1 observations per month.

$\overline{X}_2$ = Monthly mean of sample having N_2 observations per month.

Σd_1^2 = Sum of the squares of the deviations of N_1 observations from the monthly mean.

Σd_2^2 = Sum of the squares of the deviations of N_2 observations from the monthly mean.

A chi-square test on each of the three random samples conformed with normal curve requirements. Random samples are not always representative since they are subject to the laws of chance. In this particular instance, the use of the 4-station random sample would appear to be the least satisfactory.

Table 4.—Chi-square test of deviations of weekday ratios of ADT from the monthly averages

Class interval	X	$\frac{X}{S}$	Cumulative frequency theoretical	Theoretical f_t	Cumulative frequency observed	Observed f_o	f_o-f_t	$(f_o-f_t)^2$	$\frac{(f_o-f_t)^2}{f_t}$
0. 00–1. 99	2. 00	0. 38	104. 8	104. 8	88	88	−16. 8	282. 24	2. 69
2. 00–3. 99	4. 00	. 76	195. 7	90. 9	197	109	18. 1	327. 61	3. 60
4. 00–5. 99	6. 00	1. 15	265. 4	69. 7	260	63	−6. 7	44. 89	. 64
6. 00–7. 99	8. 00	1. 53	309. 4	44. 0	296	36	−8. 0	64. 00	1. 45
8. 00–9. 99	10. 00	1. 91	334. 1	24. 7	325	29	4. 3	18. 49	. 75
10. 00–11. 99	12. 00	2. 29	346. 2	12. 1	340	15	2. 9	8. 41	. 70
12. 00–13. 99	14. 00	2. 67	351. 3	5. 1	350	10	4. 9	24. 01	4. 71
14. 00–15. 99	16. 00	3. 05	353. 2	1. 9	352	2			
16. 00–17. 99	18. 00	3. 44	353. 8	. 6	354	2	1. 3	1. 69	. 63
18. 00 and over	-----	----	354. 0	. 2	354	0			
Degrees of freedom=8−2=6, 0.05>P>0.01, S=±5.24									x^2=15.17

Grouping Stations

It was previously mentioned that the Tennessee 30-station data could have had a heterogeneous population. The following method was used to divide the original data into population groups having similar characteristics or, as in this case, pattern conformity: (1) An array of the 30 stations based on their ratio values was set up for each month of the year, as shown in table 5; (2) the median and quartile values for each month were determined; (3) arbitrary values were assigned to the quartile position of each station for each month, as shown in table 6, thereby setting up a configurative pattern for each station's relationship to all other stations; and (4) st tions were grouped into five categories accor ing to individual patterns.

Group I.—Stations having a relatively sm amplitude of deviations from the month medians.

Group II.—Stations tending to devia greatly from the monthly median values f the first 6 months of the year.

Group III.—Stations tending to devia greatly from the monthly median values f the last 6 months of the year.

Group IV.—Stations having monthly valu occurring within the interquartile range f more than 9 months of the year. In a norm distribution the interquartile range is t 50-percent probability level as contrast with the standard deviation of 68 percer For the Tennessee data, this range was a proximately ±5 percent and the grou included 12 of the 30 stations.

Group V.—A station having monthly valu closest to the monthly mean or median of stations was selected. Using the month mean or median values of this station (No. 51 as a control, all stations having values falli within ±10 percent of the control values we included in group V. Although this metho does not necessarily separate populations fro a heterogeneous group, it does elimina extreme values and trouble spots whi probably should have been eliminated orig nally for one reason or another.

Testing by Statistical Method

To test whether groups I through V belon to significantly different populations, the were checked against each other by the use the *F*- and *T*-tests. The results showed th groups I, II, and III were distinct population and groups I and IV were not significantl different, since their selection was based mo or less on the frequency of monthly centr tendency. Group IV is a mixed populatio

Table 5.—Frequency distribution of traffic stations by values of the ratio of annual average daily traffic to the average daily traffic volumes for each month [1]

Ratio	January	February	March	April	May	June	July	August	September	October	November	December
0.80	----	----	----	----	----	----	----	1	----	----	----	----
.84	----	----	----	----	----	----	----	1	----	----	----	----
.85	----	----	----	----	----	----	----	----	----	----	1	----
.86	----	----	----	----	----	1	1	----	1	----	----	2
.87	----	----	----	----	----	----	----	2	1	1	----	----
.88	----	----	----	----	1	----	2	1	----	----	----	----
.89	----	----	----	----	----	1	----	1	1	1	----	----
.90	----	----	----	----	----	1	1	1	----	----	----	----
.91	----	----	----	----	----	1	1	----	1	----	1	1
.92	----	----	----	----	----	2	----	----	----	----	----	----
.93	----	----	2	1	1	1	*3*	----	----	1	----	3
.94	----	----	----	1	----	*6*	3	*4*	2	----	2	----
.95	----	----	1	2	*6*	2	2	1	1	1	1	1
.96	----	1	1	1	6	----	2	1	*2*	1	2	*1*
.97	----	1	2	*3*	*5*	*3*	*1*	*2*	1	*5*	*3*	2
.98	----	----	1	3	2	2	2	5	1	2	2	2
.99	----	2	*2*	----	*3*	*4*	2	*2*	*6*	*5*	1	1
1.00	1	----	3	*6*	3	----	2	2	4	2	1	*5*
1.01	----	1	3	3	1	2	*1*	----	*2*	3	*4*	1
1.02	1	*3*	*2*	1	1	----	1	1	4	----	2	1
1.03	2	2	5	*4*	1	1	1	1	----	*4*	1	*3*
1.04	----	3	----	1	----	1	1	1	1	1	----	2
1.05	2	*2*	*3*	2	----	2	----	2	1	1	*4*	1
1.06	----	4	1	----	----	----	2	----	----	1	----	----
1.07	*3*	1	----	----	----	----	2	----	----	----	1	----
1.08	2	1	1	----	----	----	----	----	----	----	1	----
1.09	*4*	----	----	----	----	----	----	----	----	1	----	----
1.10	1	*3*	1	----	----	----	----	----	----	----	----	----
1.11	2	1	1	1	----	----	----	----	----	----	2	2
1.12	1	----	----	1	----	----	----	----	----	----	----	----
1.13	2	1	----	----	----	----	----	----	----	----	----	1
1.14	----	1	1	----	----	----	----	----	----	----	----	----
1.15	*2*	1	----	----	----	----	----	----	----	----	----	----
1.16	----	1	----	----	----	----	----	----	----	----	----	----
1.17	1	----	----	----	----	----	----	----	----	----	----	----
1.19	1	----	----	----	----	----	----	----	----	----	----	----
1.21	1	----	----	----	----	----	----	----	----	----	----	----
1.22	1	----	----	----	----	----	----	----	----	----	----	----
1.24	1	----	----	----	----	----	----	----	----	----	----	----
1.28	1	----	----	----	----	----	----	----	----	----	----	----
Number of stations	29	29	30	30	30	30	30	29	29	30	29	29

[1] Numbers in italics indicate the first, second, and third quartile points in each month.

Table 6.—Quartile position by month for each station in relation to all stations [1]

Station number	Group number	January	February	March	April	May	June	July	August	September	October	November	December
500	III, IV, V	3	Q_1	2	Q_1	Q_2	Q_3	2	3	4	3	3	2
501	I, V	3	1	Q_1	3	2	4	4	4	Q_3	Q_1	Q_1	1
502	III, IV, V	--------	--------	2	1	Q_2	Q_1	1	1	3	Q_3	Q_3	2
503	I, IV	4	3	Q_1	1	Q_1	Q_1	3	3	2	Q_2	Q_2	Q_2
504	II, V	Q^1	2	3	Q_2	Q_3	4	4	2	1	1	Q_2	Q_2
505	I, IV, V	Q_2	2	3	Q_3	Q_2	1	2	Q_1	Q_2	4	3	Q_2
506	II	Q_2	4	4	4	Q_1	1	1	1	1	1	1	3
507	I, V	1	3	Q_3	3	4	1	Q_1	3	3	3	Q_2	4
508	I, IV, V	1	3	Q_2	Q_1	Q_1	3	3	3	--------	Q_1	2	1
509	III	1	1	1	1	1	Q_3	4	4	4	4	Q_3	--------
510	II, IV, V	2	2	2	Q_3	4	Q_3	Q_3	Q_3	Q_1	Q_1	Q_1	1
511	II, V	4	3	Q_3	4	2	1	2	1	1	Q_2	1	4
512	I, V	Q_1	Q_2	3	3	4	4	1	4	4	1	1	4
513	II	4	4	4	4	Q_1	1	1	1	Q_2	Q_2	1	Q_2
515	I, IV, V	3	2	1	2	3	Q_1	Q_1	Q_1	Q_1	Q_3	4	Q_3
517	I, IV, V	Q_3	Q_2	Q_2	Q_2	2	3	2	Q_1	4	2	3	Q_2
518	II	4	4	Q_3	2	Q_1	2	Q_1	1	1	Q_2	--------	4
519	I, IV, V	2	3	3	3	3	2	2	Q_1	2	3	Q_2	Q_3
520	II	3	4	4	Q_3	4	3	4	Q_3	Q_3	1	1	1
521	II	4	4	4	4	2	1	1	1	1	3	4	4
522	III, IV, V	1	Q_1	2	Q_2	Q_3	Q_1	3	3	Q_2	Q_3	Q_3	2
523	II	3	Q_3	3	Q_3	4	4	Q_2	Q_2	Q_2	1	1	1
524	I	2	1	1	Q_2	2	4	4	4	1	Q_1	Q_1	2
525	I, IV, V	3	3	2	Q_2	2	Q_3	3	Q_2	1	2	2	3
526	I, V	1	1	1	Q_1	4	4	3	--------	Q_2	Q_2	2	Q^1
527	I, V	1	2	2	2	Q_2	Q_3	4	4	Q_2	Q_1	2	2
528	III, IV, V	2	Q_1	1	Q_2	Q_2	Q_1	2	2	3	Q_3	4	Q_3
529	III	Q_1	1	1	1	1	1	4	4	3	4	4	4
530	III	Q_3	Q_3	1	1	Q_3	3	3	4	4	4	Q_3	1
532	II	4	Q_3	4	4	Q_1	3	2	1	4	3	1	1

[1] Numbers 1-4 shown in the columns for the respective months express the following relation: 1=ratio value$<Q_1$, 2=ratio value$>Q_1<Q_2$, 3=ratio value$>Q_2<Q_3$, and 4=ratio value$>Q$

ut it can be used when the least variance ·om the mean is desired. Group V is also a iixed population, tending to resemble groups and IV; it serves to eliminate undesirable xtreme values due to error or forces incomatible with the remainder of the data. The eparate populations can be broken down into ubpopulations; however, there is danger in ccepting the manifestations of a small group f individual stations which may not be truly epresentative of the whole population group.

The chi-square test was applied to all five roups with satisfactory results for all except roups III and V, indicating that these two roups still had heterogeneous populations nd could be divided into more populations.

Another test supplementing the chi-square oodness-of-fit test to the normal curve was lso made, namely Fisher's g_1 and g_2 statistics. 'or each sample, these values are based on the rst through the fourth moments of the deiations of the observations from the mean of frequency distribution where the X-axis s the class interval of the monthly value of he ratio of each station's ADT to the average day of the month, and the Y-axis is the frequency of occurrence. Just as the first and second moments about the mean are measures of the average deviation from the mean and the standard deviation, respectively, so are the first through the third moments used to obtain a measure of asymmetry (g_1) and the first through the fourth moments a measure of the kurtosis, flatness, and/or peakedness (g_2) as compared with the normal curve. The statistics g_1 and g_2 are calculated from the k statistics, which are in turn derived from the sum of the powers, from the second through the fourth, of the deviations from the mean of a frequency distribution. Thus,

$$g_1=\frac{k_3}{\sqrt{k_2^3}} \text{ and } g_2=\frac{k_4}{k_2^2}$$

Where:

$$k_2=S_2/(N-1)$$

$$k_3=NS_3/(N-1)(N-2)$$

$$k_4=\frac{N[(N+1)S_4-3(N-1)S_2^2/N]}{(N-1)(N-2)(N-3)}$$

S_2 = The sum of the squares of the deviations about the mean.

S_3 = The sum of the cubes of the deviations about the mean.

S_4 = The sum of the fourth powers of the deviations about the mean.

In converting the values of g_1 and g_2 to t values which show the probability levels and significance of the sample in relation to the normal curve, the following formulas were used:

$$t_{g_1}=\frac{g_1}{S^2_{g2}} \text{ and } t_{g2}=\frac{g_2}{S^2_{g2}}$$

Where:

$S^2_{g_1}$ (variance of g_1) $= \frac{6N(N-1)}{(N-2)(N+1)(N+3)}$

$S^2_{g_2}$ (variance of g_2) $= \frac{24N(N-1)^2}{(N-3)(N-2)(N+3)(N+5)}$

N = Number of observations in samples.

An interesting sidelight on the value of g_2 is its use in determining the minimum size of a sample to be taken from a larger sample or population when the value of g_2 of the larger sample is known. The minimum sample size is computed as follows: $\beta_2=g_2+3$, and N (size of sample) $=(\beta_2-1)/4V^2$. In the Tennessee 30-station data, the value of g_2 is 0.4477, and assuming the desired coefficient of variation (V) of the standard deviation is equal to 10 percent, $\beta_2=0.4477+3.000=3.4477$. The size of sample $N=3.4477-1/\ 4\ (0.10)^2=2.4477/\ 0.04=61.2$ months.

Since each station reports for 12 months, the minimum sample required is 61.2/12 or 5 stations. However, this sample of 61.2 months is a random sample distributed over all stations and not clustered in 5 stations. This cluster effect has not yet been investigated, but because of its possible effect the number of stations may have to be raised to 6 or 7.

It has been observed that when the chi-square test for goodness of fit showed weakness, the g_1 and g_2 tests tended to substantiate this weakness. A summary of the results of the various tests for selected groups is shown in table 7.

Table 7.—Summary of various statistical tests for selected station groupings

Comparison	Standard deviation	F-test of variance [1]	T-test of means	Chi-square test [2]	g-criteria probability levels [3]	
					t_{g_1}	t_{g_2}
All 30 stations	±5.24	-----	-----	0.05>P>0.01	P>0.90	0.10>P>0.05
All 30 stations compared with—						
6-station random sample	-----	1.28	-----	-----	-----	-----
5-station random sample	-----	1.24	-----	-----	-----	-----
4-station random sample	-----	4.29	-----	-----	-----	-----
Group I stations	-----	2.12	-----	-----	-----	-----
Group II stations	-----	1.09	(4)	-----	-----	-----
Group III stations	-----	1.49	(4)	-----	-----	-----
Group IV stations	-----	3.20	-----	-----	-----	-----
Group V stations	-----	2.05	-----	-----	-----	-----
6-station random sample	±5.93	-----	-----	.70>P>.50	P>.90	.70>P>.60
6-station sample compared with—						
5-station random sample	-----	1.59	-----	-----	-----	-----
4-station random sample	-----	5.49	-----	-----	-----	-----
Group I stations	-----	2.71	-----	-----	-----	-----
Group II stations	-----	1.18	-----	-----	-----	-----
Group III stations	-----	1.91	-----	-----	-----	-----
Group IV stations	-----	4.10	-----	-----	-----	-----
Group V stations	-----	2.70	-----	-----	-----	-----
5-station random sample	±4.70	-----	-----	.30>P>.20	.80>P>.70	.30>P>.20
5-station sample compared with—						
4-station random sample	-----	3.45	-----	-----	-----	-----
Group I stations	-----	1.70	-----	-----	-----	-----
Group II stations	-----	1.35	-----	-----	-----	-----
Group III stations	-----	1.20	(4)	-----	-----	-----
Group IV stations	-----	2.57	-----	-----	-----	-----
Group V stations	-----	1.65	-----	-----	-----	-----
4-station random sample	±2.53	-----	-----	.90>P>.80	.20>P>.10	.50>P>.40
4-station sample compared with—						
Group I stations	-----	2.03	-----	-----	-----	-----
Group II stations	-----	4.66	-----	-----	-----	-----
Group III stations	-----	2.88	(4)	-----	-----	-----
Group IV stations	-----	1.34	-----	-----	-----	-----
Group V stations	-----	2.09	-----	-----	-----	-----
Group I (13 stations)	±3.60	-----	-----	P=.10	.30>P>.20	.10>P>.05
Group I stations compared with—						
Group II stations	-----	2.30	(4)	-----	-----	-----
Group III stations	-----	1.42	(4)	-----	-----	-----
Group IV stations	-----	1.51	-----	-----	-----	-----
Group V stations	-----	1.03	-----	-----	-----	-----
Group II (10 stations)	±5.46	-----	-----	.90>P>.80	.60>P>.50	P>.90
Group II stations compared with—						
Group III stations	-----	1.62	(4)	-----	-----	-----
Group IV stations	-----	3.47	(4)	-----	-----	-----
Group V stations	-----	2.22	(4)	-----	-----	-----
Group III (7 stations)	±4.29	-----	-----	.02>P>.01	.50>P>.40	.02>P>.01
Group III stations compared with—						
Group IV stations	-----	2.14	(4)	-----	-----	-----
Group V stations	-----	1.37	(4)	-----	-----	-----
Group IV (12 stations)	±2.93	-----	-----	.20>P>.10	.90>P>.80	P>.001
Group IV stations compared with—						
Group V stations	-----	1.56	-----	-----	-----	-----
Group V (18 stations)	±3.66	-----	-----	.05>P>.02	.50>P>.40	.01>P>.001

1 Values exceeding 1.35 are significant at the 5-percent level.
2 Acceptable probability level is between 0.95 and 0.05.
3 P values less than 0.05 are considered significantly different from a normal fit.
4 Difference in means is highly significant at the 5-percent level.

Nashville and Memphis Studies

From the data of 6 stations located in Nashville, 63 random samples of 24-hour duration were selected as shown in table 8. These samples were adjusted to the ADT estimates by application of the 6-station monthly means of ratios of ADT to the respective average weekday traffic volumes as shown in table 9. The differences (errors) of these estimates from their respective true values were expressed by the standard deviation of ±6.7 percent. Recalling that the sampling error of the 24-hour samples was measured by the standard deviation of ±5.9 percent for Memphis, the effect of factorization on the final error is small indeed.

Further, to test the practical meaning of the significance of the observed ±10-percent range of variation in the monthly characteristics of the variations among stations, it was assumed that no monthly adjustment ratios were available from Nashville stations. Instead, the monthly mean ratios for the 6 stations located in Memphis were used for estimating the ADT in Nashville using the same 63 samples. The standard deviation resulting from this procedure was ±7.2 percent.

The difference between 7.2 and 6.7 percent could hardly be considered of practical significance, and yet it implies the absence of need for Nashville data for the adjustment of samples. At least for this purpose, the six stations in Nashville could be considered unnecessary. Furthermore, the identification of possible different populations as previously discussed could not have had any appreciable practical effect on the accuracy of ADT estimates based on 24-hour weekday samples, as the error could not be expected to fall below the ±5.9 percent standard deviation of sampling.

A comparison of the same 63 sample coun with the ADT disclosed that the differenc between the sample traffic volumes and t respective ADT volumes were measured by standard deviation of ±8.7 percent. Co sidering that the corresponding minimum po sible measure was ±5.9 percent, and the be results upon factorization (by Nashville fa tors) was 6.7 percent, a significant conclusi is derived. If on a 68-percent confiden limit, errors of 9 percent or less would

Table 8.—Errors in ADT estimates of Nashville traffic for 1956, based on 24-hour weekday samples expanded by mean factors

Month	24-hour week-day volumes	Using mean Nashville factor: Factor	Estimated ADT	Error [1]: Volume	Error [1]: Percent	Using mean Memphis factor: Factor	Estimated ADT	Error [2]: Volume	Error [2]: Percent
Station 500—ADT 26,635									
January	24,821	1.09	27,055	420	1.6	1.06	26,310	−325	−1.2
February	25,528	1.02	26,038	−597	−2.2	1.03	26,294	−341	−1.3
March	25,727	.98	25,212	−1,423	−5.3	1.01	25,984	−651	−2.4
April	27,727	.95	26,341	−294	−1.1	1.01	28,004	1,369	5.1
May	29,876	.92	27,486	851	3.2	.96	28,681	2,046	7.7
June	30,435	.93	28,305	1,670	6.3	.93	28,304	1,669	6.3
July	27,407	.93	25,489	−1,146	−4.3	.96	26,311	−324	−1.2
August	--------	.92	--------	--------	--------	.94	--------	--------	--------
September	--------	.95		--------	--------	.95			--------
October	25,680	.95	24,396	−2,239	−8.4	.96	24,653	1,982	−7.4
November	24,853	.97	24,107	−2,529	−9.5	.96	23,859	2,776	−10.4
December	--------	.94	--------	--------	--------	.95	--------	--------	--------
Station 501—ADT 576									
January	458	1.09	499	−77	−13.3	1.06	485	−91	−15.8
February	594	1.02	606	30	5.2	1.03	612	36	6.3
March	668	.98	655	79	13.7	1.01	675	99	17.2
April	548	.95	521	−55	9.5	1.01	553	−23	−4.0
May	602	.92	554	−22	−3.8	.96	578	2	.3
June	565	.93	525	−51	−8.9	.93	525	−51	−8.9
July	605	.93	563	−13	−2.3	.96	581	5	.9
August	530	.92	488	−88	−15.3	.94	498	−78	−13.5
September	531	.95	504	−72	−12.5	.95	504	−72	−12.5
October	561	.95	533	−42	−7.3	.96	539	−37	−6.4
November	573	.97	556	−20	−3.5	.96	550	−26	−4.5
December	633	.94	595	19	3.3	.95	601	25	4.3
Station 502—ADT 4,868									
January	4,456	1.09	4,857	−411	−8.4	1.06	4,723	−145	−3.0
February	4,489	1.02	4,579	−289	−5.9	1.03	4,624	−244	−5.0
March	5,285	.98	5,179	311	6.4	1.01	5,338	470	9.7
April	5,736	.95	5,449	581	11.9	1.01	5,793	925	19.0
May	5,515	.92	5,074	206	4.2	.96	5,294	426	8.8
June	5,844	.93	5,435	567	11.6	.93	5,435	567	11.6
July	5,928	.93	5,513	645	13.2	.96	5,691	823	16.9
August	--------	.92	--------	--------	--------	.94	--------	--------	--------
September	5,099	.95	4,844	−24	−.5	.95	4,844	−24	−.5
October	5,140	.95	4,883	15	.3	.96	4,934	66	1.4
November	5,267	.97	5,109	241	4.9	.96	5,056	188	3.9
December	--------	.94	--------	--------	--------	.95	--------	--------	--------

Month	24-hour week-day volumes	Using mean Nashville factor: Factor	Estimated ADT	Error [1]: Volume	Error [1]: Percent	Using mean Memphis factor: Factor	Estimated ADT	Error [2]: Volume	Error [2]: Percent
Station 503—ADT 7,615									
January	7,436	1.09	8,105	490	6.4	1.06	7,882	267	3.5
February	7,834	1.02	7,991	376	4.9	1.03	8,069	454	6.0
March	7,967	.98	7,808	193	2.5	1.01	8,047	432	5.7
April	8,219	.95	7,808	193	2.5	1.01	8,301	686	9.0
May	8,641	.92	7,950	335	4.4	.96	8,295	680	8.9
June	8,010	.93	7,449	−166	−2.2	.93	7,449	−166	−2.2
July	8,295	.93	7,714	99	1.3	.96	7,963	348	4.6
August	8,453	.92	7,777	162	2.1	.94	7,946	331	4.3
September	8,363	.95	7,945	330	4.3	.95	7,945	330	4.3
October	7,861	.95	7,468	−147	−1.9	.96	7,547	−68	−.9
November	8,023	.97	7,782	167	2.2	.96	7,702	87	1.1
December	7,980	.94	7,501	−114	−1.5	.95	7,581	−34	−.4
Station 504—ADT 7,863									
January	8,061	1.09	8,786	923	11.7	1.06	8,545	682	8.7
February	--------	1.02	--------	--------	--------	1.03	--------	--------	--------
March	8,226	.98	8,061	198	2.5	1.01	8,308	445	5.7
April	8,734	.95	8,297	434	5.5	1.01	8,821	958	12.2
May	8,281	.92	7,619	−244	−3.1	.96	7,950	87	1.1
June	8,822	.93	8,204	341	4.3	.93	8,204	341	4.3
July	7,936	.93	7,380	−483	−6.1	.96	7,618	−245	−3.1
August	8,540	.92	7,857	−6	−.1	.94	8,028	165	2.1
September	--------	.95	--------	--------	--------	.95	--------	--------	--------
October	8,772	.95	8,333	470	6.0	.96	8,421	558	7.1
November	8,400	.97	8,148	285	3.6	.96	8,064	201	2.6
December	8,601	.94	8,085	222	2.8	.95	8,171	308	3.9
Station 505—ADT 17,439									
January	17,869	1.09	19,477	2,038	11.7	1.06	18,941	1,502	8.6
February	--------	1.02	--------	--------	--------	1.03	--------	--------	--------
March	17,420	.98	17,072	−367	−2.1	1.01	17,594	155	.9
April	17,061	.95	16,208	−1,231	−7.1	1.01	17,232	−207	−1.2
May	18,993	.92	17,474	35	.2	.96	18,233	794	4.6
June	19,157	.93	17,816	377	2.2	.93	17,816	377	2.2
July	--------	.93	--------	--------	--------	.96	--------	--------	--------
August	18,274	.92	16,812	−627	−3.6	.94	17,178	−261	−1.5
September	17,998	.95	17,098	−341	−2.0	.95	17,098	−341	−2.0
October	18,810	.95	17,869	430	2.5	.96	18,058	619	3.5
November	17,883	.97	17,346	−93	−.5	.96	17,168	−271	−1.6
December	19,789	.94	18,602	1,163	6.7	.95	18,800	1,361	7.8

[1] Standard deviation (Nashville): $S=\frac{\sqrt{\Sigma(\text{percent error})^2}}{N-1}=\frac{\sqrt{2{,}786.54}}{63-1}=\pm 6.7$ percent.

[2] Standard deviation (Memphis): $S=\frac{\sqrt{\Sigma(\text{percent error})^2}}{N-1}=\frac{\sqrt{3{,}255.18}}{63-1}=\pm 7.2$ percent.

Table 9.—Ratios (mean factors) of annual average daily traffic to average weekday traffic volumes for Nashville and Memphis, 1956

City and station number	January	February	March	April	May	June	July	August	September	October	November	December	Average daily traffic
Nashville:													
500	1.09	1.02	1.01	0.96	0.97	0.94	0.94	0.96	1.01	1.00	1.02	0.95	26,635
501	1.12	1.00	1.01	1.00	.95	1.04	1.01	1.01	1.00	.95	.97	.91	576
502	1.14	1.11	.94	.88	.89	.88	.84	.82	.93	.94	.96	.92	4,868
503	1.15	1.00	.94	.91	.89	.89	.92	.92	.93	.93	.96	.96	7,615
504	1.10	.98	.97	.94	.93	.94	.96	.88	.88	.88	.94	.94	7,863
505	1.03	.98	.98	.98	.91	.89	.90	.90	.94	.99	.98	.95	17,439
Mean	1.09	1.02	.98	.95	.92	.93	.93	.92	.95	.95	.97	.94	--------
Memphis:													
506	1.12	1.16	1.10	1.11	1.01	.95	.94	.90	.91	.90	.95	.99	23,671
507	.95	.99	.99	.97	.96	.87	.88	.93	.97	.97	.95	.99	10,394
508	1.05	1.06	1.02	.97	.95	.97	.98	.97	.98	.96	.97	.92	12,282
509	.99	.93	.95	.91	.90	.90	1.03	1.00	1.01	.99	1.01	.95	21,254
510	1.07	1.01	.98	1.01	.99	.96	.97	.95	.94	.95	.93	.92	7,058
511	1.17	1.04	1.04	1.10	.95	.90	.93	.87	.88	.96	.92	.95	27,903
Mean	1.06	1.03	1.01	1.01	.96	.93	.96	.94	.95	.96	.96	.95	--------

cceptable as sufficiently accurate, then a 4-hour weekday traffic count may be assumed to represent the ADT.

Similar tests of Detroit and St. Louis data appear to bear out this conclusion with the following qualifications: (1) The months of January, July, August, and December show a high degree of dispersion for the test observations and hence are not representative months of the year; (2) there are low-volume roads in urban areas which will also show a high degree of dispersion and may not be reliable; and (3) the average weekday count is generally higher than the respective ADT, the average difference for the year being about +5 percent of the ADT. When seasonal variation is considered, the average range of the 24-hour weekday count is about 95 to 110 percent of the ADT. In Tennessee, because the factors are already available, the adjustments for monthly variations will be made.

Table 10.—Factors for the expansion of 4-hour urban counts to 24-hour counts on weekdays and the evaluation of the accuracy of these factors

Month	Number of counts	Average ratio of 24-hour traffic to 4-hour traffic			Number of counts	Average ratio of 24-hour traffic to 4-hour traffic		
		Ratio	Standard deviation of ratio	Standard error of ratio		Ratio	Standard deviation of ratio	Standard error of ratio
	6 a. m.–10 a. m.				7 a. m.–11 a. m.			
January	262	4.54	0.85	0.05	262	4.10	0.64	0.04
February	631	4.72	.84	.03	631	4.29	.62	.02
March	719	4.52	.73	.03	719	4.26	.55	.02
April	672	4.40	.59	.02	672	4.27	.52	.02
May	643	4.43	.55	.02	643	4.35	.51	.02
June	685	4.60	.63	.02	685	4.45	.58	.02
July	603	4.61	.70	.03	603	4.46	.59	.02
August	736	4.57	.67	.02	736	4.46	.61	.02
September	690	4.53	.84	.03	690	4.38	.67	.03
October	633	4.34	.66	.03	633	4.18	.57	.02
November	623	4.42	.72	.03	623	4.15	.60	.02
December	414	4.50	.73	.04	414	4.19	.60	.03
Average	--------	[1] 4.50	.71	--------	--------	[1] 4.31	.59	--------
	8 a. m.–12 noon				11 a. m.–3 p. m.			
January	262	4.53	0.65	0.04	262	4.47	0.54	0.03
February	631	4.50	.66	.03	631	4.26	.62	.02
March	719	4.50	.56	.02	719	4.30	.56	.02
April	672	4.53	.51	.02	672	4.39	.55	.02
May	643	4.60	.52	.02	643	4.50	.58	.02
June	685	4.54	.53	.02	685	4.33	.52	.02
July	603	4.59	.52	.02	603	4.47	.51	.02
August	736	4.63	.53	.02	736	4.46	.57	.02
September	690	4.57	.58	.02	690	4.51	.62	.02
October	633	4.45	.50	.02	633	4.46	.60	.02
November	623	4.39	.57	.02	623	4.34	.60	.02
December	414	4.45	.57	.03	414	4.35	.57	.03
Average	--------	[1] 4.53	.56	--------	--------	[1] 4.40	.57	--------
	12 noon–4 p. m.				1 p. m.–5 p. m.			
January	262	4.14	0.41	0.03	262	3.66	0.34	0.02
February	631	3.93	.48	.02	631	3.57	.36	.01
March	719	3.96	.45	.02	719	3.62	.33	.01
April	672	4.08	.42	.02	672	3.71	.10	.00
May	643	4.18	.48	.02	643	3.79	.34	.01
June	685	4.16	.42	.02	685	3.85	.10	.00
July	603	4.30	.45	.02	603	3.94	.36	.01
August	736	4.25	.51	.02	736	3.90	.37	.01
September	690	4.21	.52	.02	690	3.87	.39	.01
October	633	4.10	.49	.02	633	3.74	.37	.01
November	623	4.00	.47	.02	623	3.65	.34	.01
December	414	3.98	.48	.02	414	3.63	.34	.02
Average	--------	[1] 4.11	.47	--------	--------	[1] 3.75	.31	--------

[1] Weighted average based on card count.

Four-Hour Weekday Counts

Manual counts of 4-hour duration on weekdays are also used in Tennessee cities for the purpose of estimating ADT. The evaluation of the conversion of weekday 24-hour counts to estimates of ADT has already been discussed. Utilizing an electronic computer, a population study was made on the 1955 data of 33 urban continuous-count recorders for the purpose of determining and evaluating the procedure for the expansion of these 4-hour samples into estimates of traffic for 24-hour periods on weekdays.

Table 10 shows the mean expansion factors, the standard deviation, and the standard errors of the means of the expansion factors by months and by different 4-hour periods of traffic counts. The great similarities of the mean monthly factors and the consistency of the standard deviation for various 4-hour periods are evident. It is observed, however, that the greatest variation, average standard deviation ±0.71, occurs during the period from 6 a. m. to 10 a. m., being 15.8 percent of the mean factor of 4.5. The smallest variation is for the period from 1 p. m. to 5 p. m. for which the average standard deviation is ±0.31 or ±8.3 percent of the mean factor of 3.75. These characteristics indicate that estimates of 24-hour weekday volumes are accurate in terms of standard deviations of about ±12 to 13 percent, which may be considered satisfactory for practical purposes.

Traffic Article Postponed

The article *Traffic and Travel Trends*, which has appeared annually (except for 1954) in Public Roads magazine since 1946, will not be included this year.

The comprehensive study of highways, begun in 1956 in accordance with section 210 of the Highway Revenue Act of 1956, was given preference over the work of reporting and analyzing the 1957 traffic trends data. The consequent postponement of this work has delayed the publishing of the usual traffic trends article for this one year. Tabular material, which would have been a part of the report had it been published, will be available to subscribers of Public Roads during the first quarter of calendar year 1959, and a set of tables giving 1957 traffic information will be furnished at that time upon request addressed to the Bureau of Public Roads.

Traffic data furnished in conjunction with the section 210 study will undoubtedly result in revisions being made in tables to be published for 1957. Furthermore, the new information resulting from the section 210 study will make it possible to check a series of estimates of total rural and urban travel.

The present plan is to publish in Public Roads the 1957 traffic trends along with 1958 data when they become available. It is expected that the consolidated article will include a more detailed analysis of travel characteristics than has been published since the end of World War II.

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