MICHIGAN DEPARTMENT OF TRANSPORTATION

URBAN MODEL CALIBRATION STANDARDS

April 23, 1993

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INTRODUCTION

Computerized travel demand forecasting currently serves as the basis for producing system-level traffic forecasts. These forecasts are used for deficiency analyses, alternative testing and corridor and sub-area studies. The refinement of these forecasts, which is one of the most critical tasks in performing highway project planning and design studies, requires a review and modification of computer model results to ensure their overall accuracy and reasonableness. Fewer modifications to the model output are required for project level analysis if the model is calibrated to high standards.

The downside of high calibration standards is the additional time required to increase the level of accuracy. Federal standards have been set regarding the acceptable accuracy of system-level traffic forecasts. These standards were developed to identify the acceptable level of error in calibrated models in order to meet long range planning requirements and additional highway laneage evaluations. The standards are based on the assumption that the maximum desirable traffic assignment deviation should not affect the number of lanes required to handle the projected volume.

In 1989 the Michigan Department of Transportation established standards which roughly paralleled those at the federal level. However, MDOT has chosen a more rigorous set of standards than proposed by the Federal Highway Administration. MDOT's higher standards were developed because the urban travel demand models were being asked to do things which they were not originally designed to do, such as corridor, sub-area and site impact analysis.

The purpose of this report is to compare MDOT's <u>current</u> standards with the actual results of four recently calibrated models. This comparison allows us to evaluate and adjust the standards to a level which is obtainable using our current methods of model calibration. Based on this evaluation, new urban model standards will be introduced. The MDOT standards which are shown graphically throughout this document illustrate the current standards related to MDOT experience.

CALIBRATION DECISION TREE

The method used to evaluate model accuracy is to make comparisons between simulated and actual base year traffic. Simulated traffic data is based on trips per dwelling unit, trips per capita and average trip length by purpose. These comparisons will often indicate the need to review and, where appropriate, modify the socio-economic data, trip generation variables or other input variables, network configurations and related impedances, so that study area link volumes are better simulated. In calibrating a model, MDOT's approach is to use a calibration decision tree consisting of increasing levels of rigor. Total areawide Vehicle Miles of Travel (VMT) and the base year external station volumes are first validated, followed with the Root Mean Square Error (%RMS) which represents the standard error by volume group. VMT by link type and jurisdiction are then validated, representing comparisons in areawide assigned VMT versus count VMT, by functional class and jurisdiction. Screenlines or cutlines are examined, relating count volumes with assigned volumes. Finally, individual links are calibrated. This procedure becomes cyclical as subsequent calibration steps occur.

EXISTING STANDARDS

The first stage in the MDOT calibration process involves comparing the base year simulated areawide VMT within the study area with the base year VMT obtained from actual traffic count data. MDOT and FHWA have established a standard of no more than five percent error for total VMT. The results of four recently calibrated models, developed by MDOT, were well within the standards with a range of 0.2 to 2 percent deviation.

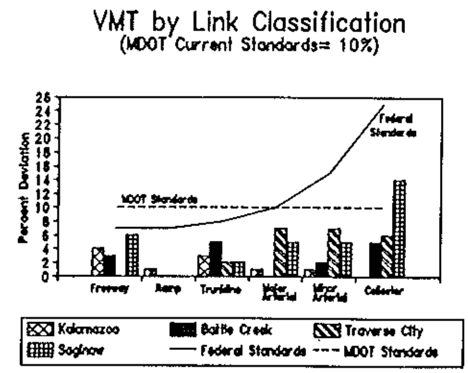

Figure 1

The next stage in the decision tree process is to calculate the Root Mean Square Error percentage. %RMS error is used to identify the average error on links, within volume groups. For example, a %RMS error of 20.0 in the <1000 volume group indicates that there is an average error of 20% on these links. In other words, the assignment is within 20% of the count. A lower %RMS error indicates a better calibrated model.

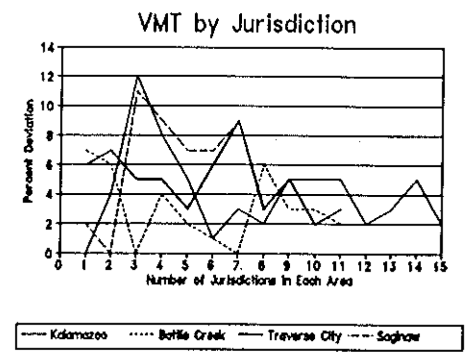

Figure 2

Next, VMT by link type and jurisdiction are validated. Both MDOT and FHWA have established standards based on VMT by link type. The state currently requires that assignments for each link are within 10% of the count. The Federal Highway Administration varies in their standards for link type with less than 7% for freeways, less than 10% for major arterials, less than 15% for minor arterials and less than 25% for collectors. MDOT also has a 10% allowable error for link jurisdiction, while there are no federal jurisdiction standards.

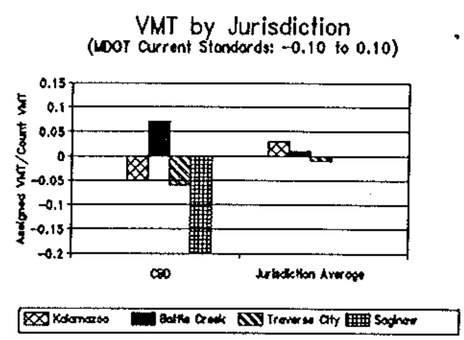

Figure 3

CALIBRATION ANALYSIS

An analysis of four models was conducted to determine to what degree these standards are being achieved. The 1992 models of Traverse City and Kalamazoo, the 1986 model of Battle Creek, and Saginaw's 1985 model were studied. Figure 1 illustrates the computations made for each link type in these models, showing the degree of precision that was achieved. Figure 2 depicts the VMT calculations made in each jurisdiction within the study areas, while Figure 3 illustrates the CBD totals along with an average for all other jurisdictions in each city.

Screenline/cutline refinement procedures, which are the next phase in the decision tree, are tools that are used to improve area type and link type assignments. A screenline is an imaginary line that divides the study area in two sections, usually along a physical barrier (such as a river or road). A study area usually has one, or sometimes two screenlines, depending on its size. Screenline counts are used to check the geographic distribution of trips reported in the Home Interview Survey. The screenline procedure involves comparing the base year traffic assignments, along a screenline, with actual base year traffic counts. The magnitude of deviation between these two values enables the analyst to decide whether to make an initial adjustment to future year link volumes.[1] For the screenline, a summation of assignment to count (A/C) ratios are calculated to determine if enough, or too much, traffic is being generated across the screenline.

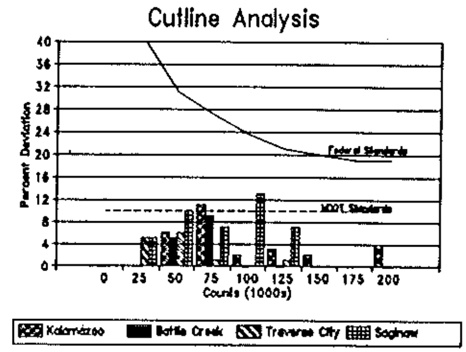

Figure 4

Cutlines are imaginary lines which "cut" across parallel links within a major traffic corridor. For every cutline a summation of A/C ratios are calculated to determine if enough, or too much, traffic is being generated across a major corridor, similar to the screenline procedure. A number of cutlines were established in each study area to aid in calibration and to determine the level of accuracy that was achieved. Figure 4 displays the precision of data at each cutline within the study areas, along with standards established at the federal and state levels. Each bar represents, by volume group, the average level of accuracy that was obtained for each study area. A summary of cutlines in each area follows:

<u>Study Area Cutlines Exceeding Current State Standards</u>

Study Area	# of Cutlines	Greatest Deviation	Lowest Deviation	Median Deviation	# Exceeding Standards
Kalamazoo	10	11%	0%	3%	1
Battle Creek	8	11%	1%	6%	1
Traverse City	6	8%	0%	4%	0
Saginaw	14	20%	0.2%	9%	5

Figure 5 provides a comparison between current MDOT and FHWA standards and actual results using the MDOT modeling process. It compares the median percent deviation in four urban study areas with the state and federal calibration standards. The deviation is expresssed as the %RMS error of link assignment volumes to Average Annual Daily Traffic (AADT) counts for the base year.

The final phase of the decision tree process is to calibrate individual links. The required model accuracy varies according to the volume on each facility. As the AADT on a facility increases, the

[1]*Transportation Research Board, NCHRP Report 255, <u>Highway Traffic Data for Urbanized Area Project Planning and Design</u>, December, 1982, p. 45.*

expected accuracy of the model should increase as well. Therefore, the acceptable deviation is higher on low volume roads where a large percentage deviation will not have major design implications. For example, if a model forecasts an AADT of 5,000 and the actual AADT is 2,000 a design change would not result (based on NCHRP 255's figure of about 10,000 vehicles per lane per day). The number of lanes necessary for an AADT of 2,000 is two lanes and the number of lanes needed for an AADT of 5,000 is still two lanes. The level of accuracy on low volume roads only becomes critical where you are near the capacity of the roadway. In spite of having an error of 150% the required number of lanes remains the same. As the AADT on a facility increases, the expected accuracy of the models should increase as well. For instance, links with an AADT of 100,000 would have an acceptable range of error of ±15% or 85,000 to 115,000, according to the FHWA. The number of required lanes would not change.[2]

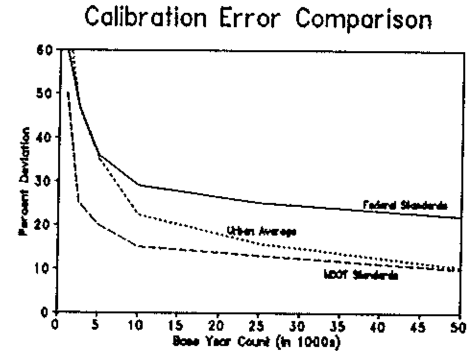

Figure 5

CONCLUSIONS AND RECOMMENDATIONS

An analysis of the four calibrated models shows that the current standards for accuracy have been nearly satisfied, however we offer adjustments to the current standards so that they truly represent our actual results. The ranges of error for total VMT, in these models, are well below the standards set by the federal and state governments. Standards for total VMT by link type have also been satisfied by each model. Deviations from the standard occurred in the A/C ratios for link jurisdiction and %RMS error in the Kalamazoo and Saginaw studies. Traverse City and Battle Creek showed deviations in the %RMS error for links with AADT's less than 10,000. Generally, there is a greater need for accuracy in calibration for high volume links. Therefore, links with lower volumes of traffic receive less concern resulting, at times, in higher degrees of error. The error in cutline analysis was higher for the Saginaw study than in the other models. Although this study did not meet state cutline standards for all link types, it did meet the standards for some link types. Additionally, it met calibration standards for areawide VMT and VMT by jurisdiction and link type.

In model calibration MDOT has strived to achieve a level of accuracy which is more rigorous than the standards set by the FHWA, since our models are used for corridor and subarea travel impact analysis. The purpose of the higher standard level is to minimize the level of adjustment required for project level analysis. Further, the model becomes a much more credible tool for use in policy and project level analysis. It is felt that the four models compared in this analysis are representative of the levels of accuracy which are obtainable in all urban area models.

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[2] *Federal Highway Administration,* *Calibration and Adjustment of System Planning Models,* *December, 1990, p.33.*

Based on this analysis, the Michigan urban model standards are as follows:

VMT Standards
Total areawide VMT: ±5% Assignment/Count
VMT by link jurisdiction= ±10% Assignment/Count

VMT by link classification:

Michigan Group Standards	**FHWA Current Group Standards**
Freeway: ±6% Assignment/Count	Freeway: ±7% Assignment/Count
Ramp: No Standard	Ramp: No Standard
Trunkline: 6%	Trunkline: No Standard
Major Arterial: 7%	Major Arterial: 10%
Minor Arterial: 10%	Minor Arterial: 15%
Collector: 20%	Collector: 25%

Cutline Standards = ±10% Assignment/Count
Screenline Standards = ±5% Assignment/Count

Individual Link Standards (Percent Deviation of A/C volumes on a link-by-link basis):

AADT	**Percent Deviation**	
	MDOT	Federal
<1,000	200	60
1,000-2,500	100	47
2,500-5,000	50	36
5,000-10,000	25	29
10,000-25,000	20	25
25,000-50,000	15	22
>50,000	10	21

* Note: External links are to have 0% deviation.