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Research Article

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Transportation Planning & Validation of Surface Transportation Models in Houston, Texas, USA through Implementation of a Traffic Network Simulation enhanced by Transportation Analysis Simulation System

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Abstract—

The paper is based on the author's project, implemented during his masters, that comprises of evaluation of current transportation models followed intending to validate the same by traditional method of volume-capacity comparison. The paper focuses on surface vehicular transportation modeling, and network design for emission management. Transportation management remains under-focused aspect in the traffic modeling, globally, & this project has been successful in initiating the right measures for the Houston area, in Texas, USA, by the transportation management authorities such as Department of Transportation, Federal Highway Administration and Houston-Galveston Area Council. The chief objective of the project was to validate the recent transportation models designed in Transportation Analysis and Simulation Software (TRANSIMS), identifying the possible causes behind the variation of these models over the sponsor data from HGAC. Hub of the global cancer research, 'Texas Medical Center' area in Houston, TX, USA, was the scope for the transportation modeling in this project.
The paper shall recommend possible solutions to a major shortcoming, in TRANSIMS, i.e., it lacks the calibration and validation of transportation models. Thus, the University of Houston research team focused on modeling the traffic supply-demand in TRANSIMS, assessing its conformance with the data supplied by HGAC, and suggested improved validation and verification measures in an event of deviation in observations.

Keywords — Transportation Planning, Simulation, Calibration, Validation, Surface Vehicular Traffic

I. INTRODUCTION

According to the 2000 U.S. Census, Houston experienced the sixth-largest 10-year population increase among the U.S. metro areas. The Houston-Galveston Area Council (H-GAC) 2025 Regional Growth Forecast anticipates the Houston metro area will grow by another three million people by 2025. Thus, this emphasizes the forthcoming transportation needs that need to be addressed in light of this population increase forecast, which in turn will lead to after effects such as increased traffic volume, traffic congestions, and subsequently increased air pollution.

In Houston, the local agencies such as HGAC (Houston-Galveston Area Council) and national agencies such as DoT (Department of Transportation) have already initiated their efforts towards researching for a better commutation options. However, these efforts are in the pilot phase and need to adopt a validated transportation planning policy and guidelines, so that modern computational and time-effective transportation network design approach can be established.

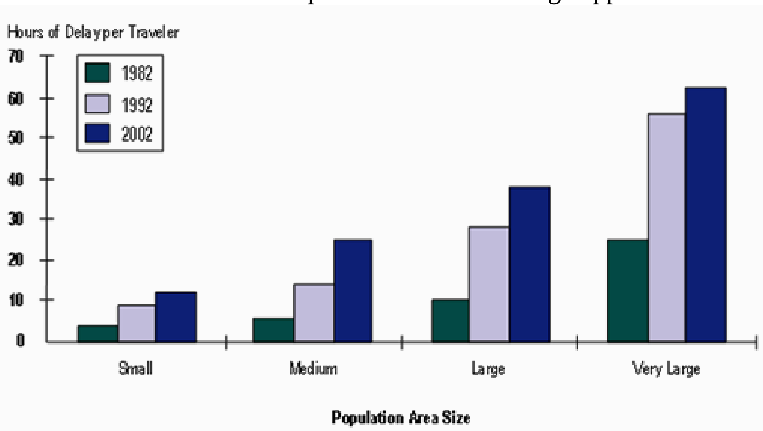

Figure 1 - Congestion Growth in U.S. Cities over the Past 20 Years

A. *TRANSPORTATION PLANNING*

Transportation helps shape an area's economic health and quality of life. Not only does the transportation system provide for the mobility of people and goods, it also influences patterns of growth and economic activity by providing access to land. The performance of the system affects public policy concerns like air quality, environmental resource consumption, social equity, land use, urban growth, economic development, safety, and security. Transportation planning recognizes the critical links between transportation and other societal goals. The planning process is more than merely listing highway and transit capital projects. It requires developing strategies for operating, managing, maintaining, and financing the area's transportation system in such a way as to advance the area's long-term goals. Transportation planning is a cooperative process designed to foster involvement by all users of the system, such as the business community, community groups, environmental organizations, the traveling public, freight operators, and the general public, through a proactive public participation process conducted by the Metropolitan Planning Organization (MPO), state Department of Transportation (state DOT), and transit operators. Transportation planning comprises of:

- Monitoring existing conditions;
- Forecasting future population and employment growth, including assessing projected land uses in the region and identifying major growth corridors;
- Identifying current and projected future transportation problems and needs and analyzing, through detailed planning studies, various transportation improvement strategies to address those needs;
- Developing long-range plans and short-range programs of alternative capital improvement and operational strategies for moving people and goods;
- Estimating the impact of recommended future improvements to the transportation system on environmental features, including air quality; and
- Developing a financial plan for securing sufficient revenues to cover the costs of implementing strategies.

In the current practice, a traditional four-step model, which includes (i) trip generation, (ii) trip distribution, (ii) mode choice, and (iv) traffic assignment, has been widely used since the 1960s. The four step model is based on zonal and link volume aggregations, and is designed to identify macroscopic questions such as where to build new highways or whether or not an installation of rail line for future travel demand is adequate. As such, the four step travel demand model does treat microscopic operational issues such as estimating the motor vehicle fuel consumption or emissions effects (requiring second-by-second vehicle speed and acceleration) and evaluating the improvements in traffic operations.

B. TRANSIMS DEFINITION - MAIN PHILOSOPHY

The Transportation Analysis and Simulation System (TRANSIMS), developed at Los Alamos National Laboratory, tracks the movements, over a 24-hour period, of a population of software agents matched statistically to a city's residents. The Transportation Analysis and Simulation System, or TRANSIMS, is an integrated system of travel forecasting models designed to give transportation planners accurate and complete information on traffic impacts, congestion, and pollution. It was developed by Los Alamos National Laboratory to address new transportation and air quality forecasting procedures required by the Clean Air Act, the Intermodal Surface Transportation Efficiency Act, and other regulations. The goal of TRANSIMS is to develop technologies that can be used by transportation planners in any urban environment. TRANSIMS will offer transportation planning agencies increased policy sensitivity, more detailed vehicle-emission estimates, and improved analysis and visualization capabilities. The philosophy underlying TRANSIMS is that to study the transportation system's performance effectively, one needs to simulate travel in a study area with a rather fine temporal and spatial resolution. TRANSIMS is a disaggregate, behavioral, regional transportation planning package developed by Los Alamos National Laboratory (LANL) under funding from US DOT, EPA, and Department of Energy. It is an integrated system of travel forecasting models designed to give transportation planners accurate, complete information on traffic impacts, congestion, and pollution by simulating on a second-by-second basis the movements of every person and every vehicle through the transportation network of a large metropolitan area.

II. PROBLEM

Although the previous models, designed in TRANSIMS, provide a set of default values for each parameter and users can conduct a simulation without calibrating them, the default values may not always be representative of the traffic situation under study. When using a simulation model for different geographic and traffic conditions, the most important and difficult step is the calibration and validation of the model. The calibration is the process by which the values of a simulation model input parameters are refined and adjusted so that the model accurately replicates field-measured and observed traffic conditions. TRANSIMS is a microscopic, time-step and behavior-based simulation model developed to model urban traffic and public transit operations. The aim of validation is to develop responses to following questions-
(1) How well does TRANSIMS reproduce field conditions?
(2) Can TRANSIMS be trusted to represent reality under new, untried conditions (e.g., revised signal timing plans)?

For TRANSIMS to fully bridge the gap between planning and operations, it must provide intersection performance measures that are commonly used to assess traffic operations quality, such as control delay or stopped delay. While TRANSIMS output provides travel time, it does not provide the control delay or stopped delay. Consequently, the control delay must be extracted from TRANSIM's vehicle event output files before they can be compared with the industry accepted models and field delay data. Therefore, to allow more useful operations analysis and comparisons with field data and industry models, a Traffic Data Extractor Tool (TDET) has to be developed to extract approach and stopped delay from the TRANSIMS vehicle event files (vehicle snapshot files).

III. METHODOLOGY

The approach used to validate travel models can vary a great deal depending on a variety of factors such as the types of policy options being tested and the availability of historical data.

A. VALIDATION TESTS

The validation tests for highway assignment can be done at three levels; system wide, corridor, and link specific. This increasing detail of validation tests is correlated to the step(s) in the model chain that could be the cause of the possible error(s). There are several systems wide or aggregate validation checks of the auto assignment process. The checks are generally made on daily volumes, but it is prudent to make the checks on volumes by time-of-day as well. Systemwide checks include Vehicle Miles of Travel (VMT), Vehicle Hours of Travel (VHT), cordon volume summaries and screenline summaries. In addition to checking summations of VMT, VHT, and volumes, the average VMT and VHT per household and person should be checked.

1) VEHICLE MILES OF TRAVEL (VMT):

Validation of the model using VMT addresses all major steps in the travel demand models including trip generation (the number of trips), trip distribution (the trip lengths), and assignment (the paths taken). VMT validation is particularly important in urban areas that are designated by the Environmental Protection Agency (EPA) as non-attainment for moderate and serious carbon monoxide (CO). VMT is simply the product of the link volume and the link distance, summed over the desired geographic area and facility types. The observed VMT is a product of a comprehensive traffic count program.

B. BENCHMARKING STANDARDS

Although absolute criteria for assessing the validity of all model systems cannot be precisely defined, a number of target values have been developed. These commonly-used values provide excellent guidance for evaluating the relative performance of particular models. As noted earlier, observed versus estimated volumes should be checked by facility type and geographic area. The Federal Highway Administration (FHWA) and Michigan Department of Transportation (MDOT) define targets for daily volumes by facility type as shown in Table 1

TABLE 1 - PERCENT DIFFERENCE TARGETS FOR DAILY TRAFFIC VOLUMES BY FACILITY TYPE
(source - Model Validation and Reasonableness Checking Manual Prepared for Travel Model Improvement Program Federal Highway Administration ; Prepared by Barton-Aschman Associates, Inc. and Cambridge Systematics, Inc.; February 1997)

Facility Type	**FHWA Targets (+/-)**	**MDOT Targets (+/-)**
Freeway	7%	6%
Major Arterial	10%	7%
Minor Arterial	15%	10%

The above FHWA standards will be adopted to check the validation process results in this project. The deviation standard that will be used will be +/- 15% deviation of the observed values verses the estimated values, in the parameter comparisons.

IV. PROJECT EXECUTION

A. PROJECT EXECUTION

The project was executed in 4 phases, as per the baseline plan, in the following order -

1) PHASE 1- RESOURCES:

The resources that were required for the project were TRANSIMS tool, TRANSIMS simulated model, ArcGIS software and reference network data. The TRANSIMS tool is a open source software, with extensive research being explored. It was downloaded from the opensource.org website and installed on the compatible computing system. ArcGIS software is the graphic tool that is required to convert TRANSIMS outputs into visual form for analysis. It was also installed on the same computing system and included two main modules of ArcCatalog and ArcMap. The simulation model designed in TRANSIMS was used from the past research in University of Houston. The project sponsor provided the reference data for the transportation network in the form of shape (*.shp) files. These files included the network design for the vehicular transportation with the link details, sub-link details, and link capacities.

2) PHASE 2 – DEFINITION OF PROJECT SCOPE:

Texas Medical Center (TMC) planning and development department deals with the problems related to traffic, construction, changing signal controls or road network etc. They have detailed information of TMC area also they are conducting some projects to mitigate the traffic problems. So to define the study area, consulting this department was the best option.

The scope of the project was defined with regard to following aspects –

- Traffic network area – Texas Medical Center area in Houston, TX
- Mode of transportation – Vehicular surface transportation on road
- Tools used for data analysis – TRANSIMS, ArcGIS and MS Excel
- Reference data for comparison – As per Houston Galveston Area Council (HGAC) compilation
- Approach of Validation – To compare the major road capacities that are outcomes at the end of the simulation of the model

3) PHASE 3 – TRANSIMS MODEL:

The model that was used for this project was from Texas Medical Center Area Transportation Planning – A TRANSIMS Study *(Published – March 2010 by Cheng, L., Chaudhari, R., Ha, A., Yu, Z., and Wetzel, E.)*.

This model was designed on the TRANSIMS framework that included following steps –

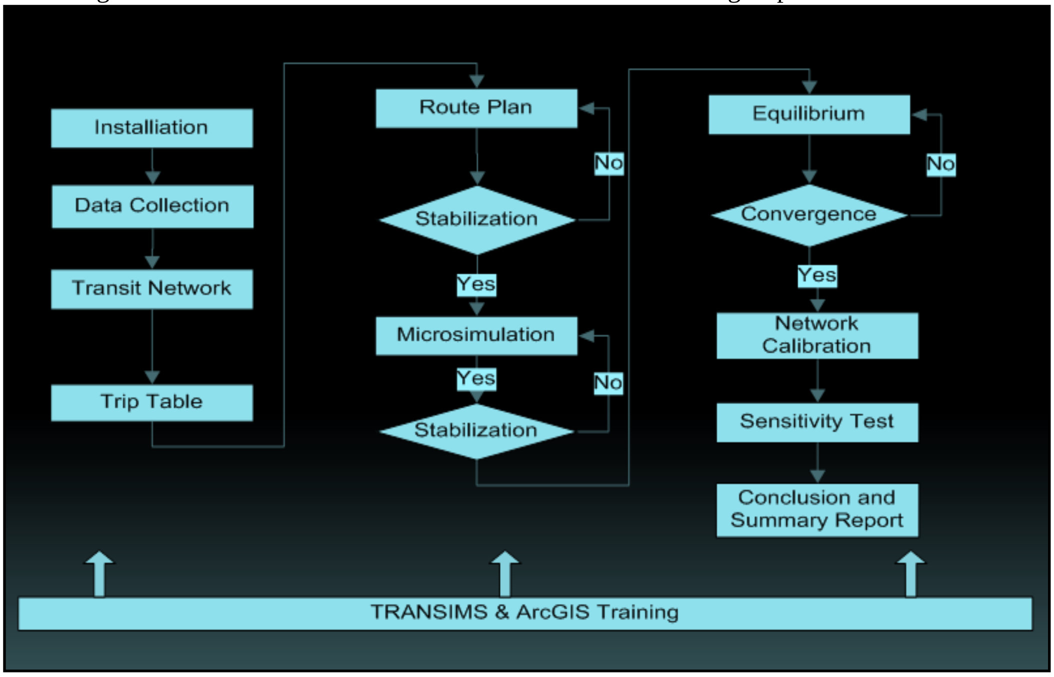

Figure. 2 TMC TRANSIMS Project process flow chart

Step 1 – Secondary Data collection

This step is the most crucial for the project. The output of the TRANSIMS depends on how detailed and the accurate data is. It requires new data or new data formats throughout the sophisticated numerical modeling and computational process. Such network data would include coding every street, every lane group, bus route, signal, intersection, and parking facility. So before processing it is required to convert available data into the TRANSIMS format.

The main data sources for this project are: HGAC (Houston Galveston Area Council), Transportation division of the public works and Engineering department – City of Houston, Department of Planning and Development - TMC. All these sources have different amount of data in different formats, so research team combined the data to use it for this project.

Step 2 – Network conversion

In this step team performed network conversion process that generates synthetic skeletal TRANSIMS network structure. The project team synthesizes the zone, node, link, transit data associated with highway networks collected from HGAC and City of Houston. The data was converted to establish the TRANSIMS transit network files. The synthesized network consisted of pocket lanes, lanes connections, signal timing and other transit components.

Step 3 – Trip Table conversion

Trip tables basically contain data like, travels origin, travel time, route, destination and more, for travelers in the study area. This task established Origin-Destination (OD) trip table on the converted transit network from the step 2. First the OD matrix, as represented by daily volumes moving from a given origin zone to a given destination zone, is disaggregated to individual traveler level. The origin zones and destination zones locations are modeled within the TRANSIMS network as 'parking lots' (i.e. activity locations) on links. Then synthetic methods were used to specify the block face and street level location of households, employment and other trip generating activities. Detailed activity surveys, including traveler and activity locations and daily trips by time of day and mode, are necessary for TRANSIMS. Zone based trip simulation is employed to model external trips into and through the study area not made by local household members. The concept of iterative trips is used to capture the impacts of these trips. Itinerant trips include trips from outside of the region, trips travel through the region and trips by commercial vehicles within the region. Then the zone-based trips are allocated to activity locations within the zone through zone-to-zone trip tables. Trips are distributed to a time of day based on the diurnal distribution. The output of this step is the file converted from ArcGIS data, zone-to-zone trip tables, synthesized population information and transit pattern data on a personal level.

Step 4 – Route Assignment

From this step onwards Router-Microsimulator iterations were performed to simulate the TMC area's transportation supply and demand. The route plan file which is created in the route finder represents the "demand" for transportation. TRANSIMS generates the route plan file identified for each traveler. The original file contains the complete enumeration of the vehicles that will travel from a given parking lot (i.e. origin) to a given parking lot (i.e. destination) at a particular departure time based on free flow link travel time without delay. In following simulation runs, minimum time or travel plans are constructed for each trip based on the latest link travel times.

The modeling execution is based on the assumption that the travel demand emerges as a result of a series of feedback loops. A router-microsimulator iterative process identifies the optimal way for each traveler's daily activities. The process involves programs combined to model the supply-demand of a transit system.
The first technique, Volume to Capacity (V/C) Ratio stabilization, is a router based stabilization process. This technique focuses on stabilizing the network performance and identifies the potential bottleneck locations within the microsimulator. The second technique, Travel Time Stabilization, is also a router based stabilization in which travelers who experience a significant difference between their expected travel time and the travel times computed from link delays are selected and rerouted. This process moves closer to user equilibrium state and helps reduce inconsistencies between the travels times computed from the link delay file and plan duration. The process continues until the number of household for rerouting becomes small or stops decreasing. Finally, the stabilization travel route plan files to be used for microsimulator are the deliverable of this task. This step was conducted using first technique.
<u>Step 5 – Microsimulator and Stabilization</u>
The travel times used for path building in Router process were based on traditional volume-delay equations which do not account for travel times and delays on arterial networks controlled by signals and stop signs. Vehicle interaction, lane changing, and turning movements, however, have significant impacts on roadway performance. The microsimulator takes into account the delays that occur at intersections due to traffic controls, network congestion and vehicle interactions. The microsimulator therefore releases the assumptions about capacity and travel time used to generates the plans. The researchers will send the initial plan set generated by previous step to the microsimulator as the starting point to model the interaction of demand and supply. It is unlikely that the original routes with free flow travel times would still be the actual shortest routes for a given OD pair. The metrics output included link volume, travel time and control delay. Review of the simulation results on the output visualization evaluates whether the microsimulation generated logical levels of congestion by time of day.
The microsimulator stabilization process is executed to address network coding issues. The random stabilization process is a microsimulator based stabilization process in which a small percentage of travelers during a congested time period are randomly selected for re-routing. The process begins by simulating the plans generated in step 5 until the network becomes severely congested with gridlock and cascading queues, indicating illogical levels of congestion. This typically occurs during the morning peak period. Within the identified time period, the randomly selected households are re-routed using the simulated travel times, merged with the rest of the plans and re-simulated. During this process, the simulation results are visually reviewed after each run using the output viewer.
Morning peak iterations are followed by additional iterations to address the mid-day time period and further iteration to clear major traffic problems during the evening peak period. The stabilization process continued until the percentage of qualified households no longer decreases or the queues subside and all of the trips for the day are simulated.
<u>Step 6 – Network-wide equilibrium convergence</u>
This task was performed to minimize the path for each and every trip. In this process, if a traveler's new travel time is significantly different from the travel time on the original path, the traveler's old plan is replaced with the new plan and the full plan set is re-simulated. Accordingly, all paths will be accounted for through the task.
<u>Step 7 – Network Calibration</u>
Route planning and network wide equilibrium are just the starting steps to examine modeling process. Network calibration will demonstrate that the process replicates observed travel conditions for the base and behaves logically after data changes.
<u>Step 8 – Sensitivity Test and TRANSIMS result comparison</u>
Once the model replicates the observed traffic counts, diurnal distributions and speeds reasonably well, a number of tests need to be performed to examine the simulated model's sensitivity to change in supply and demand in terms of the network performance and the user equilibrium condition. A sensitivity analysis on the key parameters was performed. The sensitivity tests were designed to highlight the behavior of the model in future year forecasting and analysis. However, the sensitivity tests showed variation between the capacities by HGAC data and that of TRANSIMS model.

4) PHASE 4 – CAPACITY COMPARISON:

After the TRANSIMS model procedure was studied, test runs were conducted to verify the process and output. The process is implemented, as planned in the TMC simulation case study. The standards for comparison were adopted from Model Validation and Reasonableness Checking Manual (Prepared for Travel Model Improvement Program of Federal Highway Administration by Barton-Aschman Associates, Inc. and Cambridge Systematics, Inc. in February 1997). The validation benchmarking was set at 15% as allowable variation between traffic volumes of HGAC data and TRANSIMS data.

The shape file contains all the information about the network with regard to road identification, road divisions, and speed and road capacities. This is common point between HGAC data and TRANSIMS data, since the conditions for comparison are standardized by data being in the same format. The HGAC data contains pertaining to – Field ID (FID), Shape of the road link (Shape), Starting point of the link (A), end point of the link (B), travel time for the link (LRTTIME), section number of the network in which the link falls (SECT_NUM), length of the link (DISTANCE), facility number (FACILITY_N), facility type as in cutline/screenline/freeway (FTYPE), number of lanes on the link which are typically1/2/3 on one side (LANES), peak toll (PKTOLL), optimum toll (OPTOLL), peak hot (PKHOT), optimum hot (OPHOT), type of area (AREA_TYP), number of lanes in the opposite travel direction of the link (BALANE), type of route (RTYPE), upper daily speed for the link (UDLSPD), upper daily capacity for the link (UDLCAP), travel activity zone number (ASO_TAZ), assigned speed limit for the link (SPDLIMIT), adjusted count for the link (ADJCOUNT), route (ROUTE), corridor of the link (COR_INCT), toll by distance (TOLLBYDIST), functional aspect of the link (FUNCL), associated zone of the link (ASSOC_ZONE), central speed for the link (CENTSPD), daily link speed (DLSPD), daily link vehicle capacity (DLCAP), peak link vehicle capacity (PKCAP), velocity deviation factor (VDF), actual miles of the link (LANEMILE). The TRANSIMS data was pertaining to – field ID of the link (FID), shape of the link (Shape), link number (LINK), street name (STREET), start point of the link (ANODE), end point of the link (BNODE), length of the link (LENGTH), setback for the link at start point (SETBACK_A), setback for the link at end point (SETBACK_B), BEARING_A, BEARING_B, type of the link as in local/major (TYPE), number of lanes on the link from start node to end node (LANES_AB), LEFT_AB, RIGHT_AB, speed limit of the link from node A to node B (SPEED_AB), FSPD_AB, link capacity from node A to node B (CAP_AB), (LANES_BA), LEFT_BA, RIGHT_BA, SPEED_BA, FSPD_BA, link capacity from node B to node A (CAP_BA), link use (USE), NOTES. Out of all these fields only daily and peak capacity from HGAC data and link capacity in TRANSIMS data were of interest. The total street or road capacity was determined by summing up the capacities of its component individual links in TRANSIMS data. However, the road capacity in HGAC data was taken as the average of the component link capacities.

V. PROJECT OUTCOMES

Following are the results of this comparison –

- Number of roads in TRANSIMS but not in HGAC data – 81
- Number of roads in HGAC data but not in TRANSIMS – 17

TABLE 2 - TRAFFIC VOLUME COMPARISON

STREET	HGAC			TRANSIMS			Absolute Difference		Relative Difference (%)	
	LINKS	Daily Capacity	Peak Capacity	LINKS	Daily Capacity	Peak Capacity	Daily Capacity	Peak Capacity	Daily Capacity	Peak Capacity
MAIN ST	20	21350	2262	14	33600	1220	12250.00	-1042.00	57.38	-46.07
ALMEDA	18	15750	1668	21	33600	684	17850.00	-984.00	113.33	-58.99
FANIN	18	21905	2322	35	67200	1371	45295.00	-951.00	206.78	-40.96
OLD SPANISH TRAIL	18	23650	2509	19	45600	1139	21950.00	-1370.00	92.81	-54.60
HOLCOMBE	18	22116	2344	18	43200	2119	21084.00	-225.00	95.33	-9.60
S BRAESWOOD	13	21838	2294	23	49600	805	27762.00	-1489.00	127.13	-64.91

	TRANSIMS data				HGAC data				Daily Capacity Comparison	
Sr. No.	STREET	LENGTH	CAP_AB	CAP_BA	FACILITY_N	DLCAP	PKCAP	LANEMILE	Absolute Difference	Relative Difference (%)
1	ALMEDA RD	11815.8	33600	33600	ALMEDA	15750	1668	10.09844	17850	113.3333333
2	CAMBRIDGE ST	8412.4	36800	36800	CAMBRIDGE	11025	1167.5	1.84202	25775	233.7868481
3	FANNIN ST	14730.4	67200	67200	FANNIN	21905.55556	2322.555556	17.3359	45294.44444	206.7714938
4	GREENBRIAR ST	5522.4	16000	16000	GREENBRIAR	11341.17647	1190	6.37354	4658.823529	41.07883817
5	HOLCOMBE BLVD	10886.3	43200	43200	HOLCOMBE	22116.66667	2344.333333	11.73662	21083.33333	95.32780708
6	HOLLY HALL ST	4119.6	14400	14400	HOLLY HALL	14100	1492	5.66108	300	2.127659574
7	MAIN ST	10453	33600	33600	MAIN	21350	2262	14.97238	12250	57.37704918
8	N BRAESWOOD BLVD	1268	7200	7200	BRAESWOOD N	25400	2420	1.78812	-18200	-71.65354331
9	N MACGREGOR WAY	1436.3	4000	4000	N. MACGREGOR	14500	1536	1.513	-10500	-72.4137931
10	OLD SPANISH TRL	11676.7	45600	45600	OLD SPANISH TRAIL	23650	2509	14.44908	21950	92.81183932
11	RICE BLVD	4388.1	7200	7200	RICE BLVD	7687.5	813.5	2.63754	-487.5	-6.341463415
12	S BRAESWOOD BLVD	9656.3	49600	49600	BRAESWOOD S	21838.46154	2294.769231	8.50742	27761.53846	127.1222261
13	S SH 288-SOUTH FRWY	4173.2	20800	0	SOUTH FWY/SH 288	127750	8889	8.2513	-106950	-83.71819961
14	SUNSET BLVD	2690.2	3200	3200	SUNSET	7733.333333	818.3333333	0.79578	-4533.333333	-58.62068966
15	UNIVERSITY BLVD	4179.2	6400	6400	UNIVERSITY	7550	799	2.35048	-1150	-15.23178808

As observed, the daily capacities depicted by TRANSIMS were more than 15% than that of HGAC data, and similar was the case with peak capacities with the exception of peak capacity for Holcombe Street.

A. PRINCIPLE FINDINGS

The traffic volume comparison between TRANSIMS and HGAC lead to following high level observations, about possible sources of error, since the difference between the traffic volumes was greater than the set validation standard. There are discrepancies between STAR*Map and TRANSIMS specifications. The UH team needed to convert the network toward TRANSIMS, so the network could be edited at the link level through aerial photography or GIS image to obtain an accurate network representation. (STAR*Map is an activity-based survey involving a travel diary, possesses detailed activity system data on person trips by type, origin, destination, mode, time of day, etc. Most importantly, it included information required by TRANSIMS, such as number of lanes per link, link speeds, link capacities, and functional classifications.)

Also, a road link will start inside the study area but end right at a boundary, before another continual leg extends to external TAZ zone. Encoding roads of this type will entail network editors' judgments and change in original data. The actions will serve only for the simulation purpose and encoding results will create discrepancies between TRANSIMS files and original GIS files. More specifically, synthetic intersection control tools, i.e. signals and signs, were created accordingly to facility type specifications and area types. Changing facility types to external or connector options will consequently affect the outputs in running other programs and lead to additional editing tasks. Certainly, this will potentially cause more errors.

Following are further observations, after looking at the comprehensive comparison -

1. There are 81 streets/roads that are in TRANSIMS data but not in HGAC data. Similarly, there are 17 streets/roads that are in HGAC data but not in TRANSIMS data. These include the transit centers (or park and ride centers).
2. The peak capacities are not found for all the streets/roads in TRANSIMS data.
3. In TRANSIMS data, the capacity varies as per the number of lanes and not the length/distance of the street/roads, whereas, in HGAC data the capacity varies as per number of lanes as well as length/distance/miles of the individual street/roads. However, this postulate can't be supported statistically, unless we dig the mathematical logic and theory behind the capacity estimation.
4. It does seem like the TRANSIMS missed out completely on considering transit centers and park and ride locations in the simulation.
5. As far as comparisons are concerned, only Holly hall St and Rice blvd fit in the validation standard we set (+/- 15%), in the daily capacities. University blvd's daily capacities in TRANSIMS and HGAC data are quite close. Also, Holcombe blvd's peak capacity comparison does fit in FHWA standard. Rest all occasions fall out of standard validation.

VI. SUMMARY AND CONCLUSION

A. PROJECT SUMMARY

TMC TRANSIMS project was developed to study the TRANSIMS feasibility to TMC area. Research started with the literature review of transportation planning systems, TRANSIMS case studies, TRANSIMS user manual, etc. For data collection different agencies like HGAC, City of Houston, and TMC were consulted. The results from the model seem to be realistic and but not logical, from the comparison of those results with the regional model for validation. So, outputs from HGAC regional model for morning peak period were used. Comparison showed that the volumes from the TRANSIMS model were more than HGAC regional model. The reason is, in TRANSIMS model transit systems in TMC have not been considered. Instead it is assumed that the travelers who actually take bus or train are traveling through a car.

However, after result’s validation, detailed sensitivity tests should be conducted to see if the model changes its behavior depending on factor, so that it can be used confidently for future year forecasting or network study.

B. CONCLUSION

The validation process has five key elements: *context*, *data*, *uncertainty*, *feedback*, and *prediction*. Context is critical: it drives the formulation of evaluation functions or performance measures that are ultimately the grounds on which validation must take place and affect interpretations of uncertainty. For example, statistically significant disparities may, in the context of an application, be practically insignificant. In addition context and the specified evaluation functions can affect the selection or collection of data, both field and model output, to be used for evaluation. Conversely, the availability or feasibility of data collection can determine the choice of evaluation functions. These factors may then converge in the calculation of uncertainties stemming from noisy data and model imperfections. The outcomes of the evaluations and the associated uncertainties point to possible flaws in the models and feedback to model adjustments that correct or, perhaps, circumvent the flaws. Ultimately, it is through prediction that validation of a model is reached.

VII. FUTURE SCOPE

Thus, this project identifies future research pertaining to different validation strategies, as the following -

· A more statistically rigorous comparison of modeled results to field data resulting in improved validation and calibration.
· A detailed analysis of the internal logic (car- following, gap acceptance, etc.) of the TRANSIMS models and comparison to field data related to this logic.
· Analyses incorporating actuation logic at signalized intersections.
· Extension of the analysis to include ramp metering.
· Extension of the analysis to include freeway weaving sections near the study interchange.
· Evaluation of freeway traffic near closely spaced interchanges.

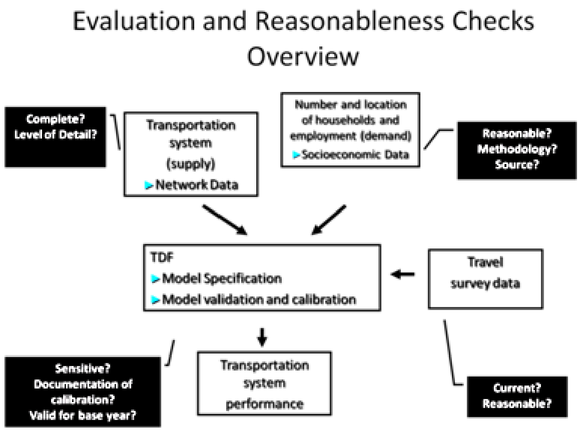

Figure 3 – Evaluation and reasonableness checks overview

(Source - minimum travel demand model calibration and validation guidelines for state of Tennessee by Dr. Fred Wegmann, Jerry Everett)

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