SONG - **Homework #2**

Transportation Network Development System Analysis

The main objectives of this assignment are to help student

- learn to draw implications of alternative policies on transportation network
- understand transportation network development process, the influencing factors and players
- learn transportation planning model (modeling process)
- understand current transportation infrastructure investment decision making process
- learn and practice the method of system analysis

Statewide transportation plan is one of the major products generated out of the *federally-mandated transportation planning process*. The transportation plan is a long range (at least 20 years), multi-model future vision for the mobility of goods and people. The plan considers factors that may affect or be affected by local and regional transportation investments. Minnesota Department of Transportation (MnDOT) is the agency holding responsibility for administrating state transportation budget. Currently, MnDOT is drafting the 2004 to 2024 Minnesota Statewide Transportation Plan. In preparation for the statewide transportation plan, MnDOT is developing a 20-year transportation management and financing strategy for the development of transportation system.

You are a transportation planner/engineer working for a local transportation consulting firm, which newly won a contract with MnDOT to perform a pilot study to examine potential system impacts of statewide application of a transportation management policy: *High Occupancy Vehicle (HOV) lanes* as opposed to the *general purpose lanes*. The project team of your firm decides to phase this study into two steps: (1) conduct a corridor level impact analysis on the case of I394 HOV vs. general purpose lanes; and (2) draw implications about the potential impacts of the two transportation management alternatives on the statewide transportation network systems.

Now imagine Phase I of the project was just finished and the project team in your firm will meet with MnDOT' s Technical Advisory Panel (TAP) in two weeks to report the major findings at this stage. You are a member of the project team, your supervisor asks you to write up an analysis memo in two week based on the data and findings from Phase I of the study and prepare her for the TAP meeting.

In particular, your memo should include the following six parts:

First, problem statement

Corresponding to two phases of the project, two problems need to be addressed:

(1) At corridor level, estimate current (2000) and future (2020) impacts of I-394 HOV lanes vs. general purpose lanes (addressed in Phase I). In your memo, you should analyze and summarize the data and findings from phase I to address problem one.

(2) Draw implications about potential impacts of the two policy options, as applied to statewide network links (addressed in Phase II).

Problem two will be addressed in the next step of this project. However, in your memo, you need to (a) provide preliminary discussion of the implications based on findings from phase I; and (b) describe the approaches for addressing problem two in Phase II.

Second, methodology

For phase I, major work of the project was to forecast the impacts of opening HOV lanes to the general traffic, in terms of traffic operations and mode split, using a *regional travel demand model* maintained by the Metropolitan Council. The regional travel demand model is a traditional four-step transportation model developed by the Metropolitan Council and the Minnesota DOT in early 1990s based on Census data and the Twin Cities Travel Behavior Inventory (TBI). In your memo, you should explain the travel demand model and the underline rationale of the model as the project methodology. Additional information about the regional travel demand model can be found from this link:

http://www.dot.state.mn.us/information/hov/pdfs/appendix_b.pdf

Third, data input, output and findings

The data inputs into the model contain (1) node data, depicting characteristics of origins and destinations including population, employment and other factors; and (2) network data describing characteristics of highway and transit networks, such as, travel time on link, average speed, capacity, direction, and transit headway. In this project, the model is updated with both 2000 and 2020 (estimated) data. More information is available on the first six pages of the document under the following link:
http://www.dot.state.mn.us/information/hov/pdfs/appendix_e.pdf .

The regional travel demand model outputs the following Measurements of Effectiveness (MOEs):

- Estimated travel speed for HOV
- Estimated vehicle volume at bottleneck locations (AM peak and PM peak)
- Estimated person volume at bottleneck location
- Volume capacity ratio at bottleneck location
- Vehicle Mile Traveled
- Vehicle Hour Traveled
- Travel Time Reliability
- Shift in total trip
- Transit Usage of HOV lane (AM, PM peak period)

These data outputs are presented in the last section of this assignment sheet. You can select information as needed for your analysis.

Fourth, evaluation and analysis

Based on the output MOEs, perform a system analysis and draw implications from two policy alternatives: HOV lanes vs. general purpose lanes. To perform a system analysis, the following parts must be addressed:

(1) Define the system

(2) Generate and assess alternatives available to management (policy scenarios)

(3) Choose alternatives and implementation (run the model)

(4) Compute and summarize MOEs from model output, and

(5) Evaluate and select the preferred policy scenario

Five, discuss implications of HOV vs. general purpose lanes on network system

Briefly discuss (a) the preliminary implications you can draw from Phase I study on the system impacts of the two policy options; and (b) discuss further study, methodology, and data needs for addressing this question thoroughly in Phase II.

Six, conclusions and recommendations

Draw conclusions from your findings. Make recommendations to assist decision making at corridor level. Discuss implications of the two transportation policy options on statewide network system.

Finally, your report should be no longer than 2500 words, 1.5 or double spaced, using 12-point Times New Roman font.

Data output from Phase I (I-394 HOV vs. General Purpose Lanes Impact Study)

Table E.1   Estimated Travel Speeds for the HOV Corridors from the Model

		2000		2020	
		A.M.	P.M.	A.M.	P.M.
With HOV:	I-394 HOV Concurrent	56.0	58.1	54.5	50.3
	I-394 General-Purpose Lanes	38.2	33.7	26.6	24.6
	I-35W HOV Lanes	62.9	61.4	57.4	52.7
	I-35W General-Purpose Lanes	34.2	32.1	16.1	16.4
	I-394 HOV Barrier	56.4	55.9	56.6	55.7
Without HOV:	I-394 General-Purpose Lanes	43.6	39.5	31.4	28.4
	I-394 Barrier	43.2	42.0	40.6	39.3
	I-35W	42.8	41.3	20.9	20.9
Difference:	I-394 HOV Barrier	-13.3	-13.9	-16.0	-16.5
	I-394 Concurrent	-12.4	-18.6	-23.1	-21.9
	I-394 General-Purpose Lanes	5.4	5.8	4.8	3.9
	I-35W HOV Facility	-20.1	-20.1	-36.5	-31.8
	I-35W General-Purpose	8.6	9.2	4.8	4.5

Table E.2   Estimated Model Vehicle Volumes at Bottleneck Locations
(A.M. Peak Period)

		AM Peak Period (6:00 to 8:00 A.M.)			
		2000 Model With HOV	2000 Model Without HOV	2020 Model With HOV	2020 Model Without HOV
EB I-394 at Penn Ave	HOV Lanes	1,289	6,628	1,625	7,712
	General Lanes	11,007	7,366	12,513	10,031
	Total all lanes	12,296	13,994	14,138	17,743
EB I-394 at Louisiana Ave	HOV Lanes	1,038	3,484	1,511	4,618
	General Lanes	7,890	6,968	9,601	9,236
	Total all lanes	8,928	10,452	11,112	13,854
NB I-35W at Minnesota River	HOV Lanes	1,497	4,087	1,988	5,011
	General Lanes	8,822	8,174	10,033	10,023
	Total all lanes	10,319	12,261	12,021	15,034

Table E.3 Estimated Model Vehicle Volumes at Bottleneck Locations (P.M. Peak Period)

		PM Peak Period (3:00 to 6:00 P.M.)			
		2000 Model With HOV	2000 Model Without HOV	2020 Model With HOV	2020 Model Without HOV
WB I-394 at Penn Ave	HOV Lanes	2,620	10,599	3,572	12,421
	General Lanes	16,512	11,893	19,795	16,326
	Total all lanes	19,132	22,492	23,367	28,747
WB I-394 at Winnetka Ave	HOV Lanes	2,420	6,372	3,757	8,244
	General Lanes	14,142	12,743	17,581	16,489
	Total all lanes	16,562	19,115	21,338	24,733
SB I-35W at Minnesota River	HOV Lanes	2,519	5,870	3,573	7,581
	General Lanes	13,289	11,741	15,525	15,161
	Total all lanes	15,808	17,611	19,098	22,742

Table E.4 Estimated Person Volumes at Bottleneck Locations for 2000

		With			Without				
		SOV & HOV	Transit	Total	SOV & HOV	Transit	Total	Change	%Change
EB I-394 at Penn Ave	HOV	2,707	2,963	5,670	7,032	1,105	8,137	2,467	44%
	General	11,009	0	11,009	7,784	1,223	9,007	-2,002	-18%
	Total	13,716	2,963	16,679	14,816	2,328	17,144	465	3%
EB I-394 at Louisiana Ave	HOV	2,180	1,603	3,783	3,674	420	4,093	311	8%
	General	7,893	0	7,893	7,347	840	8,187	294	4%
	Total	10,073	1,603	11,676	11,021	1,260	12,280	604	6%
NB I-35W at Minnesota River	HOV	3,144	986	4,130	4,258	258	4,516	386	9%
	General	8,822	0	8,822	8,515	517	9,032	210	2%
	Total	11,966	986	12,952	12,773	775	13,547	596	5%
WB I-394 at Penn Ave	HOV	5,502	3,077	8,579	11,412	922	12,334	3,755	44%
	General	16,521	0	16,521	12,752	1,031	13,783	-2,738	-17%
	Total	22,023	3,077	25,100	24,164	1,953	26,117	1,017	4%
WB I-394 at Winnetka Ave	HOV	5,082	1,868	6,950	6,820	395	7,216	266	4%
	General	14,162	0	14,162	13,641	790	14,431	269	2%
	Total	19,244	1,868	21,112	20,461	1,185	21,647	535	3%
SB I-35W at Minnesota River	HOV	5,290	1,031	6,321	6,237	218	6,455	134	2%
	General	13,289	0	13,289	12,473	436	12,909	-380	-3%
	Total	18,579	1,031	19,610	18,710	654	19,364	-246	-1%

Table E.5 Estimated Person Volumes at Bottleneck Locations for 2020

		With			Without				
		SOV & HOV	Transit	Total	SOV & HOV	Transit	Total	Change	%Change
EB I-394 at Penn Ave	HOV	3,413	4,355	7,768	8,275	1,193	9,468	1,700	22%
	General	12,541	0	12,541	10,626	1,532	12,158	-382	-3%
	Total	15,953	4,355	20,309	18,901	2,725	21,626	1,318	6%
EB I-394 at Louisiana Ave	HOV	3,173	2,356	5,530	4,889	491	5,381	-149	-3%
	General	9,601	0	9,601	9,779	983	10,762	1,161	12%
	Total	12,774	2,356	15,131	14,668	1,474	16,142	1,012	7%
NB I-35W at Minnesota River	HOV	4,175	1,449	5,624	5,220	302	5,523	-102	-2%
	General	10,034	0	10,034	10,441	605	11,045	1,011	10%
	Total	14,209	1,449	15,658	15,661	907	16,568	910	6%
WB I-394 at Penn Ave	HOV	7,501	4,523	12,024	13,423	989	14,412	2,387	20%
	General	19,816	0	19,816	17,605	1,297	18,902	-914	-5%
	Total	27,317	4,523	31,840	31,028	2,285	33,313	1,473	5%
WB I-394 at Winnetka Ave	HOV	7,890	2,746	10,636	8,855	462	9,318	-1,318	-12%
	General	17,581	0	17,581	17,710	925	18,635	1,054	6%
	Total	25,471	2,746	28,217	26,566	1,387	27,953	-264	-1%
SB I-35W at Minnesota River	HOV	7,503	1,516	9,019	8,058	255	8,313	-706	-8%
	General	15,589	0	15,589	16,116	510	16,627	1,038	7%
	Total	23,092	1,516	24,608	24,174	766	24,940	332	1%

Table E.6 Volume to Capacity Ratios for Bottleneck Locations from Model

AM Location		2000 With HOV	2000 Without HOV	2020 With HOV	2020 Without HOV
EB I-394 at Penn Ave	HOV Lanes	0.23	0.83	0.29	0.96
	General Lanes	0.94	0.63	1.07	0.86
	Total all lanes	0.71	0.71	0.82	0.90
EB I-394 at Louisiana Ave	HOV Lanes	0.37	0.89	0.54	1.18
	General Lanes	1.01	0.89	1.23	1.18
	Total all lanes	0.84	0.89	1.05	1.18
NB I-35W at Minnesota River	HOV Lanes	0.53	1.05	0.71	1.28
	General Lanes	1.13	1.05	1.29	1.28
	Total all lanes	0.97	1.05	1.13	1.28

PM Location		2000 With HOV	2000 Without HOV	2020 With HOV	2020 Without HOV
WB I-394 at Penn Ave	HOV Lanes	0.31	0.88	0.43	1.04
	General Lanes	0.94	0.68	1.13	0.93
	Total all lanes	0.74	0.76	0.90	0.97
WB I-394 at Winnetka Ave	HOV Lanes	0.58	1.09	0.89	1.41
	General Lanes	1.21	1.09	1.50	1.41
	Total all lanes	1.04	1.09	1.34	1.41
SB I-35W at Minnesota River	HOV Lanes	0.60	1.00	0.85	1.30
	General Lanes	1.14	1.00	1.33	1.30
	Total all lanes	0.99	1.00	1.20	1.30

Table E.7 Vehicle Miles Traveled and Vehicle Hours Traveled for Autos from the Travel Demand Model by Corridor

Measure/Year	With HOV							Without HOV				
	I-394 Concurrent	I-394 GP	I-35W HOV	I-35W GP	I-394 Barrier	Remainder	Total	I-394 GP	I-35W GP	I-394 Barrier	Remainder	Total
Vehicle Miles of Travel												
2000	20,595	222,769	25,229	152,668	11,030	30,566,107	30,973,997	234,473	177,866	51,398	30,558,571	31,022,327
2020	25,197	252,826	44,450	268,251	16,667	40,789,944	41,397,348	298,243	379,585	60,099	40,646,429	41,382,356
Vehicle Hours of Travel												
2000	555	6,306	575	4,306	197	1,076,440	1,087,707	5,729	4,243	1,211	1,073,792	1,084,974
2020	489	9,306	822	16,650	298	2,400,755	2,438,739	10,097	18,161	1,511	2,654,252	2,483,960

Table E.8 Travel Time Reliability from IDAS (for Freeways Only)

Year	With HOV SOV	With HOV HOV	With HOV Total	Without HOV SOV	Without HOV HOV	Without HOV Total	Change Value	Change Percent
2000	783	36	819	739	36	775	44	5%
2020	2323	100	2423	2097	105	2202	221	9%

Table E.9   Shift in Total Trips

Year	SOV	HOV	Transit
2000			
A.M. Peak Period	2807	-934	-846
P.M. Peak Period	3620	-1009	-1501
Total	6427	-1943	-2347
2020			
A.M. Peak Period	2036	65	-2173
P.M. Peak Period	2639	166	-2988
Total	4675	231	-5160

Table E.10   Morning Peak Period Transit Routes Using HOV Lanes (6:00 am to 8:00 am)

Agency	Bus Route	From	To	Trips	Avg. Headway (min)	Cycle (min)
I-35W Northbound						
MVTA	431	Hwy 13	82nd	3	31	60
	460	Hwy 13	Downtown	26	5	72
	464	Hwy 13	Downtown	3	30	105
	490	Hwy 13	Downtown	2	30	120
Metro	47	98th	Downtown	10	12	110
	44C	98th	Downtown	4	25	60
Total Trips				48		
I-35W Southbound						
MVTA	460	Entire	entire	2	30	72
Southwest Metro	681	Downtown	Hwy 62	3	42	90
Metro	47	Downtown	98th	4	19	–
	551	Downtown	98th	2	88	–
Total Trips				11		
I-394 Eastbound						
Plymouth	776	Entire	Entire	4	30	100
	772	Co Rd 73	Downtown	5	23	90
	790	Hwy 169	Downtown	7	18	90
Southwest Metro	683	Hwy 169	Downtown	1	–	130
	680	Hwy 169	Downtown	2	39	130
	682	Hwy 169	Downtown	1	30	100
	684	Hwy 169	Downtown	3	18	130
	685	Hwy 169	Downtown	4	25	100
	688	Hwy 169	Downtown	1	–	130
	690	Hwy 169	Downtown	6	14	90
	691	Hwy 169	Downtown	1	–	130
	692	Hwy 169	Downtown	4	27	130
Metro	52M	Plymouth	Downtown	2	15	84
	588	Hwy 100	Downtown	4	33	63
	587	Hwy 100	Downtown	3	27	91
	663	Louisiana	Downtown	6	18	63
	667	Hwy 169	Downtown	10	16	60
	668	Hwy 169	Downtown	3	30	–
	671	Plymouth	Downtown	4	28	72
	672	Entire	Entire	4	28	120
	674	Entire	Entire	3	40	–
	673	Co Rd 73	Downtown	10	14	45
	675	Start to Plymouth	General Mills to downtown	6	18	180
	676	Entire	entire	2	92	150
	677	Entire	Entire	3	33	–
	764	Hwy 100	Downtown	4	20	–
	765	Hwy 100	Downtown	4	20	–
	58	Hwy 100	Downtown	3	30	60
Laidlaw	664	Hwy 100	Downtown	4	30	52
	665	Hwy 169	Downtown	3	30	52
	670	Hwy 169	Downtown	3	30	69
Total Trips				120		

Table E.11 Afternoon Peak Period Transit Routes Using HOV Lanes (3:00 A.M. TO 6:00 P.M.)

Agency	Bus Route	From	To	Trips	Avg. Headway (min)	Cycle (min)
I-35W Southbound						
MVTA	431	82nd	Hwy 13	3	30	60
	460	Entire	Entire	27	6	80
	464	Entire	Entire	3	30	120
	490	Entire	Entire	2	30	120
Southwest Metro	681	Downtown	Hwy 62	1	–	90
	696	Downtown	Hwy 62	1	–	90
Metro	47	Downtown	98th	10	13	–
	44C	Downtown	98th	3	31	80
Total Trips				50		
I-35W Northbound						
MVTA	460	Entire	Entire	2	30	80
Southwest Metro	681	Hwy 62	Downtown	5	37	90
Metro	47	98th	Downtown	4	44	–
	551	98th	Downtown	2	120	–
Total Trips				13		
I-394 Westbound						
Plymouth	776	Entire	Entire	5	31	100
	772	Downtown	Co Rd 73	5	33	90
	790	Downtown	Hwy 169	8	18	90
Southwest Metro	680	Downtown	Hwy 169	2	29	130
	682	Downtown	Hwy 169	2	27	100
	684	Downtown	Hwy 169	3	33	130
	685	Downtown	Hwy 169	4	30	100
	689	Downtown	Hwy 169	2	113	100
	690	Downtown	Hwy 169	5	20	90
	692	Downtown	Hwy 169	4	33	130
Metro	52M	Downtown	Plymouth	3	34	–
	587	Downtown	Hwy 100	5	27	60
	588	Downtown	Hwy 100	3	52	–
	663	Downtown	Louisiana	9	14	60
	667	Downtown	Hwy 169	8	22	80
	668	Downtown	Hwy 169	3	30	–
	671	Downtown	Plymouth	3	29	–
	672	Entire	Entire	4	39	120
	674	Entire	Entire	4	27	–
	673	Downtown	Co Rd 73	10	18	45
	675	Downtown to General Mills	Plymouth to end	7	31	180

	676	Entire	Entire	4	50	160
	677	Entire	Entire	3	30	–
	764	Downtown	Hwy 100	3	31	–
	765	Downtown	Hwy 100	5	26	–
	58	Downtown	Hwy 100	3	31	60
Laidlaw	664	Downtown	Hwy 100	5	30	52
	665	Downtown	Hwy 169	3	30	52
	670	Downtown	Hwy 169	3	30	69
Total Trips				**128**		