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DRIM AREA TRANSPORTATION
MODEL CHECK

19.

STATUS REPORT

1975 DRIM AREA
TRANSPORTATION MODEL CHECK

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ADVANCE PLANNING OFFICE
IOWA DEPARTMENT OF TRANSPORTATION

ABSTRACT

Based upon the model check conducted so far, the staff concludes that the 1975 DRIM area vehicle trips seem to be over-generated by the original model. Over-generation is probably caused by the sharp increase in auto ownership since 1964. Trip making may have reached a marginal level, such that regardless how many extra cars each family owns, the total number of trips per household may remain more constant. A shortcut trial method is also proposed for refinement of the present trip generation model.

1975 Socio-Economic Conditions

1975 total socio-economic data and related statistics are tabulated in Table 1. A comparison with 1970 and with 1964 data is also presented in this table. Highlights of 1975 DRIM area socio-economic characteristics are:

1. Practically no growth has occurred in population since 1970.
2. Employment by place of residence increased by 17% from 1970 to 1975. This means 43% of the total population was employed in 1975.
3. The biggest increase between 1970 and 1975 was auto ownership--36.5%. Fifteen years ago, one of every 3 persons owned an automobile. By 1975, one of every 2 persons were auto owners.
4. Employment force has expanded at about 1% per year since 1970. Retail employment experienced most of the growth--30% in 5 years, while "other" employment experienced a slight decrease in the DRIM area.
5. Family size dropped slightly from 3 persons per DU to 2.81 per DU, while the car ownership increased substantially at 1.55 per family (national average is about 1.2 cars per household).

1975 Synthetic Trip Production

Table 2 lists the 1975 DRIM area's total estimated vehicle trips by trip purpose. These trips were estimated by the original trip generation rate model developed with 1960's O-D data. Comparison with base year (1964) and other study years' trips were also made in Table 3. Noticeable features of 1975 synthetic trips are as follows:

1. Total internal trips increased 70% from base year (1964).
2. Compared to 1970, synthetic trips increased 30% in 5 years.
3. All home-based trip productions experienced sharp increase ranging from 75% to 115% since the 1964 base year.
4. Non-home-based trips increased fairly moderately at an annual rate of 3% since the base year, and their proportion among other trip purposes dropped from 18% to 14% of the total productions.

TABLE 1
 Comparison of Socio-Economic Data
 DRIM Transportation Study Area

<u>Variables</u>	<u>1964</u>	<u>1970</u>	<u>1975</u>	<u>Increase From 1964</u>	<u>Increase From 1970</u>
Population	250,751	292,556	297,638	18.7%	1.7%
Dwelling Units	77,988	97,915	105,944	35.8%	8.2%
Total Employment	95,006	139,669	146,297	54.0%	4.7%
*Retail	14,344	18,307	23,627	64.7%	29.1%
*Manufacture	42,543	44,923	48,220	13.3%	7.3%
*Other	38,119	76,439	74,450	95.3%	-2.6%
Employed Residential	85,567	111,288	129,819	51.7%	16.7%
Auto Ownership	90,171	120,086	163,913	81.8%	36.5%
School Enrollment	41,883	80,676	83,529	99.4%	3.5%
*1-8 Grade	30,412	52,242	44,307	45.7%	-15.2%
*9-12 Grade	9,231	16,582	21,003	127.5%	26.7%
*College	2,240	11,852	18,219	713.3%	53.7%
Population per DU	3.22	2.99	2.81		
Car Per DU	1.16	1.23	1.55		
Empres Per DU	1.10	1.14	1.23		
Emp Per Population	0.43	0.48	0.49		
Empres/Total Emp	0.80	0.80	0.89		
Population Per Car	2.78	2.44	1.82		
Empres/Population	0.34	0.38	0.44		

Table 2A
 Vehicle Trip Productions
 DRIM Area Transportation Study

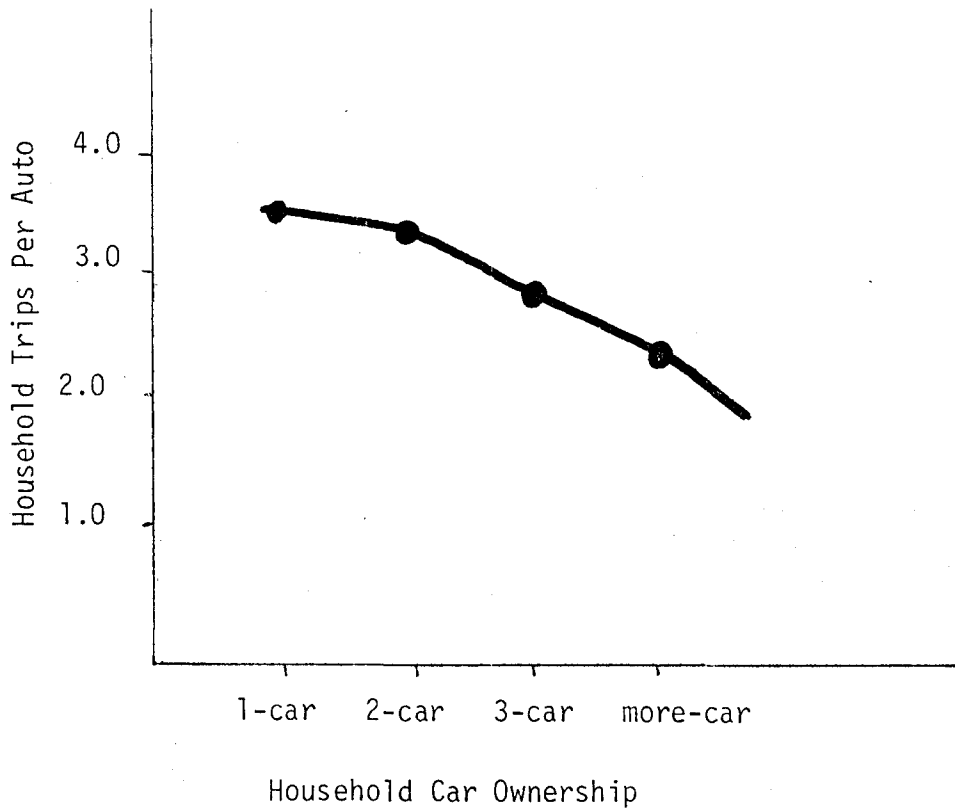
Trip Category	1964		1964		1970		1975		1985	
	OD	%	SYN	%	SYN	%	SYN	%	SYN	%
HRW-P	109,213	19.2	105,533	18.5	142,611	19.1	186,434	19.2	157,012	15.6
HBS-P	69,406	12.2	71,833	12.6	101,316	13.6	154,471	15.9	137,805	13.7
HBO-P	218,719	38.4	220,059	38.6	293,860	39.5	409,810	42.3	434,262	43.3
NHB-P	102,837	18.1	101,336	17.8	132,503	17.8	138,219	14.3	186,343	18.6
TRUCK	69,023	12.1	70,892	12.5	74,500	10.0	80,642	8.3	87,893	8.8
TOTAL	569,198	100.0	569,553	100.0	744,790	100.0	969,576	100.0	1,003,316	100.0

Table 2B
 Personal Trip Productions
 DRIM Area Transportation Study

Trip Category	1964		1964		1970		1975		1985	
	OD	%	SYN	%	SYN	%	SYN	%	SYN	%
HBW-P	145,935	16.8	138,801	16.0	182,895	16.5	218,388	15.7	196,858	13.1
HBS-P	111,848	12.9	115,198	13.3	151,155	13.7	204,472	14.7	197,237	13.1
HBO-P	392,575	45.3	394,896	45.6	509,960	46.0	688,971	49.5	753,955	50.2
NHB-P	146,558	16.9	145,824	16.9	189,479	17.1	199,811	14.3	265,687	17.7
TRUCK	69,023	8.0	70,892	8.2	74,500	6.7	80,818	5.8	87,894	5.9
TOTAL	865,939	100.0	865,611	100.0	1,107,989	100.0	1,392,460	100.0	1,501,631	100.0

TABLE 3
 Comparison of 1964-1975
 Vehicle Trip Production
 DRIM Area Transportation Study

<u>Trip Category</u>	<u>Increase from 1964</u>	<u>Annual Increase 1964-1975</u>	<u>Increase from 1970</u>	<u>Annual Increase 1970-1975</u>
HBW-P	70.7%	6.4	47.8%	9.6
HBS-P	120.6%	11.0	52.5%	10.5
HBO-P	87.4%	7.9	39.5%	7.9
NHB-P	34.4%	3.1	4.3%	0.9
TRUCK-P	16.8%	1.5	8.2%	1.6
TOTAL	70.3%	6.4	30.2%	6.0



* Figure 1. Household Trips Per Auto
 vs.
 Household Auto Ownership

* From Nationwide Personal Transportation Study, Report No. 11, U.S. Department of Transportation, December, 1974.

5. Compared to 1985 estimates, non-home based trips increase only 3.5% during the entire 10 years from 1975-85.

Trip Rate Analysis

Based on the statistics shown above, the 1975 trip estimates tend to increase at nearly the same rate as auto ownership did. For example, auto ownership increased 82% since the base year, and the total number of trip increased about 70%. Auto ownership is the single most significant independent variable in the DRIM area trip generation model, contributing about 58% of total zonal productions estimated in 1975. Furthermore, personal auto ownership (e.g., Auto/Pop rate) is used in the DRIM model for estimating vehicle trips from person trips. The model assumes that as the auto per person rate increases, car occupancy rates decrease. Thus, more vehicle trips are converted from person trips.

Question is: Is this really true in 1975 trip making? If a one-car family made 8 trips a day in the 1960's, would they double their trip making if they owned 2 cars in the 1970's, or has the total trip making per family reached a marginal level regardless how many more cars they own?

Perhaps the ultimate question: Is the model adequate for future forecasting?

Based on the analysis conducted so far, it appears that the model produces an over-generation of 1975 trips. Table 4 tabulates the statistics of a series of assignment to ground count comparisons from the first two base network assignments.

The first assignment is on the 1975 base network using 5 minute bridge penalties crossing the Mississippi River, and no K-factors. It shows an overwhelming overloading on screenlines; overloading for all functional classes except major arterials, and overloading for all link count groups. The persistent overloading throughout all count groups indicates that further network calibration would be ineffective until total trip loadings are reduced. The second assignment used the same base network with the bridge penalties increased to 8 minutes, and still without K-factors. It should be noted that trips were redistributed in the second run by the minimum time paths selected from this particular network.

the result showed improvement in the ground count comparison. However, it is still overloaded in most cases. The improvement resulted from the reduction of about 2000 trips loaded on the second network. This reduction resulted because the gravity model computed more intra-zonal trips, since the 8-minute bridge penalty resisted further long distance trips.

One may suggest that further bridge penalties (e.g., say 12-minute penalty for all Mississippi River crossings) would reduce the total trip loading and thus calm down overloading problems. There are two disadvantages in this approach:

1. Unrealistic bridge penalties would stiffen the forecast flexibility.
A 12-minute bridge penalty would probably separate the entire DRIM study area as if they were two unrelated regions.
2. Severe bridge penalties may jeopardize network balance and create a deadlock for calibration work later on.

Conclusions and Recommendation

Marginal household trip production rate is a theory that seem agreeable with a national sample survey. The Nationwide Personal Transportation Survey conducted by the Bureau of Census in early 1970 had the following observation:*

"The average number of vehicle trips made daily per household increases with increased car ownership; however, not proportionately. While the one-car household make 3.4 vehicle trips daily, two-car households make 6.4 trips and three or more car households make 8.6. vehicle trips daily. The average number of daily vehicle trips per household is slightly higher in unincorporated areas (4.3 trips per household) than in incorporated places (3.7 trips per household). Places of 1,000,000 and over averaged the fewest number of daily trips (1.9 trips per household) due to the large perponderance of "carless" households."

* Nationwide Personal Transportation Study. Report 11, Page 58, U.S. Department of Transportation, December 1974.

TABLE 4

GROUND COUNT COMPARISON FOR
1975 DRIM AREA MODEL CHECK
FIRST TWO ASSIGNMENTS

CONDITION / DESCRIPTION OF NETWORK, TT, etc.	TOTAL TRIPS LOADED		TOTAL VMT		TOTAL VHT		SCHEDULING COMPARISON	DV = VOL/COUNT DF = COUNT - VOL	COMPARISON by LINK CT-GROUP	COMPARISON by FUNC. CLASS
	SDF by SCRL	SDF by CTGROUP	SDF by FUNC.	SDF by SCRL	SDF by CTGROUP	SDF by FUNC.				
1975 DRIM AREA BASE NETWORK (9th ROW) Rescheduled	978,452	4,566,320	142,709	-498,883	-785,607	-819,214	#1 DV, DF			
1975 DRIM AREA BASE NETWORK (9th ROW) (B.O. min. B.P.)	976,456	4,409,215	142,005	-387,975	-593,497	-539,497	#2 " "			
	1.273, -26876	1.696, -68495		1.295, -27819	1.318, -29995		#3 " "			
	1.513, -40958	1.507, -40555		1.436, -43972	1.441, -46540		#4 " "			
	1.484, -21730	1.247, -29072		1.337, -40000	1.330, -50792		#5 " "			
	0.993, +1115	0.938, +10224		0.983, +2196	1.037, -4699		#6 " "			
	1.192, -27230	1.287, -40713		0.945, +2127	0.961, +1515		#7 " "			
	1.217, -23757	1.231, -25250		1.456, -61070	1.474, -63738		#8 " "			
	1.066, -12835	1.102, -19777		1.233, -44076	1.318, -60246		#9 " "			
	1.039, -3300	1.047, -4002		1.289, -12244	1.355, -15042		#10 " "			
	0.860, +17486	0.880, +14991		1.169, -10878	1.274, -17625		#11 " "			
	1.192, -9120	1.198, -9372		1.169, -10878	1.274, -17625		#12 " "			
	1.212, -189245	1.330, -295,048		1.192, -9120	1.198, -9372		#13 " "			
	0.995, +14224	1.010, -28,480		1.212, -189245	1.330, -295,048		#14 " "			
	1.167, -309807	1.202, -373,453		0.995, +14224	1.010, -28,480		#15 " "			
	1.028, -15,778	1.038, -21,849		1.167, -309807	1.202, -373,453		#16 " "			
	1.562, -51,233	1.572, -52,142		1.028, -15,778	1.038, -21,849		#17 " "			
	2.196, -41,058	2.177, -40,275		1.562, -51,233	1.572, -52,142		#18 " "			
	1.669, -368,177	1.844, -464,696		2.196, -41,058	2.177, -40,275		#19 " "			
	0.921, +170,759	2.946, +116,556		1.669, -368,177	1.844, -464,696		20K+ DV, DF			
	1.105, -300,547	1.121, -344,377		0.921, +170,759	2.946, +116,556		10-20K "			
	1.116, -95,562	1.142, -117,697		1.105, -300,547	1.121, -344,377		5-10K "			
				1.116, -95,562	1.142, -117,697		2-5K "			
							1-2K "			
							0-1K "			
							Full DV, DF			
							Mid Art DV, DF			
							Min. Art "			
							Connector "			

The survey suggests that household trips per auto decrease as household auto ownership increases. Figure 1 (Pg. 2) illustrates such marginal relationships.

On the other hand, over-generation would occur when a simple linear model follows a direct, proportional rate from auto ownership in home-based trip computation. This is found in DRIM area studies (1964-1975):

1. Home-based trips (estimates) increased as fast as (if not faster than) auto ownership did; and
2. Trips per auto did not go down even though household auto ownership increased 34% from 1.16 in 1964 to 1.55 in 1975.

It is concluded that the 1975 vehicle trips are very possibly over-generated by the original model. However, it is not known exactly how many trips are over-generated. A shortcut trial model refinement is suggested as follows:

1. Reduction of trips that are auto ownership-dependent (i.e., home-based shopping and home-based other trips) by adjustment of those zones having an auto ownership per DU rate higher than 2.0. The value 2.0 is selected as the cutoff point since no significant change in the trips per auto rate occurs between one-car and two-car families.
2. The rate of reduction is directly proportional to the AUTO/DU rate in excess of 2.0 as shown below.

$$T_i = T_i \left[1 - ((\text{AUTO/DU})_i - 2.0) * K \right]$$

Where: \bar{T}_i = adjusted home based trips in zone i.

$(\text{AUTO/DU})_i$ = auto per DU rate in zone i > 2.0.

K = rate of decrease in trips per auto; based upon national survey, K is approximately 0.15 between 2-car and 3-car family.

Suggested shortcut refinement is diagrammed in a flowchart shown in Figure 2 below.

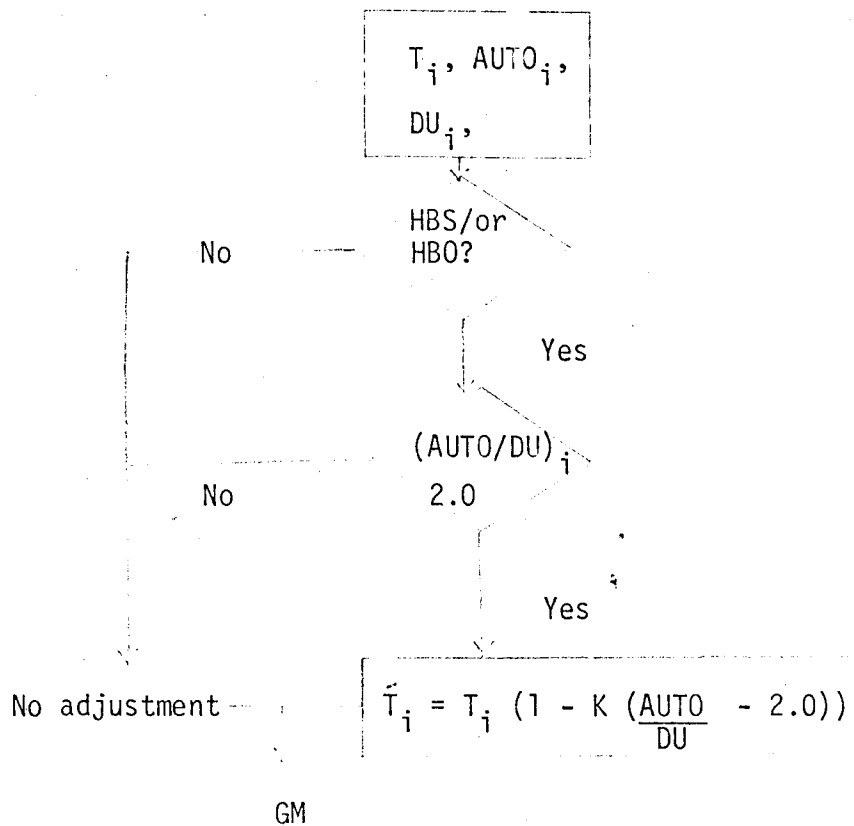


Figure 2 --a shortcut method for trips generation refinement.

TABLE 5

 TRIP RATES BY AUTO, PERSON & DWELLING UNIT
 D-RI-M TRANSPORTATION STUDY (1964 - 1975)

	O-D 1964		SYN 1964		SYN 1970		SYN 1975	
	<u>Person Trips</u>	<u>Veh. Trips</u>	<u>Person Trips</u>	<u>Veh. Trips</u>	<u>Person Trips</u>	<u>Veh. Trips</u>	<u>Person Trips</u>	<u>Veh. Trips</u>
Home Based Trips								
Per Auto	7.21	4.41	7.20	4.40	7.03	4.48	6.78	4.58
Per Person	2.59	1.58	2.59	1.58	2.88	1.84	3.74	2.52
Per DU	8.34	5.09	8.32	5.09	8.62	5.49	10.49	7.09
Total Trips (Internal)								
Per Auto	9.60	6.31	9.60	6.31	9.23	6.20	8.50	5.92
Per Person	3.45	2.27	3.45	2.27	3.79	2.55	4.68	3.26
Per DU	11.10	7.30	11.10	7.30	11.32	7.61	13.14	9.15

SUMMARY OF TRIP GENERATION EQUATIONS
PERSON TRIPS PER ZONE

Home Based Work

Productions = 41.85 + 1.58 (Emp Res)

Attractions = 62.84 + 1.35 (Tot Emp)

Home Based Shop

Productions = 64.17 + 1.13 (Cars)

Attractions

CBD = 1096.5 + 2.44 (Ret Emp)
 Shopping Center = 821.9 + 14.89 (Ret Emp)
 Strip Development = 12.8 (Ret Emp)
 Other Areas = 3.8 (Ret Emp)

Total (For control total checks only)

Productions = 596.83 + 7.13 (Cars) + 5.06 (Ret Emp)

Where: Emp Res = Employed Residents

Tot Emp = Total Employment

Ret Emp = Retail Employment

Mfg Emp = Manufacturing Employment

Oth Emp = Other Employment

Home Based Other

Illinois Productions = 45.74 + 4.72 (Cars)

* Iowa Productions = 92.79 + 3.29 (Cars)

Attractions

(1) Personal Business = 485.7 + 2.24 (Ret Emp) + 0.87 (Oth Emp)
 (2) Social-Recreation = 220.50 + 0.70 (DU) + 0.85 (Ret Emp) +
 0.21 (Oth Emp)
 (3) School (1-8) = 0.89 (Stu 1-8)
 School (9-12) = 1.52 (Stu 9-12)
 School (College) = 1.24 (Stu Col)

Non-Home Based

Productions = Attractions = 80.0 + 0.25 (HBO Att + FBS Att)

Truck

Productions = Attractions = 75.14 + 0.33 (DU) + 0.12 (Mfg Emp) +
 0.92 (Ret Emp)

Cars = Cars Owned

DU = Dwelling Units

Stu 1-8 = School Enrollment (1-8)

Stu 9-12 = School Enrollment (9-12)

Stu Col = School Enrollment (College)

* This equation was developed January 1972 since the equation listed in Interim Report #5 for Illinois zones only.

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