A Comparison of the VISSIM and CORSIM Traffic Simulation Models

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Abstract

As transportation systems have become more complex and frequently congested, simulation modeling has gained recognition as an effective approach for quantifying traffic operations. Traffic simulation packages like CORSIM and VISSIM can address these types of network issues, and are frequently used as tools for analyzing traffic. However, there is little information available to the analysts applying these models about the most appropriate models to use, or even detailed information about the accuracy of individual models. To address that need, this paper provides a detailed, technical comparison of two popular traffic simulation models (CORSIM and VISSIM).

Overall, CORSIM and VISSIM are perhaps more similar than they are different. Both models are designed to model any combination of surface street and freeway facilities, including most signal control and other operational strategies. Both models provide detailed and focused output, both in tabular format and via animated graphics. The main differences between the two models are in vehicle and driver behavior, primarily in the car-following and gap acceptance logic. However, while the nature of these differences is known, the impacts have not been documented.

To address these issues, a series of investigations was conducted to compare the two models on specific measures like throughput and LOS. CORSIM and VISSIM give similar results for performance data on the standard measures examined here. At an intersection level, the throughput and LOS predictions from the two models were similar, although the results were different in some cases from the HCM predictions. The biggest difference observed is the variability of the models. Fortunately, this issue is easily addressed by making multiple runs. The comparisons were also good for an analysis of design alternatives on a complex, congested urban street network.

1. INTRODUCTION

As transportation systems have become more complex and frequently congested, simulation modeling has gained recognition as an effective approach for quantifying traffic operations. Traditional approaches like the *Highway Capacity Manual* (HCM) *(1)* procedures often do not adequately capture the system impacts of queues and oversaturated conditions. Traffic simulation packages like CORSIM and VISSIM can address these types of network issues, and are frequently used as tools for analyzing traffic. Typically, a single software package (e.g., CORSIM) is selected for a given study; the specific model selected will depend on the circumstances (e.g., the type of facility, and the experience of the staff assigned to apply the simulation model).

However, there is little information available to the analysts applying these models about the most appropriate models to use, or even detailed information about the accuracy of individual models. Comparisons of individual models are infrequently made, especially on "real-life" projects. There are occasional studies that provide a comprehensive summary of model families and individual packages *(2)*, but direct comparisons of applications of specific models are difficult to find in the literature; references *(3)*, *(4)*, and *(5)* are examples.

To address that need, this paper provides a detailed, technical comparison of two popular traffic simulation models (CORSIM and VISSIM). Comments are directed largely at the users of these two models, but they also may be appropriate for the developers to consider. Much is learned about these models with direct comparisons, and it is hoped that the findings documented here will help to advance the knowledge of both models.

The origins of the analysis were a study of design alternatives for State Route (SR) 509 in Seattle, WA where both CORSIM and VISSIM were applied. That study was extended to investigate the two models' capabilities and results on a variety of applications.

The paper begins with a brief discussion of the CORSIM and VISSIM models, comparing the functions, features, and calibration parameters. Then, a more detailed technical comparison is described, including analysis of throughput, intersection level of service (LOS), and travel time variability. The following section summarizes the findings of the assessment of the two models on a congested urban streets network. The final section provides some concluding remarks about the models and the process, recommendations to users, and suggested areas of additional research.

2. COMPARISON OF THE TWO MODELS

2.1 CORSIM

CORSIM *(2, 3, 6, 7)* is a microscopic simulation model designed for the analysis of freeways, urban streets, and corridors or networks. The model includes two predecessor models: FRESIM and NETSIM. FRESIM is a microscopic model of freeway traffic, and NETSIM is a model of urban street traffic. CORSIM's capabilities include simulating different intersection controls (e.g., actuated and pre-time signals); almost any surface geometry including number of lanes and turn pockets; and a wide range of traffic flow conditions. CORSIM is based on a link-node network model. The links represent the roadway segments while the nodes mark a change in the roadway, an intersection, or entry points.

CORSIM was developed and is maintained by the Federal Highway Administration (FHWA). It is run within a software environment called the Traffic Software Integrated System (TSIS), which provides an integrated, Windows-based interface and environment for executing the model. A key element of TSIS is the TRAFVU output processor, which allows the analyst to view the network graphically and assess its performance using animation. Version 4.32 of TSIS is the latest release of the software, as of this writing.

2.2 VISSIM

VISSIM *(8, 9, 10)* is a microscopic, time step and behavior based simulation model developed to analyze the full range of functionally classified roadways and public transportation operations. VISSIM can model integrated roadway networks found in a typical corridor as well as various modes consisting of general purpose traffic, buses, light rail, heavy rail, trucks, pedestrians, and bicyclists. The model was developed at the University of Karlsruhe, Germany during the early 1970s. Commercial distribution of VISSIM began in 1993 by PTV Transworld AG, who continues to distribute and maintain VISSIM today. VISSIM version 3.01 is the latest release of the software, as of this writing, although version 2.91 was used for the analyses described here.

The model consists of two primary components: (1) simulator and (2) signal state generator (SSG). The simulator generates traffic and is where the user graphically builds the network. The user begins by importing an aerial photo or schematic drawing of the study area into the simulator. Next, the user begins "drawing" the network and applying attributes (e.g., lane widths, speed zones, priority rules, etc.). Although links are used in the simulator, VISSIM does not have a traditional node structure. The lack of nodes provides the user with the flexibility to control traffic operations (e.g., yield conditions) and vehicle paths within an intersection or interchange.

The SSG is separate from the simulator. It is where the signal control logic resides. Here, the user has the ability to define the signal control logic and thus emulate any type of control logic found in a signal controller manufacturer's firmware. The SSG permits the user to analyze the impacts of signal operations including, but not limited to: fixed time, actuated, adaptive, transit signal priority, and ramp metering. It is important to note that fixed time control can be implemented in the simulator. The SSG reads detector information from the simulator every time step. Based on the detector information, the SSG decides the status of the signal display during the subsequent time step.

2.3 MODEL COMPARSION

In general, CORSIM and VISSIM have similar structures and capabilities. There are, however, some distinct differences that are noteworthy. First, CORSIM is based on a link-node structure while VISSIM uses links and connectors built over a graphical map. Second, the car-following model in CORSIM sets a desired amount of headway for individual drivers while VISSIM uses the psycho-physical driver behavior model developed by Wiedemann *(8)* in 1974. Finally, while umerous types of output data are available from both models, VISSIM allows the user somewhat more flexibility to specify where and what type of data is to be collected. Another output difference is that CORSIM generates travel times for each link (turn-specific travel times can be generated) which can be aggregated to determine travel time for a particular route. Within VISSIM, travel time routes are specified between two points.

2.4 RELEVANCE FOR MODELERS

Overall, CORSIM and VISSIM are perhaps more similar than they are different. Both models are designed to model any combination of surface street and freeway facilities, including most signal control and other operational strategies. Both models provide detailed and focused output, both in tabular format and via animated graphics. Figures 1 and 2 are screen shots from the two models that illlustrate typical animation output.

The main differences between the two models are in vehicle and driver behavior, primarily in the car-following and gap acceptance logic. The differences in network structure also likely contribute to potential variations in results. However, while the nature of these differences is known, the impacts have not been documented. This is the motivation for the detailed evaluation described in the next section, so that modelers can understand how these differences translate into variations in throughput, intersection LOS, and travel time predicted by the two models.

FIGURE 1
CORSIM Screen Shot

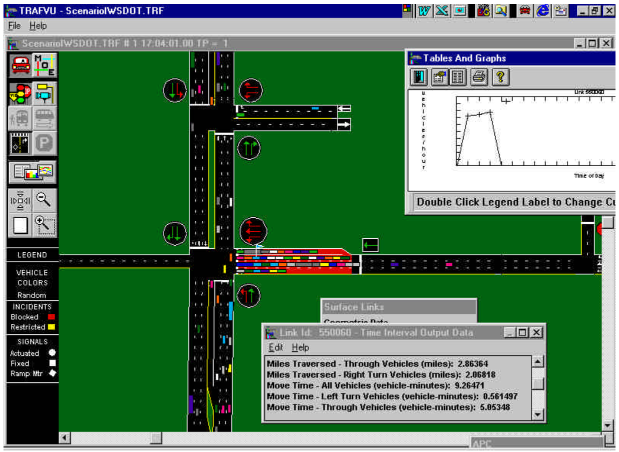


FIGURE 2
VISSIM Screen Shot

3. DETAILED COMPARISON

3.1 THROUGHPUT

A section of roadway from the Seattle SR 509 study was analyzed to compare the throughput volume on a congested facility. The section consisted of three lanes of an approach to a signalized intersection. The intersection was oversaturated and controlled by an actuated signal. To ensure a common basis for comparison, similar input values for saturation flow rates (approximately 1800 vehicles/hour/lane) and start-up lost time (two seconds) were used for both models.

Simulation of the intersection was conducted with both models; the results of 10 simulation runs are reported in Table 1. VISSIM and CORSIM, on average, reported similar throughput across this particular section. VISSIM's throughput was approximately one percent greater than CORSIM's. The variability among the runs, however, was greater for CORSIM than VISSIM as measured by the standard deviation.

TABLE 1: LOCAL COMPARISON OF THROUGHPUT (VEHICLES/HOUR)

Run	VISSIM	CORSIM
	m_{v}	m_{c}
1	1258	1126
2	1245	1270
3	1255	1208
4	1234	1201
5	1244	1244
6	1260	1230
7	1239	1198
8	1238	1278
9	1189	1314
10	1273	1225
Average	1244	1230
Std. Dev.	23	53
Avg. % difference	1.1%	

3.2 INTERSECTION LOS

The analysis described in Section 3.1 was expanded to a full intersection. The intersection was based on one from the SR 509 study, but a variety of permutations were investigated. Specifically, the intersection was loaded with four different levels of traffic, and two different signal controllers were tested (pre-timed and actuated). As before, ten runs were made with both CORSIM and VISSIM.

The results are provided in Table 2. The control delay was determined for the intersection as a whole, and the minimum, maximum, and standard deviation values were noted.

In general, CORSIM and VISSIM agreed in most cases. The LOS was the same for seven of the eight scenarios; CORSIM was barely LOS F for scenario 6, while VISSIM was LOS E. In all cases, both VISSIM and CORSIM predicted worse LOS than the HCM predictions. This is consistent with expectations, particularly for the higher volume scenarios, because HCM does not consider the impacts of limited storage for queues in the turn bays. This phenomenon was most evident in the moderate scenarios, where the NB left-turns spilled back out the turn bay in both CORSIM and VISSIM, blocking the through movements in some cases. The HCM methodologies do not capture this level of detail.

For both CORSIM and VISSIM, the standard deviation of the control de lay increased for the higher volume scenarios. It was interesting to note that the CORSIM deviation was less than that for VISSIM; the opposite as the result reported in Section 3.1. The deviations were highest for the LOS F scenarios, which would likely have little impact on an operational analysis. However, note that in a few cases (scenarios 1, 5, and 6 for VISSIM, scenario 6 for CORSIM) the high and the low intersection delays observed for different runs would give different LOS values. This result underscores the importance of conducting multiple runs, with different random number seeds, when using either model.

TABLE 2: INTERSECTION LOS COMPARISON

Scenario	Description	Intersection Delay (seconds)/LOS								
		CORSIM				VISSIM				HCS
		Mean	StdDev	High	Low	Mean	StdDev	High	Low	Mean
1	Low volume, pre-timed	36/D	0.1	36.4	36.2	36/D	1.4	38.8	33.8	31/C
2	Moderate, pre-timed	75/E	3.1	79.9	71.5	64/E	2.9	69.8	58.6	36/D
3	Heavy, pre-timed	166/F	6.3	176.0	156.2	196/F	10.4	212.6	180.9	94/F
4	Very heavy, pre-timed	321/F	8.5	337.9	308.4	227/F	14.9	258.1	207.2	173/F
5	Low volume, actuated	32/C	0.2	32.0	31.5	34/C	0.9	36.0	33.4	30/C
6	Moderate, actuated	84/F	2.7	78.4	87.3	69/E	10.0	88.6	59.1	34/C
7	Heavy, actuated	96/F	1.8	98.9	93.8	260/F	17.2	282.0	233.4	94/F
8	Very heavy, actuated	291/F	14.5	316.3	261.9	268/F	18.5	301.3	246.4	172/F

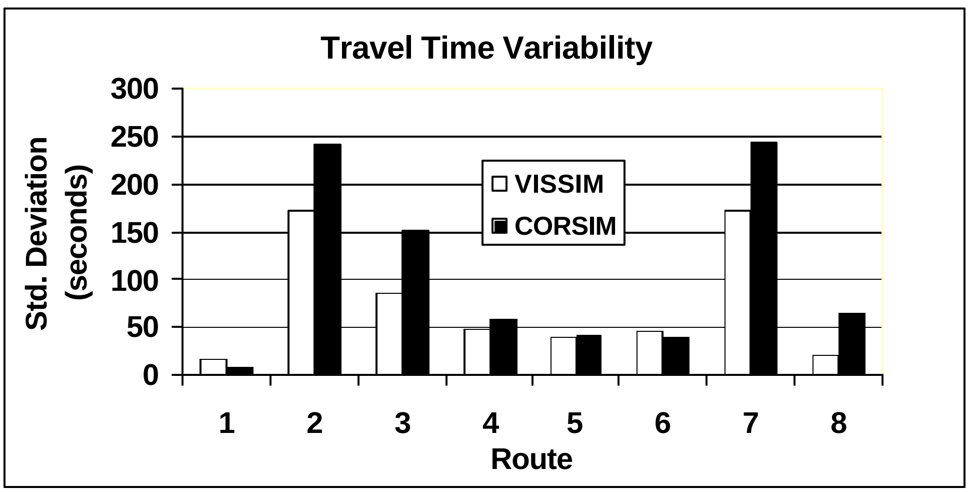
3.3 TRAVEL TIME VARIABILITY

The third detailed comparison of the two models used a higher level measure. Travel time variability was defined as the standard deviation in travel times for various routes on the street network (generally in congested conditions). The travel times reported by the two models for each of 10 simulation runs were aggregated to determine the standard deviation for each route. The results of the travel time variability comparison are reported in Table 3 and illustrated in Figure 3.

TABLE 3: TRAVEL TIME VARIABILITY

ROUTE	Length (feet)	Average TT (seconds)		Standard Deviation of TT (seconds)	
		VISSIM	CORSIM	VISSIM	CORSIM
1	633	84	80	17	9
2	6394	482	594	172	241
3	4630	280	334	86	152
4	4998	236	223	49	57
5	4230	510	534	39	41
6	6210	590	593	46	39
7	5256	444	539	174	243
8	7002	364	357	21	65
	All Routes	2990	3254	196	236

FIGURE 3
Travel Time Variability for the Two Models



Of the eight routes examined, CORSIM produced greater variability than VISSIM on six routes. When all routes were considered, CORSIM (σ = 195.5 seconds) demonstrated about 20% more travel time variability than VISSIM (σ = 235.3 seconds). Although CORSIM exhibited greater variability, Figure 3 reveals that both models exhibited similar trends in the magnitude of variability. In other words, routes where CORSIM exhibited greater or lesser variability, VISSIM did as well.

It is important to note that this comparison, as well as the other comparisons reported in this paper, is highly dependent on the study area. The findings may differ for other networks and other roadway functional classifications, although it is the authors' observation that similar patterns would likely hold.

3.4 RELEVANCE FOR MODELERS

CORSIM and VISSIM give similar results for performance data on the standard measures examined here. At an intersection level, the throughput and LOS predictions from the two models were similar, although the delay predictions were higher than those from the HCM. For congested intersections with complex geometrics, these models may be more appropriate than the HCM methodology.

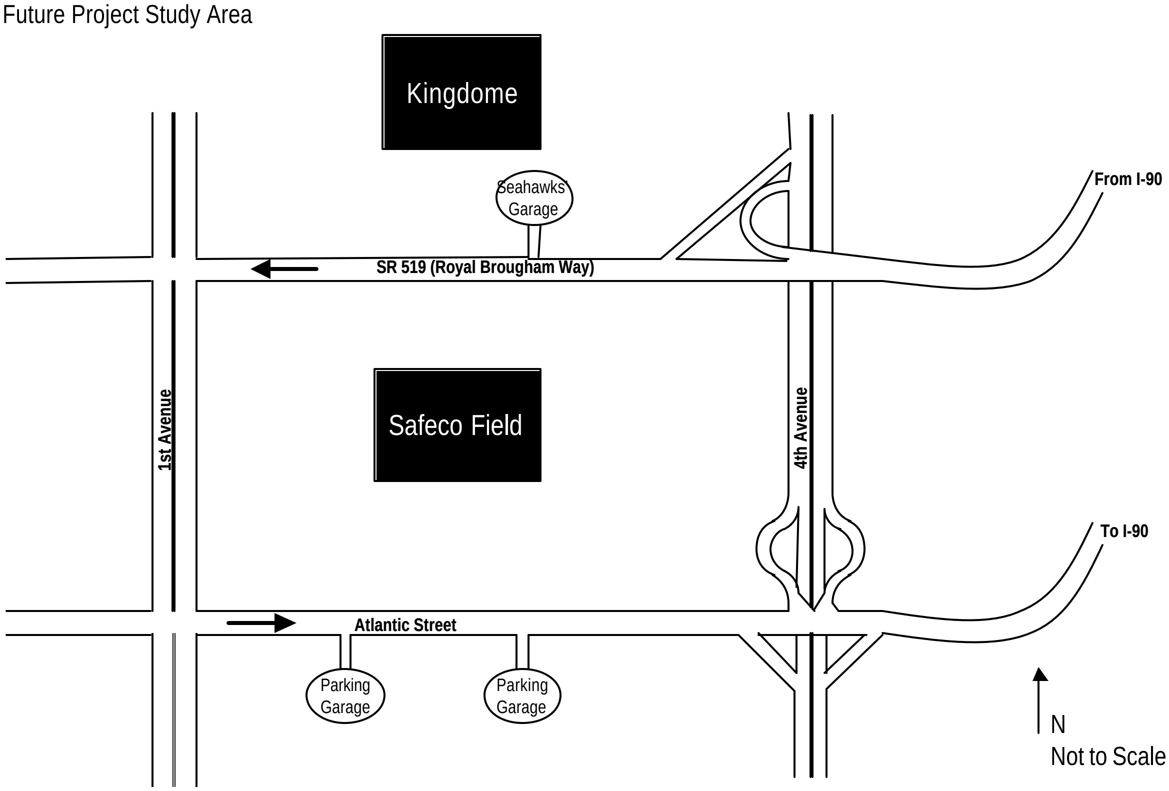
The biggest difference observed is the variability of the models. Modelers often neglect to consider the deviation due to randomness when using models like CORSIM and VISSIM, and it can have a significant impact on the findings.

For low level measures like throughput, the deviation is not particularly high, but becomes more significant for standard performance measures like LOS and travel time. Fortunately, this issue is easily addressed by making multiple runs. The exact number must be determined by an analysis of the variance and a determination of an appropriate confidence interval. However, the results here suggest that ten to twenty runs might be a good starting point.

4. ASSESSMENT ON A CONGESTED NETWORK

To expand the analysis described in the previous sections, an examination of the two models' results on an urban street network is presented. CORSIM and VISSIM were applied as part of the SR 519 alternative analyses conducted for the Washington State Department of Transportation (WSDOT) in 1999. Figure 4 illustrates the future project study area, which is located in downtown Seattle, just south of the Central Business District (CBD). SR 519 and nearby roadways are often highly congested during the peak periods. WSDOT identified the need for physical improvements to the roadway network to eliminate an at-grade railroad crossing, to improve overall traffic performance, and to accommodate future growth. Six design alternatives were analyzed using forecasted 2020 demands during the PM peak period when an event (baseball game) was scheduled.

FIGURE 4
Future Project Study Area



4.1 MODEL APPLICATION

Simulation modeling described in this paper was undertaken to help quantify the benefits and impacts of different alternatives. The study network and design alternatives were coded in both VISSIM and CORSIM. The analysts developing the two models frequently communicated to ensure that the same supply, demand, and control assumptions were used in both models. However, since one goal for this study was to compare the results of VISSIM and CORSIM, the two models were developed independently to allow a fair comparison between the two sets of results.

Coding, testing, and validation of the simulations were completed, and a series of model runs and analyses were conducted. Ten (10) runs were made for each design alternative and model, since both VISSIM and CORSIM are stochastic (random) models.

4.2 RESULTS

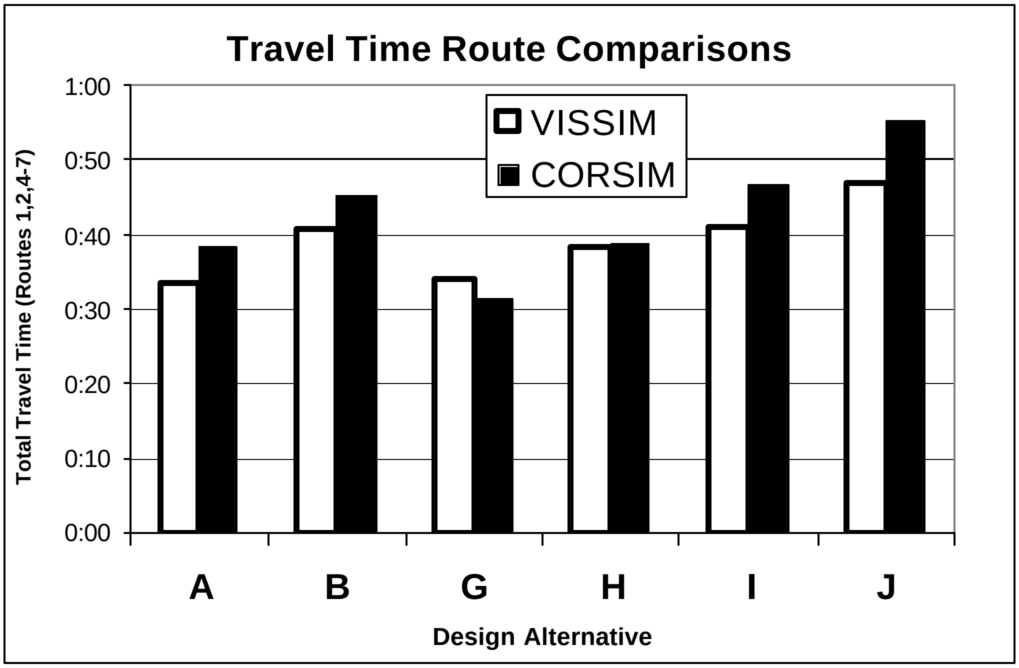
A comprehensive quantitative analysis of the VISSIM and CORSIM outputs for the SR 519 study was conducted, and is discussed below. The results best suited to comparing the two models are a comparison of travel time (for specific routes and the system as a whole), and the sensitivity of travel time to demand changes.

Route-Specific Travel Time

Route-specific travel time was used to compare predicted travel times from specific routes (i.e., 1, 2, 3, etc.) for various design alternatives for the two models. Forty-two (42) comparisons were made, and there was only one case where the difference in travel time between the two models was more than forty percent (40%). Thirty-three (33) of the comparisons were within twenty percent (20%). Also, VISSIM and CORSIM were found to agree on whether or not the travel times are significantly higher for specific design alternatives.

System travel time was also evaluated. Figure 5 is comparison of the total travel time for six routes (1, 2, 4, 5, 6, and 7) for each scenario. These six routes represent a range of typical trips in the network, so adding up the travel time may be a reasonable measure of the relative system traffic performance of each design alternative. Note that VISSIM and CORSIM are consistent in suggesting that the total travel for various design alternatives. For example, design alternative G consistently had the lowest total travel time for both models, while design alternative J had the highest. Overall, CORSIM travel times are 9% greater than VISSIM, although the difference ranges from –8% to 18%, depending on the design alternative.

FIGURE 5
Travel Time Comparison for Selected Travel Time Routes



Travel Time Sensitivity Analysis

Figures 6 and 7 present the results of a sensitivity analysis for the design alternative comparisons (for CORSIM and VISSIM, respectively). To test the sensitivity of the results to demand changes, two additional sets of simulation runs were completed. One set of runs used traffic demands 10% higher than the base case (110% demand). The other set used traffic demands 10% lower (90% demand). Figures 6 and 7 suggest that travel times are sensitive to the level of traffic demand, as would be expected. Also, it suggests that the relative comparisons between the scenarios are consistent even with higher or lower traffic demands.

FIGURE 6
CORSIM Sensitivity Analysis

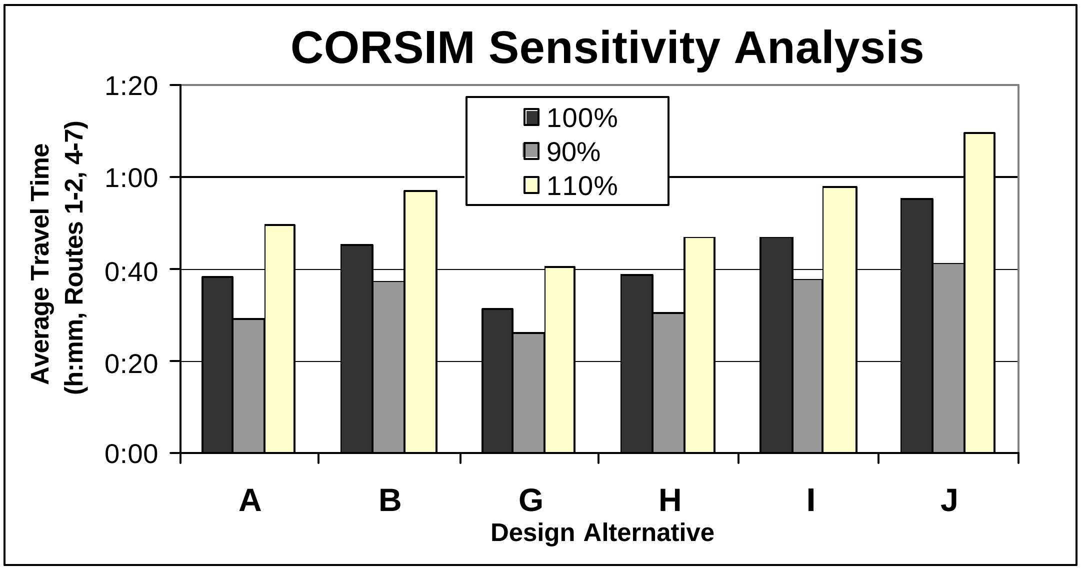
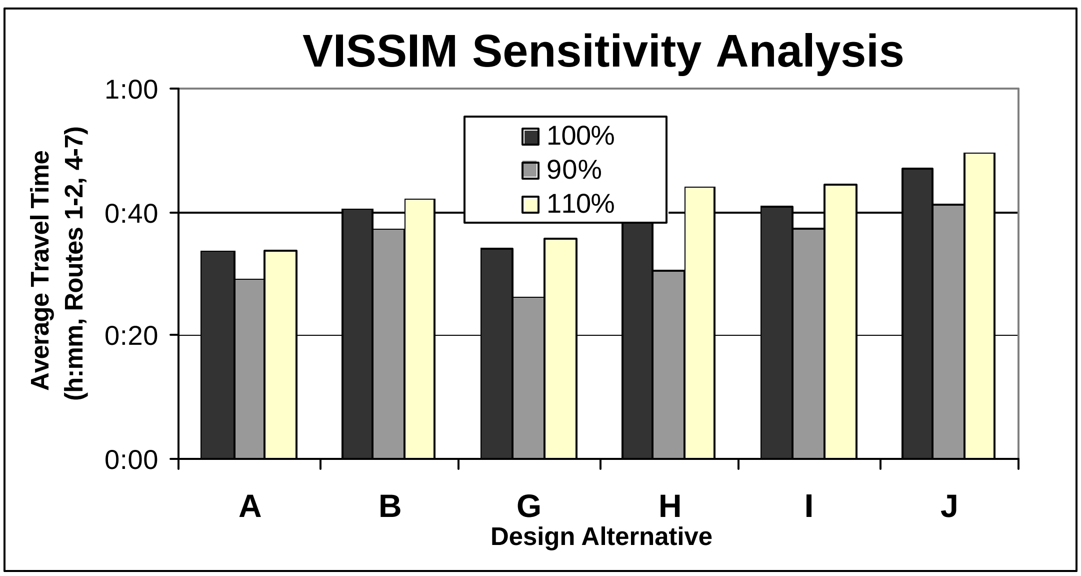


FIGURE 7
VISSIM Sensitivity Analysis



5. CONCLUSIONS

The authors have worked on a wide range of projects and studies where traffic simulation models have been applied. This experience, plus reviews of others' work, has suggested that there is a wide range of approaches used when applying simulation models. This leads to the conclusion that it may be appropriate to develop recommendations for applying these tools to traffic analyses. A full treatment is beyond the scope of this paper, but some general comments are provided here, based on detailed analyses of the two models described in this paper.

Overall, CORSIM and VISSIM are perhaps more similar than they are different. However, there are documented differences between the two models at the program level, related to vehicle and driver behavior, primarily in the car-following and gap acceptance logic. This research has been a step towards understanding the impacts of these differences in terms of model results for traffic analysis.

The comparison of the two models on specific measures like throughput and LOS was generally good. At an intersection level, the throughput and LOS predictions from the two models were similar. There were differences from the HCM predictions, and for congested intersections with complex geometrics, these models may be more appropriate than the HCM methodology. The biggest difference observed is the variability of the models, which should be addressed by making multiple runs.

At a higher level, relative travel times were consistent between the models and lead to the same conclusions about design options. However, there were differences in the absolute predictions of the two models for some scenarios. The analysis suggested that both models are appropriate for modeling congested arterial street conditions, but suggested the value of using more than one model for traffic analysis. In this case, data were available from two models, for multiple performance measures, and for a range of demand scenarios. The results were generally consistent, and the end product was a set of clear, defensible, and well-supported conclusions about the performance of the design alternatives.

The driver for this work was that simulation model comparisons have been performed at a very high level where only the features among the models are compared. In some instances, professionals perform the comparisons with little knowledge or detailed experience with the simulation models being compared. Although the effort presented in this paper provides a more detailed comparison, it still remains a relatively broad comparison between two models as they are applied to selected performance measures for pre-defined scenarios. The lack of detailed comparisons provides an opportunity for further research. Some of the areas that appear ripe for further comparative research include:

- More statistically rigorous comparisons among a wide variety of models applied (a) to the same network and (b) to roadways of different functional classifications;
- An analysis of the number of runs needed to achieve results within a given confidence interval;
- Comparisons of the two models to field data;
- A more complete sensitivity analysis of performance measures (e.g., delay, travel time, etc.) based on varying (a) demand volume levels and (b) traffic compositions; and
- A document summarizing comparison of the internal logic (e.g., car-following, lane change, and gap acceptance) of the models.

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