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Determining the Feasibility of using Micro Simulation to asses safety of Pedestrian Crossings

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DETERMINING THE FEASIBILITY OF USING MICRO SIMULATION TO ASSESS SAFETY OF PEDESTRIAN CROSSINGS

by

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ABSTRACT

For the past several decades, pedestrian safety has been an oncoming issue that has thrown the area of transportation engineering into a frenzy. Pedestrian safety has become predominantly one of the leading causes of fatalities in traffic accidents. Florida has been reported as one of the leading states in pedestrian fatalities with 2.56 fatality rate per 100,000 population and about 20 percent of all traffic fatalities in the state of Florida. Nonetheless, as research is being done and hypotheses are being calibrated and produced, there has to be a way of measuring and determining the number of pedestrian-to-vehicle conflicts without having to yet apply the system on the field without further validation. Moreover, pedestrian-to-vehicle conflicts have been a rising issue in correlation to the pedestrian fatalities. The fact that the highway safety manual has limited information about crash modification functions for pedestrian and that pedestrian fatality is a rare event, it is worthwhile identifying and adopting surrogate safety measures for pedestrian. Thus, having the capability to analyze various surrogate safety measures within the confines of micro simulation would be a great contribution to real-world application. As a result, the purpose of this thesis is to determine the feasibility of using micro simulation to assess safety of pedestrian crossings using specifically VISSIM and SSAM. During this study, a great deal of data extraction was taken from videotapes collected at nine various intersections, each with its own environmental and geometrical factors. Various parameters were taken from the different sites in order to calibrate and validate VISSIM and SSAM. The parameters included traffic and pedestrian volumes, walking speeds, crossing times, signal timings, and pedestrian-to-vehicle conflicts. During this study, an extensive amount of analysis testing was done in order to obtain the optimum threshold within various combinations of thresholds that would define the pedestrian-to-vehicle conflicts. The analysis was initiated for the

time to collision (TTC) and post encroachment time (P.E.T) thresholds. This is done so that the typical scenario of an intersection can be analyzed and comparisons can be made efficiently between observed and simulated conflicts. There were 55 combinations of TTC and PET thresholds produced that were also statistically calculated using the mean absolute percent error (MAPE) in order to determine the most efficient threshold for all 9 intersections. Calibration also was done for parameters in VISSIM that included the safety distance factor (SDF) and the Add-stop distance to assess the sensitivity of these parameters in computing the number of pedestrian-to-vehicle conflicts. These thresholds and factors were used for further validation and assessment of the feasibility of the SSAM and VISSIM model. Data results displayed that the simulated conflicts and the observed conflicts illustrated reasonable correlation. However, even with the feasibility of VISSIM and SSAM being validated, there still are questions that arise pertaining to whether VISSIM and other micro simulation can assess real-world driver behavior and the unpredictability of driver maneuvering. More research with more intersections are recommended to be done.

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INTRODUCTION

For the past several decades, pedestrian safety has been an oncoming issue that has thrown the area of transportation engineering into a frenzy. Traffic fatalities has increased to be one of the leading causes of death in the United States and pedestrian fatalities is counted to be a great number in that category. In the U.S alone, about 32,000 fatalities occurred in 2013 according to the crash database and pedestrian fatalities accounted for 14 percent of that count. Various factors can be alluded to as to the cause of pedestrian crashes such as inebriation, other intoxication, speeding, possible physical environments, pedestrian-to-vehicle conflicts, and other aggressive driving behavior. Furthermore, in the state of Florida, pedestrian fatalities are even more of a problem as the pedestrian fatality rate is significantly higher than the national rate. Florida has a 2.56 fatality rate per 100,000 population in comparison to the national rate of 1.50 (FARS Encyclopedia). It can be shown below the national statistics for pedestrian fatalities in comparison to other states of the U.S of high pedestrian deaths in two categories of pedestrian fatalities as well as pedestrian fatality rates.

Table 1: National Annual Pedestrian Traffic Fatalities

U.S Annual Pedestrian Traffic Fatalities			
Year	Total Fatalities	Pedestrian Fatalities	Percent of total fatalities
2003	42,884	4,774	11
2004	42,836	4,675	11
2005	43,510	4,892	11
2006	42,708	4,795	11
2007	41,259	4,699	11
2008	37,423	4,414	12
2009	33,883	4,109	12
2010	32,999	4,302	13
2011	32,479	4,457	14
2012	33,561	4,743	14

Table 2: Top Ranked U.S States in Pedestrian Fatalities in 2013(NCSA Publications & Data Requests)

Most State total pedestrian fatalities 2013						
Rank	State	Pedestrian Fatality Rate per 100,000 population	**Pedestrian Fatalities**	Percent of Total	Total Traffic Fatalities	Resident Population (thousands)
1	California	1.83	701	23.37	3,000	38,333
2	Florida	2.56	501	20.81	2,407	19,553
3	Texas	1.81	480	14.19	3,382	26,448
4	New York	1.70	335	27.94	1,199	19,651
5	Georgia	1.76	176	14.93	1,179	9,992

Table 3: Top Ranked U.S States in Pedestrian Fatality Rates in 2013(NCSA Publications & Data Requests)

Greatest pedestrian fatality rate 2013						
Rank	State	**Pedestrian Fatality Rate per 100,000 population**	Pedestrian Fatalities	Percent of Total	Total Traffic Fatalities	Resident Population (thousands)
1	Delaware	2.70	25	25.25	99	926
2	Florida	2.56	501	20.81	2,407	19,553
3	Montana	2.36	24	10.48	229	1,015
4	New Mexico	2.35	49	15.81	310	2,085
5	Nevada	2.33	65	24.81	262	2,790

From observation, it can be seen that Florida is not only ranked amongst the top states in pedestrian fatalities and fatality rates, but has ranked number 2 in both categories. Furthermore, *Dangerous by design* reports that Florida is ranked number one using the Pedestrian Danger

Index (PDI). This has not only been a problem during the year of 2013, but has been an issue for the past decade. The following table displays the pedestrian statistical rates from 2003 as well as the number ranking for the corresponding years. With the exception of the years 2006 and 2012, Florida has ranked in number 2 in pedestrian fatality rate for majority of the past decade. It can also be seen that the population has increased over the years with the number of pedestrian fatalities remaining constant. Furthermore, the percent of pedestrian fatalities in relation to total traffic fatalities has also increased over the years indicating the severity of the issue of pedestrian safety.

Table 4: Florida Annual Pedestrian Traffic Fatalities

Florida Annual Pedestrian Traffic Fatalities						
National Ranking	Year	Total Fatalities	Pedestrian Fatalities	Percent of total fatalities	Pedestrian Fatality Rate per 100,000 population	Population (thousands)
2	2003	3,169	500	15.78	3.17	17,004
2	2004	3,244	493	15.20	2.83	17,415
1	2005	3,518	571	16.23	3.20	17,842
3	2006	3,357	544	16.20	2.99	18,167
2	2007	3,213	530	16.50	2.89	18,368
1	2008	2,980	490	16.44	2.64	18,527
1	2009	2,560	467	18.24	2.50	18,653
1	2010	2,444	486	19.89	2.58	18,846
1	2011	2,400	490	20.42	2.57	19,083
5	2012	2,431	477	19.62	2.47	19,321
2	2013	2,407	501	20.81	2.56	19,553

If the population has increased and yet the percent of pedestrian fatalities to total traffic fatalities has also increased, it brings the question of whether pedestrian safety are being considered or whether effective countermeasures are being implemented.

Nonetheless, as research is being done and hypothesis are being calibrated and produced, there has to be a way of measuring and determining without having to yet apply the system on the field with further validation.

For several years, research have been in study, conducted, and in debate as to the feasibility of micro-simulation and whether it can effectively be used to measure traffic safety. In particular, pedestrian-to-vehicle crashes has been an area of topic which has accumulated limited knowledge as it pertains to micro simulation and the use of it to project pedestrian-to-vehicle conflicts. The fact that the highway safety manual has limited information about crash modification functions for pedestrian and that pedestrian fatality is a rare event, it is worthwhile identifying and adopting surrogate safety measures for pedestrian. The purpose of this thesis is to determine the feasibility of using micro simulation to assess safety of pedestrian crossings using specifically VISSIM and SSAM. VISSIM is a software that is generally used to simulate motor-vehicles and helps in developing a model based system for dynamic simulation. VISSIM has always been a tool used to simulate various scenarios of traffic and calibrating particular parameters such as vehicle travel times, volumes, delay, signal timing, etc. However, there are various safety measurements that VISSIM does not project. Thus, the establishment of SSAM (Surrogate Safety Assessment Model) is implemented which combines micro-simulation with automated conflict analysis that projects vehicle-to-vehicle conflicts. Conversely, since SSAM only computes vehicle-to-vehicle conflicts, it would be difficult to assess safety as it pertains to pedestrian. One of two methods can be implemented as it pertains to assessing pedestrian safety with micro simulation, specifically VISSIM; to use the default settings that are coded for pedestrian behavior or to assume that pedestrians behaves like a vehicle and to set the pedestrian as a vehicle and set other various parameters to iterate pedestrian-like behavior. The latter is used so that the data can be transferable to the SSAM model, converting it to trajectory files, and evaluating pedestrian conflicts in that manner. The methodology is later explained in this thesis as to the process of executing this calibration and validation of VISSIM and SSAM. There were some interesting findings and results that brought both consideration and inquiries as to whether this system model can be utilized.

BACKGROUND RESEARCH

As mentioned before there are two methods of calibration of pedestrian behavior in VISSIM; to use the default settings that are coded for pedestrian behavior or to assume that pedestrians behaves like a vehicle and to set the pedestrian as a vehicle and set other various parameters to iterate pedestrian-like behavior. In past research, it has been validated that the car-following algorithm can be used to effectively compare and determine pedestrian and vehicle flows as it relates to realistic scenarios in the field (Ishaque and Noland 2009). Parameters used in this research were related to that of flow, density, and speed in order to calibrate speed-flow curves and to compare the various widths of crosswalks in correspondence to pedestrian speed. If the flow of the pedestrian and vehicles can simulate real-life scenarios using the car-following algorithm, then the same algorithm can be used in micro simulation and calibration towards the concept of pedestrian-to-vehicle conflicts. Furthermore, in (Lownes and Machemehl 2006), an in-depth calibration was done for various parameters in microsimulation that affect simulation capacity. Moreover, combinations of these parameters were utilized to further understand and obtain more information on various components and the values that will have the simulation model run proficiently. Although this research was done for vehicle, it could give insight as to the possible factors that may also affect pedestrian safety. In other research (Huang et al 2013), a two stage calibration was used in order to reduce the mean absolute percent error of the comparisons between the simulated number of conflicts and the observed number of conflicts. In this 2nd stage, calibration was done for 3 different conflict types in SSAM; rear-end, crossing, and lane-changing conflicts. The mean absolute percent error (MAPE) is a calculation method used to measure the difference between observed and simulated number of conflicts for intersections in traffic modelling. Thus, for vehicle-to-vehicle conflicts, extensive calibration may be used in order to obtain a reasonable and acceptable value of the percent difference for the number of conflicts as it was for this research.

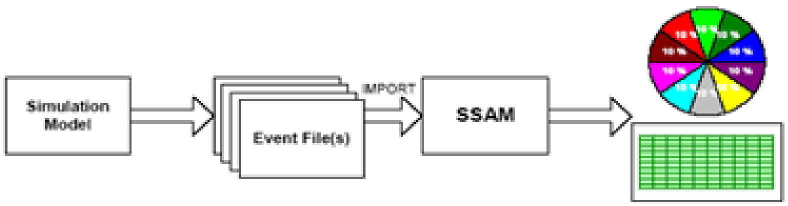

Figure 1: Procedure for calibrating and validating VISSIM simulation models and SSAM

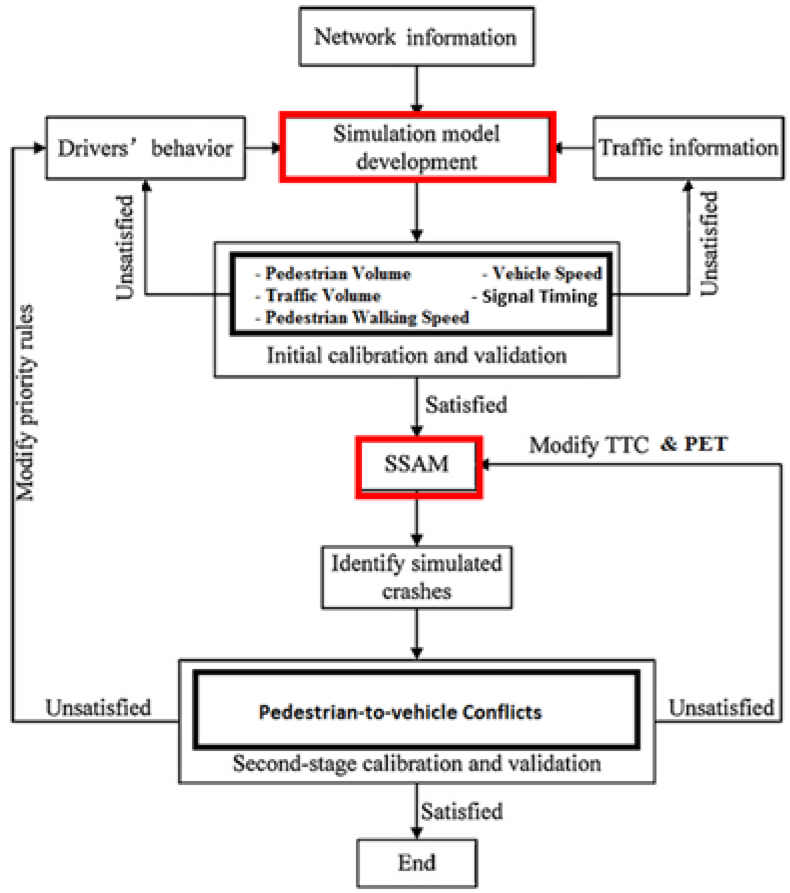

Figure 2: Procedure for calibrating and validating VISSIM simulation models and SSAM (Huang, Liu, Wang)

The procedure for calibrating and validating VISSIM and SSAM can be seen in Figure 1 above. This is a procedure used for the calibration and validation of the aforementioned software in order to acquire safety surrogate measures for vehicle-to-vehicle conflicts (Huang, Liu, and Wang 2012). In this literature review, the mean absolute percent error (MAPE) was deemed to be acceptable for the rear-end conflicts and total conflicts as it pertained to the correlation of simulated conflicts with observed conflicts.

Despite the various models and distributions that are produced in the experimentation and research of traffic analysis, VISSIM continues to be the software predominantly used for simulation of traffic in order to obtain the capacity data. In one research (Xiaoming et al. 2009), the data input were of mixed traffic conditions in which the presence of pedestrians and bicyclists were most evident in exclusive turning lane capacities (left turns or right turns). Comparisons between simulated runs of traffic conditions and before-after studies have been conducted in order to implement a sufficient method of calibrating vehicular conflicts. In order for countermeasures to be considered for an intersection, sufficient evaluations of various scenarios must be implemented to determine the effectiveness of the newly produced safety measure. A study by (Shahdah, Saccomnno, and Persaud-2013) was conducted to show the proficiency of evaluating effectiveness of countermeasures based upon simulated traffic conflicts and the results displayed the consistency of the data that yielded crash modification factors in comparison to a conventional Empirical Bayes method before and after analysis. Many other applications of traffic are used in sync with VISSIM in order to produce analytical data pertaining to traffic operations. In past research (Ge, Qiao, Menendez 2012), an extensive calibration of VISSIM was conducted in order to pinpoint the most important or sensitive parameters that can affect the modelling. As a result, five parameters were deemed to have what they called Total Sensitivity Index (TSI) in which one of the parameters were Safety distance reduction factor which was one of the factors assessed in our results. Thus, it is imperative that more research is done in calibrating this parameter for further study in pedestrian safety. As a result, this thesis implements a further study to calibrate and validate the combinational utilization of VISSM and SSAM for pedestrian-to-vehicle conflicts at signalized intersections.

METHODOLOGY

Field Data

The first procedure in calibrating the VISSIM model was to gather field data from various intersections with various scenarios of pedestrian-to-vehicle conflicts. A field data collection was designed for nine intersections with each one having different geometric and environmental factors. The criteria for selecting these nine intersections were based on the following:

- Total No. of Pedestrian crashes (annually) → > 6
- No. of Pedestrians (daily) → > 300
- No. of Fatalities (annually) → >0

Any intersection with at least one fatality was automatically chosen as that is crucial for pedestrian safety assessment. Thus, there were a couple intersections that had 1 fatality with at least 300 pedestrian volume and 6 annual crashes. Thus, these numbers were selected as the minimal criteria for the selection of the intersections. With each intersection having their own elements factored in, the volume and distribution of pedestrians also varied. The intersections are as followed; Orange Ave & Central Boulevard, Primrose Drive & Colonial Drive, Silver Star & Hiawassee Road, Sand Lake Road & International Drive, Kirkman Road & Conroy Road, John Young Parkway & Colonial Drive, Michigan Street & Orange Avenue, Semoran Boulevard & Pershing Avenue, Curry Ford Road & Semoran Boulevard. There were intersections located near Orlando downtown with heavy pedestrian volume or near the theme parks where both pedestrian and vehicle volume would be high. For each intersection, cameras were installed for recording. Video cameras were installed at high elevation for adequate viewing of the whole intersection.

Recording was initiated for 24 hours for 2 days out of the week but only one day of recording was extracted. During data extraction, only 6 hours were extracted within the hours of what was assumed to be the peak hours of the day; 9am to 12pm and 3pm to 6pm. Parameters that were recorded from the field included: vehicle volumes, pedestrian volumes, pedestrian walking speed, pedestrian crossing time, and the pedestrian-to-vehicle conflicts. Vehicle and pedestrian volumes were recorded using traffic data collection tools such as Miovison and a Jamar Box with 15-minute intervals. The vehicles per hour and pedestrians per hour can be seen in the table below for the observed data results.

Table 5: Observed Vehicle volumes per hour and Pedestrian volumes per hour for each intersection

Observed										
Intersection Name	Date	Start Time	Eastbound		Southbound		Westbound		Northbound	
			vph	ped/h	vph	ped/h	vph	ped/h	vph	ped/h
Orange Ave & Central Blvd	3/25/2015	9:00 am-10:00 am	147	55	869	35	161	55	0	55
		10:00 am-11:00 am	148	65	853	46	159	68	0	39
		11:00 am-12:00 pm	177	130	956	79	159	138	0	65
		3:00 pm-4:00 pm	209	132	1039	52	188	114	0	79
		4:00 pm-5:00 pm	264	97	1130	66	207	118	0	69
		5:00 pm-6:00 pm	258	92	1014	66	217	120	0	58
Primrose Dr & Colonial Dr	3/26/2015	9:00 am-10:00 am	1243	8	81	14	1684	1	188	4
		10:00 am-11:00 am	1386	11	75	9	1649	2	176	7
		11:00 am-12:00 pm	1581	4	74	19	1845	4	244	8
		3:00 pm-4:00 pm	1864	14	113	29	1888	4	280	10
		4:00 pm-5:00 pm	1938	11	106	17	1802	6	331	9
		5:00 pm-6:00 pm	1955	11	118	16	1937	1	358	8

Silver Star & Hiawassee Rd	3/25/2015	9:00 am-10:00 am	778	15	988	23	783	7	700	14
		10:00 am-11:00 am	834	12	836	19	818	4	658	8
		11:00 am-12:00 pm	762	13	816	21	779	15	868	11
		3:00 pm-4:00 pm	947	16	909	13	1107	15	995	8
		4:00 pm-5:00 pm	974	12	917	29	1259	30	1220	19
		5:00 pm-6:00 pm	1056	12	1098	22	1390	10	1235	15
Sand Lake Rd & I-Drive	3/24/2015	9:00 am-10:00 am	1554	24	706	19	856	52	541	20
		10:00 am-11:00 am	1385	26	688	12	942	36	689	18
		11:00 am-12:00 pm	1432	37	650	23	1048	79	748	38
		3:00 pm-4:00 pm	1433	38	615	22	1177	73	979	17
		4:00 pm-5:00 pm	1446	47	700	8	1249	43	1020	32
		5:00 pm-6:00 pm	1443	67	785	17	1152	65	1345	30
Kirkman Rd & Conroy Rd	4/1/2015	9:00 am-10:00 am	754	4	1084	1	1178	1	1360	5
		10:00 am-11:00 am	737	8	957	11	1043	7	1327	16
		11:00 am-12:00 pm	833	4	1101	6	1102	3	1495	12
		3:00 pm-4:00 pm	1088	16	1814	1	1271	3	1826	11
		4:00 pm-5:00 pm	1176	0	1879	17	1248	21	1819	0
		5:00 pm-6:00 pm	1468	9	1927	10	1311	16	1981	47
JYP @ Colonial Drive	1/27/2016	9:00 am-10:00 am	1618	2	1749	6	934	2	1520	7
		10:00 am-11:00 am	1135	3	1533	5	951	4	1449	2
		11:00 am-12:00 pm	1112	5	1297	13	1134	2	1280	5
		3:00 pm-4:00 pm	1449	1	1623	9	1420	1	1503	13
		4:00 pm-5:00 pm	1413	2	1684	8	1453	3	1731	16
		5:00 pm-6:00 pm	1554	12	1859	10	1578	10	1890	26
Michigan Street @ Orange Ave	1/27/2016	9:00 am-10:00 am	885	6	794	3	1273	5	1388	5

		10:00 am-11:00 am	843	4	846	4	920	5	1199	5
		11:00 am-12:00 pm	804	5	953	2	914	3	1203	6
		3:00 pm-4:00 pm	968	5	1172	7	976	6	1315	6
		4:00 pm-5:00 pm	1038	6	1310	4	896	8	1346	9
		5:00 pm-6:00 pm	1072	2	1371	4	906	7	1416	6
Semoran Blvd & Pershing Ave	4/15/2015	9:00 am-10:00 am	279	4	1622	9	695	4	1445	5
		10:00 am-11:00 am	249	6	1653	6	620	3	1418	5
		11:00 am-12:00 pm	339	10	1786	5	627	3	1439	9
		3:00 pm-4:00 pm	468	7	1937	5	814	5	1978	8
		4:00 pm-5:00 pm	534	21	2219	10	770	5	2068	10
		5:00 pm-6:00 pm	627	7	2300	6	847	10	2383	7
Curry Ford Rd @ Semoran Blvd	1/27/2016	9:00 am-10:00 am	659	0	1785	0	1079	5	1761	8
		10:00 am-11:00 am	653	4	1847	7	1077	5	1416	3
		11:00 am-12:00 pm	718	14	1477	1	952	4	1442	12
		3:00 pm-4:00 pm	968	6	1812	5	977	7	1644	6
		4:00 pm-5:00 pm	1089	3	2052	1	991	6	1678	5
		5:00 pm-6:00 pm	1089	9	1410	5	959	0	1878	14

Pedestrian walking speed were calibrated from the crossing times which were also counted manually. The time of crossing would start when the pedestrian would leave the curb and step on the road and the time would end once the pedestrian has completely cleared the roadway onto the sidewalk. A conflict is the event in which two road users (vehicle or non-motor vehicle) are approaching each other in a traffic flow situation in such a way that a collision may occur unless one party takes an evasive action such as braking or some other form of maneuvering to avoid collision. Thus, for the pedestrian to vehicle conflict it was at the discretion of the observer to record a conflict that displayed such action between a vehicle and pedestrian where the drive could have potentially crashed into the pedestrian within 9.99 seconds of encroachment time. This number is used because that is the maximum number (9.99) for the PET threshold used in SSAM. Thus, any recordings that displayed a PET of 10 seconds or greater was discarded. Therefore, the recorded PET times were to be within 9.99 seconds for the use and analysis of SSAM. Other parameters that will be calibrated in VISSIM were also taken from the field such as crosswalk length, crosswalk width, speed limit of each approach, number of lanes, and signal timings from each respective intersection.

Definitions

Below are the definitions of the variables and surrogate safety measure subsets from SSAM. The primary terms assessed and studied extensively were the TTC and PET. Other variables from the SSAM excel output gave results for speed analysis such as the deceleration rate which describes a vehicle's possible behavior of braking when approaching a pedestrian for a probable conflict. If the deceleration rate is a positive number, then the vehicle is not slowing down and therefore shortens the TTC and the PET. There are no specific parameters that directly affect the deceleration rate from VISSIM except to reduce the speed or provide speed yield configuring as it relates to the vehicle and pedestrian interaction. The yielding was accounted for using the conflict areas of VISSIM.

TTC is the minimum time-to-collision value observed during the conflict. This estimate is based on the current location, speed, and trajectory of two vehicles at a given instant.

PET is the minimum post encroachment time observed during the conflict. Post encroachment time is the time between when the first vehicle last occupied a position and the second vehicle subsequently arrived at the same position. A value of 0 indicates an actual collision occurred. The following figures displays illustrations of TTC and PET, respectively.

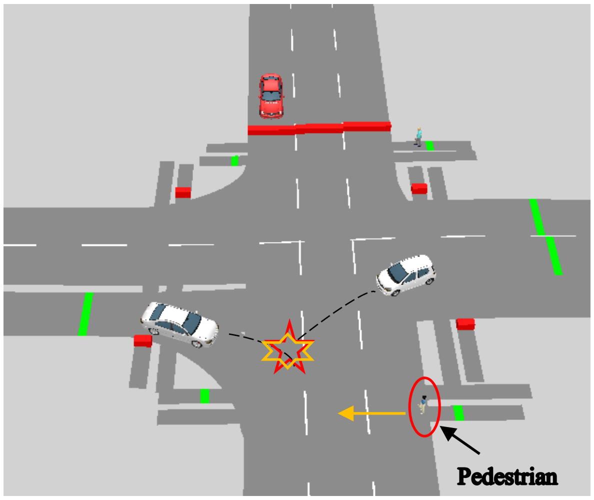

Figure 3: TTC - Time to Collision

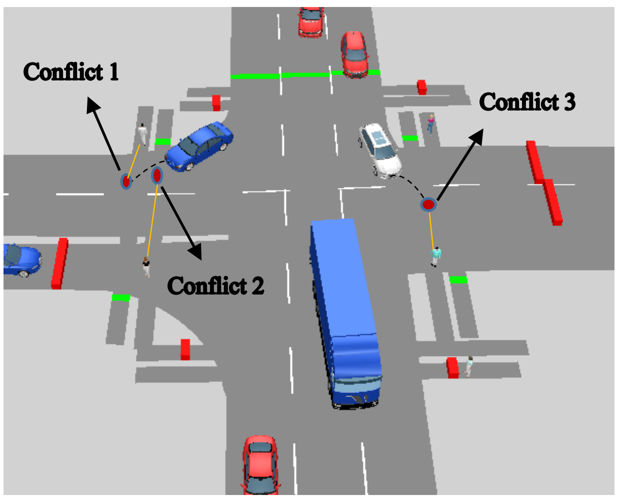

Figure 4: PET - Post Encroachment Time of Pedestrian-to-vehicle conflict

VISSIM/SSAM Calibration

During the process of configuring VISSIM, there are a few provisions a user must be aware of so as to efficiently configure a model with minimal error as possible. Geometrical effects may alter simulation results. VISSIM can be very user-sensitive in the sense that the way that one may align the links of the intersections or connect the links. These effects can range from being minimal to causing a disturbance in either traffic flow or the detection of vehicle conflicts. An example of a configured intersection in VISSIM is shown in the figure below. When creating a network of links in VISSIM, it is imperative that the roads and sidewalks align as close and efficient as possible to the field. Furthermore, when adding the signal heads onto the roads, the signal head must be inserted behind the connection of the main approach and the connector (shown in the figure below in the red circle). This is critical for a functional traffic flow in the network. Various other nuances are to be observed when producing a network in VISSIM, but with repetition a user will find themselves becoming acclimated to the program.

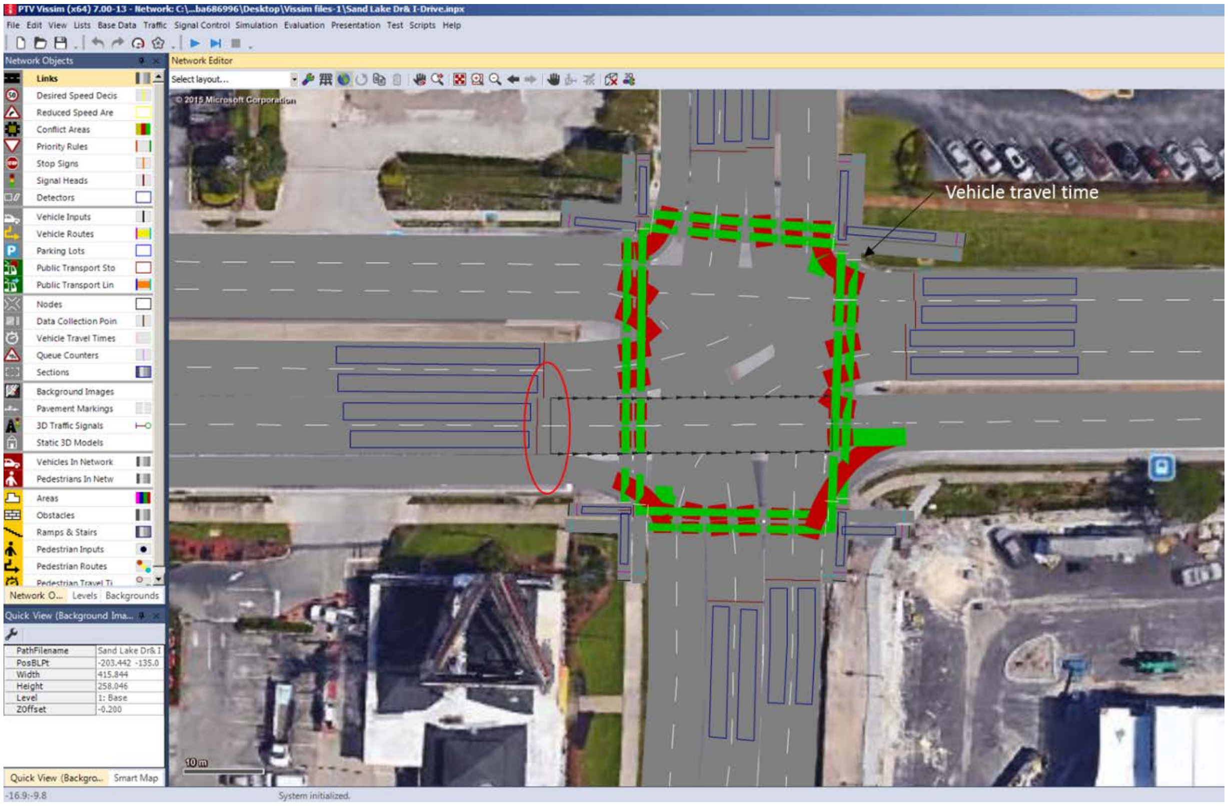

Figure 5: Configuration of modeled intersection in VISSIM

Once the field data was extracted from each intersection, the dataset was then inserted and coded into the VISSIM model to the corresponding parameters. All of the major components were taken into consideration. First, it was imperative to add the correct speed distribution for both vehicles and pedestrians as well as the percentage of vehicles and trucks for traffic flow to help create a real-world environment. VISSIM is a discrete, stochastic, time-step based model that simulates microscopic traffic flow (Lownes et al 2006). Furthermore, a network is configured to replicate an intersection using links that depicts the roads, links that will depict the sidewalk and crosswalk for the pedestrians, and links that attaches one link to another to create a whole route. Once the network was created, the necessary parameters (vehicle volume, pedestrian volume, vehicle routes, walking speed, signal timing, etc.) were input into the model. Figure 3. Shows an illustration of the network produced in the VISSIM model.

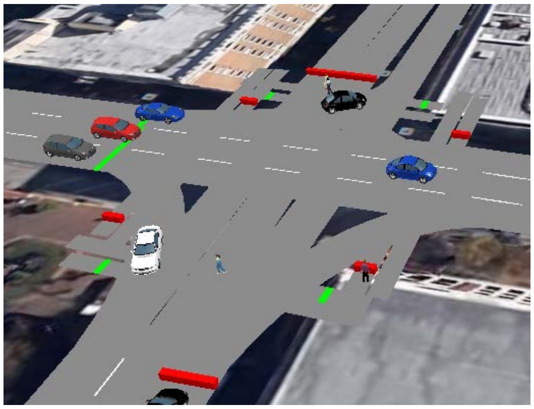

Figure 6: VISSIM Illustration

As mentioned before, the method that was used to assess the pedestrian conflicts is a method that simulates the pedestrians as a vehicle so that SSAM detects the conflicts between the pedestrians and the vehicles. Furthermore, after running the SSAM model with the trajectory files from VISSIM, not only were the conflicts evaluated, but also the Post Encroachment Time (PET). Once the trajectory files from VISSIM have been obtained, the files are then inserted into SSAM. An illustration can be seen below of the Surrogate Safety Model. After analysis, SSAM exports the results in the form of a csv excel file where the number of pedestrian-to-vehicle conflicts can be filtered. The process of filtering is using the first and second length to identify the type of conflicts that is being assessed. The first length indicating the length of the pedestrians and the second length indicating the length of the vehicles. Since pedestrians are set as vehicles, the length will be given between 0.1 m to 0.5m in length. The length of vehicles can range from 3 m to 10 m long. To determine the number of pedestrian-to-vehicle conflicts, the first length was set to the length of the pedestrians and the second length was set to the vehicle lengths.

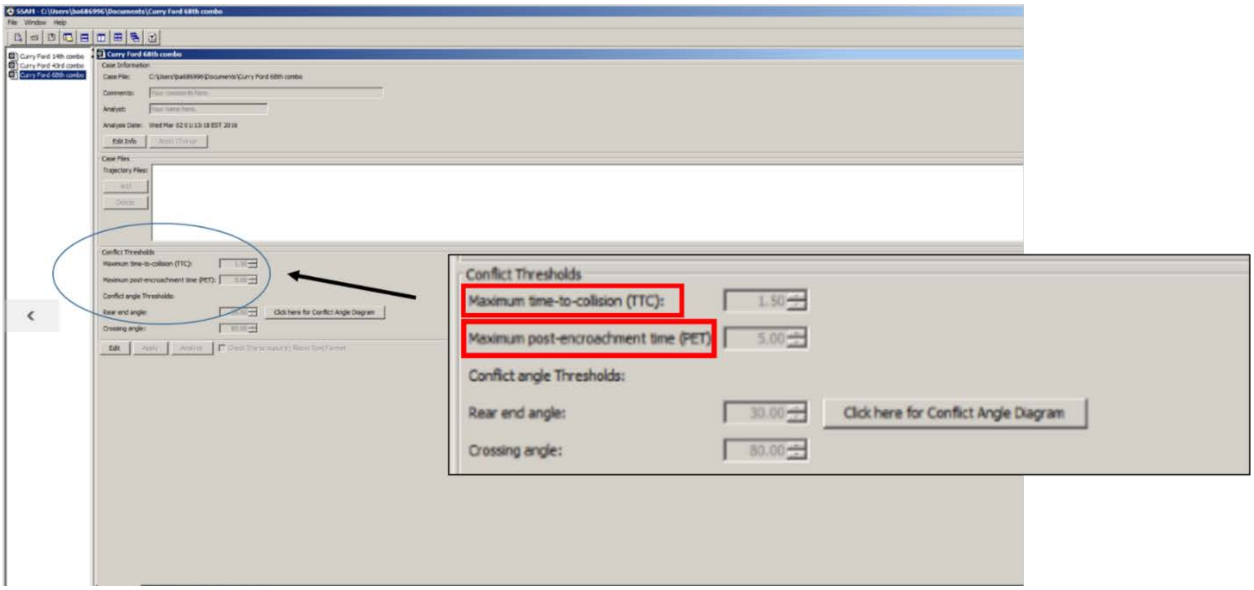

Figure 7: SSAM Configuration

Threshold Analysis

During this study, it became apparent that it would be necessary to do an experimental analysis for the TTC and PET threshold. The default numbers for the threshold of vehicle-to-vehicle conflicts were 1.5 and 5 for the TTC and PET, respectively. Since pedestrian-to-vehicle conflicts is not an area that has been widely explored and investigated, it was essential that an analysis test was to be done in order to obtain the correct combination of threshold of TTC and PET for the SSAM model. Several iterations and combinations were initiated in order to find the proper combination of TTC and PET that produced the optimum values that would define pedestrian-to-vehicle conflicts. Four various sets of combinations was produced that gradually formed a detailed schematic of the increased number of conflicts so as to properly determine the threshold for pedestrian to vehicle conflicts. For the first set, the TTC was generated in odd numbers of 1, 3, 5, 7, 9 and the PET ranged 4 through 9 consecutively for each numbered TTC. For the second set of combinations, the aforementioned numbered TTC remained the same, but the PET was changed to seek a more precise determination of the threshold by implementing decimal figures in the PET. Thus, the range for the post encroachment time in the second set was listed from 4.1 to 9.9 with each decimal point being recorded in odd numbers. After obtaining results from the first and second set, it was observed that a TTC of 3 seconds was predominantly the number of which the optimum number of conflicts were occurring. However, a more extensive sensitivity analysis was generated to produce another set of combinations that had a TTC range of 2, 2.1, 2.3, 2.5, and 2.7 with a PET range of 4 through 9. This third set produced significantly greater number of conflicts than the prior two sets. Lastly, a fourth set of combinations with the same TTC range as the 3rd set and set the PET in the same range as the 2nd set ranging from 4.1 to 9.9. The following illustrations in figure 7 and figure 8 displays the sets of combinations for the sensitivity analysis test for the determination of the threshold for pedestrian safety.

1st Set				2nd set				3rd set			
Combinations	TTC	P.E.T	No. of Conflicts	Combinations	TTC	P.E.T	No. of Conflicts	Combinations	TTC	P.E.T	No. of Conflicts
1	1	4		1	3	4.1		1	2	4	
2	1	5		2	3	4.3		2	2	5	
3	1	6		3	3	4.5		3	2	6	
4	1	7		4	3	4.7		4	2	7	
5	1	8		5	3	4.9		5	2	8	
6	1	9		6	3	5.1		6	2	9	
7	3	4		7	3	5.3		7	2.3	4	
8	3	5		8	3	5.5		8	2.3	5	
9	3	6		9	3	5.7		9	2.3	6	
10	3	7		10	3	5.9		10	2.3	7	
11	3	8		11	3	6.1		11	2.3	8	
12	3	9		12	3	6.3		12	2.3	9	
13	5	4		13	3	6.5		13	2.5	4	
14	5	5		14	3	6.7		14	2.5	5	
15	5	6		15	3	6.9		15	2.5	6	
16	5	7		16	3	7.1		16	2.5	7	
17	5	8		17	3	7.3		17	2.5	8	
18	5	9		18	3	7.5		18	2.5	9	
19	7	4		19	3	7.7		19	2.7	4	
20	7	5		20	3	7.9		20	2.7	5	
21	7	6		21	3	8.1		21	2.7	6	
22	7	7		22	3	8.3		22	2.7	7	
23	7	8		23	3	8.5		23	2.7	8	
24	7	9		24	3	8.7		24	2.7	9	
25	9	4		25	3	8.9		25	3	4	
26	9	5		26	3	9.1		26	3	5	
27	9	6		27	3	9.3		27	3	6	
28	9	7		28	3	9.5		28	3	7	
29	9	8		29	3	9.7		29	3	8	
30	9	9		30	3	9.9		30	3	9	

Figure 8: First 3 sets of threshold combinations

During the research, an observation was made in an earlier set of preliminary combinations where the post encroachment time were significantly less than the time-to-collision and for those combinations, the number of conflicts were considerably low and almost nonexistent. Even in the 1st set of combinations in Figure 8, it can be observed that there were certain combinations where the PET was less than the TTC (ex. TTC 9, PET 4) and a low number of conflicts was recorded. Thus, a further extensive sensitive analysis were done in the other sets to get a more efficient and elaborate set of combinations that will help determine a threshold that will produce an optimum number of conflicts. As seen by the red box in the figure below, this was the section that was examined in the further assessment of the number of conflicts in this combinations. It can be observed that it is in this area where the most number of conflicts are being recorded thus, a great deal of time was saved by cutting down the number of combinations to analyze in SSAM from 120 to 44 combinations with additional 11 more combinations of TTC 3 and PET 5.1 to 7.1 for a total of 55.

4th set				4th set				4th set				4th set			
Combinations	TTC	P.E.T	No. of Conflicts	Combinations	TTC	P.E.T	No. of Conflicts	Combinations	TTC	P.E.T	No. of Conflicts	Combinations	TTC	P.E.T	No. of Conflicts
1	2	4.1	16	31	2.3	4.1	10	61	2.5	4.1	9	91	2.7	4.1	5
2	2	4.3	15	32	2.3	4.3	10	62	2.5	4.3	8	92	2.7	4.3	6
3	2	4.5	17	33	2.3	4.5	12	63	2.5	4.5	9	93	2.7	4.5	3
4	2	4.7	17	34	2.3	4.7	18	64	2.5	4.7	13	94	2.7	4.7	9
5	2	4.9	19	35	2.3	4.9	25	65	2.5	4.9	19	95	2.7	4.9	12
6	2	5.1	21	36	2.3	5.1	21	66	2.5	5.1	17	96	2.7	5.1	13
7	2	5.3	20	37	2.3	5.3	25	67	2.5	5.3	20	97	2.7	5.3	16
8	2	5.5	20	38	2.3	5.5	20	68	2.5	5.5	16	98	2.7	5.5	11
9	2	5.7	19	39	2.3	5.7	22	69	2.5	5.7	18	99	2.7	5.7	13
10	2	5.9	18	40	2.3	5.9	21	70	2.5	5.9	18	100	2.7	5.9	15
11	2	6.1	17	41	2.3	6.1	21	71	2.5	6.1	17	101	2.7	6.1	15
12	2	6.3	17	42	2.3	6.3	22	72	2.5	6.3	19	102	2.7	6.3	14
13	2	6.5	17	43	2.3	6.5	21	73	2.5	6.5	17	103	2.7	6.5	13
14	2	6.7	17	44	2.3	6.7	20	74	2.5	6.7	18	104	2.7	6.7	12
15	2	6.9	17	45	2.3	6.9	20	75	2.5	6.9	18	105	2.7	6.9	13
16	2	7.1	17	46	2.3	7.1	20	76	2.5	7.1	18	106	2.7	7.1	13
17	2	7.3	17	47	2.3	7.3	20	77	2.5	7.3	18	107	2.7	7.3	13
18	2	7.5	17	48	2.3	7.5	20	78	2.5	7.5	18	108	2.7	7.5	13
19	2	7.7	17	49	2.3	7.7	20	79	2.5	7.7	18	109	2.7	7.7	13
20	2	7.9	17	50	2.3	7.9	20	80	2.5	7.9	18	110	2.7	7.9	13
21	2	8.1	17	51	2.3	8.1	20	81	2.5	8.1	18	111	2.7	8.1	13
22	2	8.3	17	52	2.3	8.3	20	82	2.5	8.3	18	112	2.7	8.3	13
23	2	8.5	17	53	2.3	8.5	20	83	2.5	8.5	18	113	2.7	8.5	13
24	2	8.7	17	54	2.3	8.7	20	84	2.5	8.7	18	114	2.7	8.7	13
25	2	8.9	17	55	2.3	8.9	20	85	2.5	8.9	18	115	2.7	8.9	13
26	2	9.1	17	56	2.3	9.1	20	86	2.5	9.1	18	116	2.7	9.1	13
27	2	9.3	17	57	2.3	9.3	20	87	2.5	9.3	18	117	2.7	9.3	13
28	2	9.5	17	58	2.3	9.5	20	88	2.5	9.5	18	118	2.7	9.5	13
29	2	9.7	17	59	2.3	9.7	20	89	2.5	9.7	18	119	2.7	9.7	13
30	2	9.9	17	60	2.3	9.9	20	90	2.5	9.9	18	120	2.7	9.9	13

Figure 9: Fourth set of threshold combinations

RESULTS

After calibrating VISSIM to the conditions of the field for all 9 intersections and recording the trajectory files from SSAM, the results are then assessed and analyzed for validation of VISSIM and SSAM relating to pedestrian safety. The vehicles per hour and pedestrians per hour can be seen in the table below for the simulated data results. Moreover, a validation of the calibrated VISSIM model is examined in order to further elaborate and determine the efficiency of the number of conflicts computed from the Surrogate Safety Assessment Model. The GEH, an empirical formula developed by Geoffrey E. Havers to derive a percentage that can be used as a model acceptance criterion for traffic volumes, was the statistical model used to estimate the percentage error to compare the observed traffic volume on the field and simulated traffic volume from VISSIM. This statistical model is used in traffic engineering and modelling to compare two sets of volumes. Its mathematical form is very similar to chi-squared, but is purposed towards traffic analysis. Furthermore, basic percentage error analysis was used to analyze the pedestrian crossing times, pedestrian walking speed, and pedestrian volume.

Table 6: Simulated Vehicle volumes per hour and Pedestrian volumes per hour for each intersection

Simulated										
Intersection Name	Date	Start Time	Eastbound		Southbound		Westbound		Northbound	
			vph	ped/h	vph	ped/h	vph	ped/h	vph	ped/h
Orange Ave & Central Blvd	3/25/2015	9:00 am-10:00 am	78	69	1080	47	197	72	0	72
		10:00 am-11:00 am	179	82	1062	61	195	87	0	52
		11:00 am-12:00 pm	214	161	1183	100	194	173	0	83
		3:00 pm-4:00 pm	253	165	1284	68	231	146	0	102

		4:00 pm-5:00 pm	324	123	1398	85	255	149	0	90
		5:00 pm-6:00 pm	317	116	1255	84	268	155	0	76
Primrose Dr & Colonial Dr	3/26/2015	9:00 am-10:00 am	1557	11	103	17	2069	1	228	5
		10:00 am-11:00 am	1733	15	95	11	2031	4	212	9
		11:00 am-12:00 pm	1971	6	93	24	2270	6	299	11
		3:00 pm-4:00 pm	2314	20	144	36	2319	6	342	13
		4:00 pm-5:00 pm	2404	15	133	20	2214	9	406	13
		5:00 pm-6:00 pm	2423	15	149	21	2384	1	439	11
Silver Star & Hiawassee Rd	3/25/2015	9:00 am-10:00 am	950	21	1214	27	972	10	863	20
		10:00 am-11:00 am	1011	17	1048	23	1009	6	809	10
		11:00 am-12:00 pm	925	18	1015	25	967	22	1073	14
		3:00 pm-4:00 pm	1142	21	1122	16	1370	19	1227	10
		4:00 pm-5:00 pm	1171	16	1129	36	1559	41	1497	26
		5:00 pm-6:00 pm	1273	17	1349	27	1723	14	1523	20
Sand Lake Rd & I-Drive	3/24/2015	9:00 am-10:00 am	1926	33	883	26	1055	67	666	24
		10:00 am-11:00 am	1717	35	860	16	1161	48	849	22
		11:00 am-12:00 pm	1772	50	815	29	1287	99	923	47
		3:00 pm-4:00 pm	1774	50	770	30	1449	92	1204	20
		4:00 pm-5:00 pm	1795	60	874	12	1549	55	1246	41
		5:00 pm-6:00 pm	1779	85	977	21	1410	83	1650	35
Kirkman Rd & Conroy Rd	4/1/2015	9:00 am-10:00 am	927	4	1323	1	1470	1	1676	7
		10:00 am-11:00 am	909	11	1160	14	1305	10	1625	23
		11:00 am-12:00 pm	1031	4	1337	7	1376	4	1826	17
		3:00 pm-4:00 pm	1336	21	2207	1	1579	4	2241	15
		4:00 pm-5:00 pm	1451	0	2269	21	1558	27	2221	0

		5:00 pm-6:00 pm	1792	12	2343	13	1629	21	2417	61
JYP @ Colonial Drive	1/27/2016	9:00 am-10:00 am	2005	3	2146	8	1148	2	1870	8
		10:00 am-11:00 am	1412	4	1891	6	1169	6	1788	3
		11:00 am-12:00 pm	1380	8	1608	17	1393	3	1580	6
		3:00 pm-4:00 pm	1794	1	1999	12	1739	2	1850	15
		4:00 pm-5:00 pm	1754	3	2066	10	1777	5	2131	20
		5:00 pm-6:00 pm	1923	16	2290	14	1926	13	2328	31
Michigan Street @ Orange Ave	1/27/2016	9:00 am-10:00 am	1097	8	996	4	1573	6	1708	7
		10:00 am-11:00 am	1050	5	1064	6	1142	7	1477	7
		11:00 am-12:00 pm	1001	6	1190	3	1134	4	1478	8
		3:00 pm-4:00 pm	1201	6	1463	10	1207	8	1616	8
		4:00 pm-5:00 pm	1286	7	1623	5	1110	10	1656	13
		5:00 pm-6:00 pm	1322	3	1702	5	1121	9	1743	9
Semoran Blvd & Pershing Ave	4/15/2015	9:00 am-10:00 am	343	5	2012	12	862	6	1797	7
		10:00 am-11:00 am	306	8	2043	8	765	4	1763	7
		11:00 am-12:00 pm	421	14	2210	6	774	4	1789	13
		3:00 pm-4:00 pm	584	9	2396	7	1010	6	2423	12
		4:00 pm-5:00 pm	658	28	2748	14	953	7	2439	14
		5:00 pm-6:00 pm	774	9	2827	8	1050	13	2611	10
Curry Ford Rd @ Semoran Blvd	1/27/2016	9:00 am-10:00 am	809	0	2204	0	1325	7	2157	10
		10:00 am-11:00 am	799	5	2296	9	1319	8	1746	4
		11:00 am-12:00 pm	877	18	1846	1	1169	5	1778	16
		3:00 pm-4:00 pm	1183	8	2249	7	1197	9	2020	7
		4:00 pm-5:00 pm	1326	4	2547	2	1214	8	2062	7
		5:00 pm-6:00 pm	1326	12	1754	7	1176	0	2305	18

GEH

After simulation in VISSIM and running the trajectory files in SSAM, the output was analyzed to examine the percentage errors of the vehicle volume, pedestrian volume, pedestrian crossing times, and the pedestrian walking speed. The following equation was used to assess the difference in traffic volume and examine the percentage error between the differences, where E is the simulated volume and V is the volume recorded from the field.

$$GEH = \sqrt{\frac{(E-V)^2}{(E+V)/2}}$$

This formula is used by FHWA based on the Wisconsin DOT freeway model that was established from a similar guideline developed in England (Model Calibration 2016). When using the GEH statistic, there are criteria and acceptance thresholds that gives guidance to whether a model is accepted. The following criteria and guidelines were used to analyze the data and results from VISSIM:

GEH < 5: Acceptable

5 < GEH< 10: Caution – possible model error

GEH > 10: Warning – high probability of modeling error

At the Wisconsin department of transportation, a more elaborate description of targeted acceptance percentage of each scenario was given so as to efficiently assess the intersection results. As seen in the table (below), 85% of the whole model of which the GEH < 5 is the accepted percentage for majority of the scenarios of microsimulation models. However, for intersection turn volumes, 75% is the acceptance target for a GEH<5. This means that at least 75% of the whole intersection of the turn movements are to have a GEH of less than 5.

Table 7: GEH statistic guideline of Modeled vehicle flows compared with observed flows

Test	Criteria	Acceptance Targets
1.1.	$G_H < 5.0$	At least 85% of freeway and arterial mainline links.
1.2.	$G_H < 5.0$	At least 85% of entrance and exit ramps.
1.3.	$G_H < 5.0$	At least 75% of intersection turn volumes.
1.4.	Individual flows within ±400 vehicles per hour for flows exceeding 2700 vehicles per hour.	At least 85% of applicable mainline links.
1.5.	$G_H < 4.0$ for total flows on screenlines.	All (or nearly all) screenlines.
1.6.	Total screenline flows (normally 5+ links) within ±5%.	All (or nearly all) screenlines.

After evaluating the GEH for the traffic volume for each intersection, the results came to be that 6 out of the 9 intersections had greater than 75 percent of a GEH of less than 5. The remaining three intersections had a percentage of 64, 69, and 74 percent of the whole intersection that had a GEH of less than 5 for the turn volumes. The results and tables of these numbers can be seen in the appendix. The process of obtaining these numbers were to calculate the GEH for each turning movement for every hour of each intersection. Moreover, the hourly percentage of each turning movement that had a GEH of less than 5 were computed. Thus, the percentage of GEH less than 5 was evaluated for each hour of each intersection. Afterwards, the average percentage for each intersection was calculated. Based upon the rule of thumb of the GEH guideline for micro simulation modeling, 6 of the 9 intersections reached the acceptance target. However, 3 of the 9 intersections could either have possible error or have high probability of modeling error. As a result, further evaluation was made to determine the percentage of the intersections with a GEH less than 10. After calculating, all 9 intersections computed 100 percent of GEH less than 10. Thus, it can be observed that 6 intersections resulted with an acceptable fit and although the remaining 3 intersections did not have sufficient percentage of GEH less than 5, but all the intersections computed 100 percent of GEH less than 10. Therefore, it can be concluded that 3 of the aforementioned intersections had a mix of GEH between 5 and 10 and be deemed cautious, but since the percentages were not far from the objective as the differences of the 3 intersections from the 75 percent mark were 11percent, 6 percent, and 1 percent, respectively. Thus, it can be concluded that the overall performance of the model of all 9 intersections are acceptable and/or reasonable.

Other Calibration Factors

Other Calibration factors included the pedestrian walking speed, pedestrian volume, and pedestrian crossing times. Each parameter was computed for every hour for each intersection. A simple percentage error formula was used to examine the difference between the observed and simulated walking speeds. As seen in the table below, 6 out of the 9 intersections below had a percent error of less than 10. Reasons for the other intersections to have had a greater percentage error could have been due to the fact that in the field, pedestrians tend to either be jogging, walking faster in longer crosswalk to not get in the crosshairs of changing traffic signals, or simply violating traffic rules and could be running across the street to avoid vehicles. Also pedestrians could violate traffic rules and stop in between medians in which both violation scenarios can cause a tremendous difference in the comparisons between simulated and observed conflicts. In VISSIM, each intersection were simulated at 10 runs each to bring about an average that would determine an average closer to the observed value. Thus, once the average walking speed for the pedestrian was inserted, the model will simulate walking speed as it relates to pedestrian for all ten runs.

Table 8: Average Walking Speed and Percent Error

No.	Intersection	Extracted Avg. Walking Speed (meters/sec)	Simulated Avg. Walking Speed (meters/sec)	Percent Error
1	Primrose Dr and E. Colonial Dr	1.63	1.77	8.7
2	Silver Star and Hiawassee Rd	1.55	1.62	7.1
3	Semoran Blvd and Pershing Ave	1.49	1.58	9.4
4	Sand Lake Rd	1.48	1.63	11.0
5	Orange Ave and Central Blvd	1.28	1.49	17.2
6	Kirkman Rd and Conroy Rd	1.65	1.65	2.4
7	John Young Parkway & Colonial Dr.	1.48	1.55	6.2
8	Michigan St & Orange Ave	1.33	1.20	8.6
9	Curry Ford Rd & Semoran Blvd.	1.39	1.28	6.3

Conflicts

The purpose of this research was to assess the feasibility of micro simulation as it relates to pedestrian safety. The surrogate measure used for this evaluation is the number of pedestrian to vehicle conflicts. Thus, as we delve into the results of the outputs, our goal is not only to accept the affirmation of SSAM being able to detect the number of conflicts, but to also assess the comparison of observed and simulated conflicts so to evaluate the efficiency of the simulated model to the actual field data. As it can be seen in Table 7, there were many cases in which the simulated conflicts were under estimated in comparison to the observed number of conflicts. This could be due to the fact that pedestrians could have initiated traffic violations in which either more pedestrians got caught in near-accident conflicts with vehicles by running through traffic or simply did not adhere to the pedestrian signal and continued walking onto the crosswalk. In VISSIM, once the yield signal began to initiate (which would be signified by a yellow light), the pedestrians would stop at the stop line and not cross the street. Thus, the simulation model takes away possible pedestrian-to-vehicle collisions with this programmed configuration, however, it takes away the real field situation and thus causes less conflicts to occur. Conversely, from the results, it can also be observed from 3 intersections where the simulated conflicts were higher than the observed conflicts from the field.

Table 9: Number of Conflicts of Signalized Intersections

No.	Intersection	Time of Day	Extracted Conflicts	Simulated Conflicts
1	Primrose Dr and E. Colonial Dr	AM	23	9
		PM	41	16
2	Silver Star and Hiawassee Rd	AM	37	24
		PM	51	47
3	Semoran Blvd and Pershing Ave	AM	42	10
		PM	33	40
4	Sand Lake Rd and I-Drive	AM	139	134
		PM	156	147
5	Orange Ave and Central Blvd	AM	90	211
		PM	114	273
6	Kirkman Rd and Conroy Rd	AM	32	21
		PM	62	56
7	John Young Parkway and Colonial Dr.	AM	23	9
		PM	33	38
8	Michigan Street and Orange Ave	AM	24	58
		PM	28	86
9	Curry Ford and Semoran Blvd	AM	10	37
		PM	31	41

The way that VISSIM is designed, the more pedestrians that is added onto the model or the links, the more conflicts that will be generated by SSAM. This was true for the Central Blvd. and Orange Ave Intersection as it generated almost twice as much conflicts in the model as was observed in the field. For the other 2 intersections, during the day of recording the weather was light rain to cloudy and must have altered what is typical pedestrian behavior and thus may have skewed the number of conflicts recorded in the field. Nonetheless, as one observes the results as a whole, the model can be accepted based on the results of past literature. In Figure 10 below, a relationship between the simulated and observed conflicts can be seen. The R^2 value is observed to be 0.5804. What this means is that 58.04 % of the variability in the observed conflicts can be explained by the variation in the simulated conflicts. For each unit increase in the number of simulated conflicts, the mean of the observed conflicts increases by 0.43. As mentioned before, 3 out of the 9 intersections had simulation conflicts above the observed number of conflicts which affected the variation in correlation of determination.

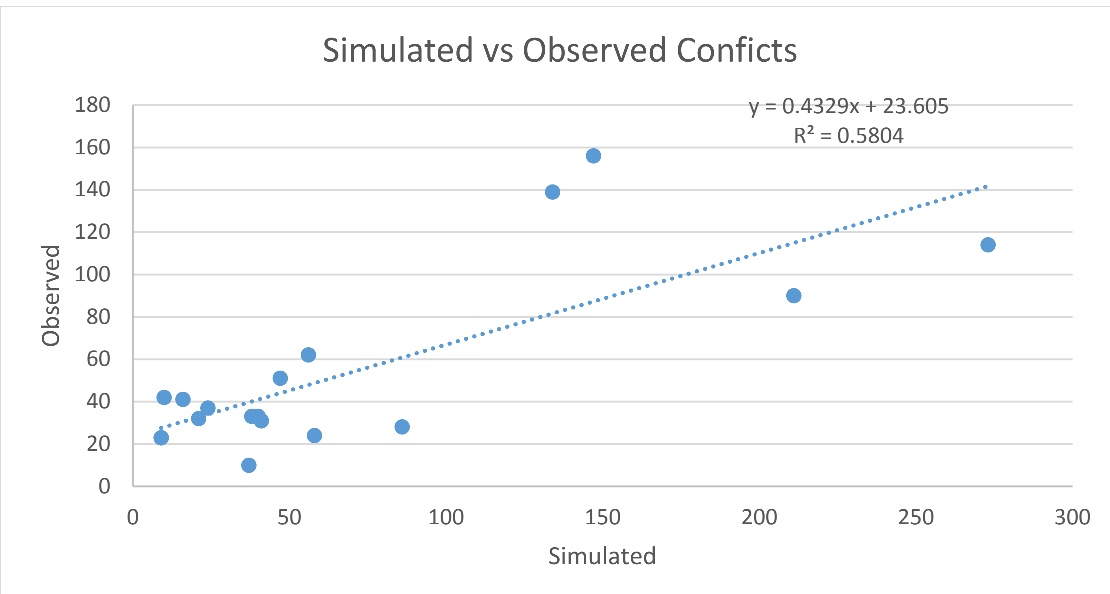

Figure 10: Relationship between observed and simulated conflicts

Furthermore, the relationship between the number of conflicts and the volumes can be observed in the figures below. Common knowledge tells us that as the number of pedestrian volume increases, the number of pedestrian-to-vehicle conflicts and/or crashes will occur also.

An empirical observation from the figures below also illustrates this statement. It can also be seen that as the traffic volume increases, the number of conflicts also increases.

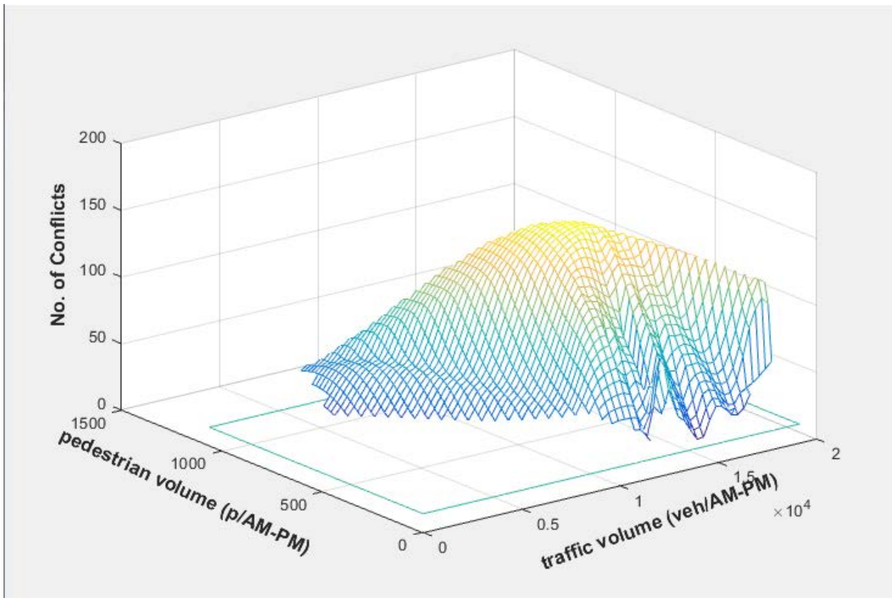

Figure 11: Relationship between observed number of conflicts and observed volumes

It can be observed in figure 12 that the peak is not necessarily at the high end point of the pedestrian volume, but is in the middle segment of the axis of the pedestrian. Moreover, the peak is located at the high end of the traffic volume. This can be explained by the fact that there were a couple intersections in which the number of conflicts simulated were greater than the number of conflicts extracted where the pedestrian volumes were not typically high for those intersections. An analysis of variance was done between the observed and simulated number of conflicts for further evaluation and there was no significance. In conclusion, in the extraction, the emphasis was on both the pedestrian volume and the traffic volume but for the simulated results, the emphasis is observed to be more on the traffic volume but still requires a relatively high number of pedestrians.

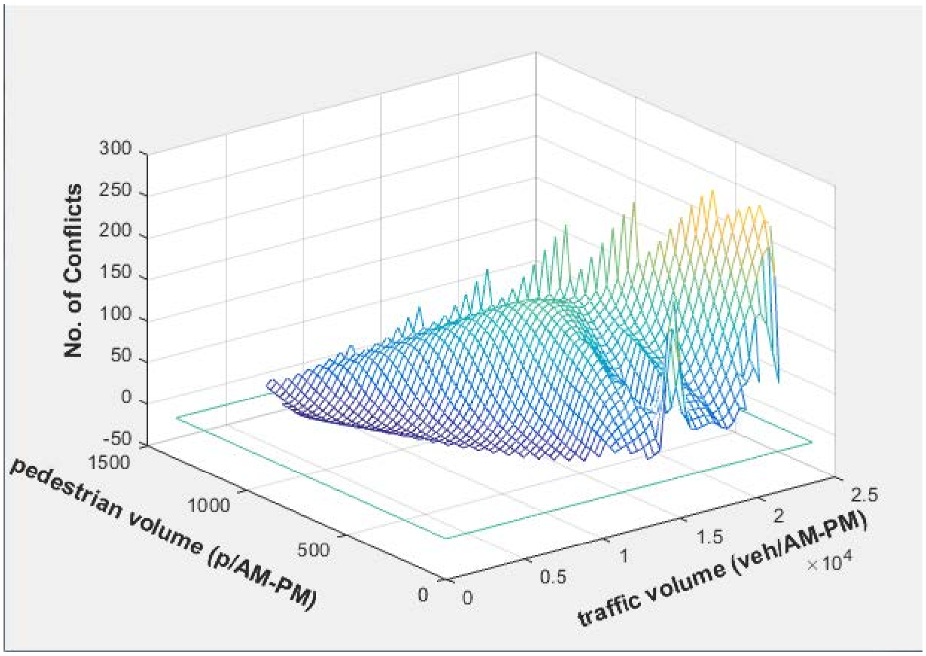

Figure 12: Relationship between simulated number of conflicts and simulated volumes

During the exploration of the various TTC and PET combinations to find the maximum threshold for pedestrian safety, the optimum threshold for each intersection varied significantly. As mentioned earlier, there were four sets combinations produced in order to find the combination of post encroachment time (PET) and time-to-collision (TTC) that would define a representative value that best describes a pedestrian-to-vehicle conflict in the field. For the 4th set, an initial number of 120 combinations were decreased to 55 combinations after a trend was recognized as to the section of combinations where the most number of conflicts were occurring. After recording the conflicts to the appropriate combinations of PET and TTC, a statistical method was used in order to obtain the difference in simulated conflicts and observed conflicts and ultimately obtain the final threshold that would be suited efficient for all the intersections. The mean absolute percent error (MAPE) was used to obtain the percent difference of the two data sets for all 9 intersections. The following formula illustrates the calculation of the mean absolute percent error:

$$\text{MAPE} = \frac{1}{n}\sum_{i=1}^{n}\left|\frac{c_m^i - c_f^i}{c_f^i}\right|$$

Where,

n = number of observations (intersections)

C_m = number of simulated conflicts

C_f = number of observed conflicts from the field

The MAPE value for the total number of conflicts for 55 combinations of PET and TTC thresholds for all 9 intersections ranged from 48% to 71%. Table 8 illustrates the MAPE values under each combination displaying possible optimum thresholds which would correlate to a MAPE value of less than 50%. A contour plot was also generated to show a more vivid illustration of the optimum threshold for all 9 intersections. Based upon the table, the optimum threshold seems to range between a PET of 6.3 to 6.9 and range of 2.5 to 2.7 for TTC. When observing the contour plot, a more widespread examination be observed. Nonetheless, based on observation and extrapolation, the best result for the threshold is a TTC of 2.6 and a PET of 6.7.

Table 10: Maximum thresholds with MAPE values

TTC \ PET	5.1	5.3	5.5	5.7	5.9	6.1	6.3	6.5	6.7	6.9	7.1
2	**0.67**	**0.65**	**0.69**	**0.65**	**0.61**	**0.61**	**0.60**	**0.60**	**0.60**	**0.60**	**0.60**
2.3	**0.71**	**0.70**	**0.70**	**0.64**	**0.58**	**0.53**	**0.53**	**0.54**	**0.52**	**0.52**	**0.51**
2.5	**0.69**	**0.68**	**0.67**	**0.67**	**0.62**	**0.61**	**0.53**	**0.52**	**0.48**	**0.50**	**0.50**
2.7	**0.60**	**0.59**	**0.63**	**0.58**	**0.53**	**0.53**	**0.49**	**0.51**	**0.48**	**0.49**	**0.51**
3	**0.57**	**0.56**	**0.71**	**0.53**	**0.48**	**0.51**	**0.50**	**0.65**	**0.51**	**0.53**	**0.51**

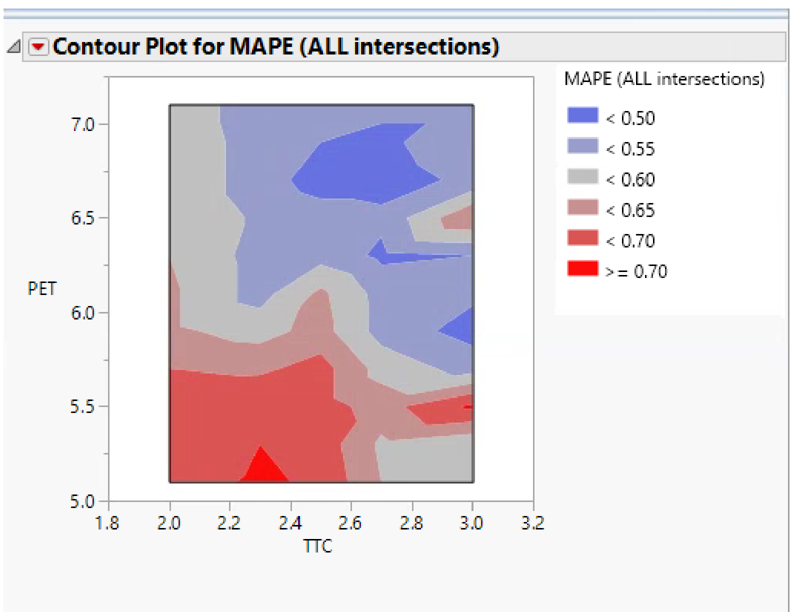

Figure 13: Contour Plot of MAPE values for PET and TTC

The comparisons between the observed PET and the simulated PET can also be seen in the table below. The average post encroachment time for the simulated PET was relatively lower than the observed post encroachment time. This may be due to the fact that cars were decelerating quicker thus extending the time that the vehicle would reach the point of conflict after the pedestrians have crossed. As mentioned before, the conflict area configuration in VISSIM was used to enable vehicles to yield to pedestrians. In the field, drivers are more aware of pedestrians and thus slow down more when entering the intersection. Also, if the area is known to have a great deal of pedestrians, then that can also affect the post encroachment time.

Table 11: Observed and Simulated PET

No.	Intersection	Observed Avg. P.E.T	Simulated Avg. P.E.T
1	Primrose Dr and E. Colonial Dr	4.5	3.64
2	Silver Star and Hiawassee Rd	4.2	5.83
3	Semoran Blvd and Pershing Ave	4.9	3.73
4	Sand Lake Rd	3.89	3.82
5	Orange Ave and Central Blvd	4.3	3.6
6	Kirkman Rd and Conroy Rd	3.64	3.68
7	John Young Parkway and Colonial Dr.	5.4	3.76
8	Michigan Street and Orange Ave	5.3	3.6
9	Curry Ford and Semoran Blvd	5.6	3.75

Safety Distance Factor and Add-Stop distance Validation

When configuring VISSIM with various links connecting one approach to another and making sure that all turn movements are completed, depending on how the network is established or how close to one another the link is created may cause merging conflicts. Initially, when cross linking the networks to create an intersection, naturally there are going to be conflict areas that emerge. Nonetheless, there will be 3 different types of conflicts that will exist in the newly configured intersection in VISSIM. As mentioned before in the literature, there were sensitivity analysis done in order to find the difference in observed conflicts and simulated conflicts by categorizing the conflicts. This second stage of validation decreased the percentage error significantly. In this research, another approach was taken to examine the effects of these variables to the number of conflicts when manipulated.

The safety distance factor and the add-stop distance parameter are 2 of various other parameters within the conflict area component of VISSIM. Once the conflict zones are selected, there a list that displays the various options of parameters that can be changed. The safety distance factor is a variable that changes the distance of which a car will yield to merging vehicles. The default value is 1.5. It can also be assumed that this factor is used mostly for freeways or expressway configuration. The add-stop distance is the variable that dictates the distance in which a vehicle will yield to a crossing vehicle. The default value is 0. In this research, four intersections were selected to observe any influence that would occur to the optimum number of simulated conflicts if these values were to change. The table below illustrates the percent error comparing the number of simulated conflicts using the default values and the results afterwards when the values are changed to 0.5 and 1.0 for the safety distance factor and add-stop distance, respectively. From observation, it can be seen that there was almost little to no significance for 3 out of the 4 intersections for the safety distance factor. This implies that the safety distance factor does not affect the number of conflicts as it pertains to pedestrian-to-vehicle conflicts. For Kirkman Rd and Conroy Rd, the number of conflicts had a 30 % error in difference with an increase of conflicts. Since the safety distance factor has to do with merging conflicts, thus the fact that this intersection has 3 approaches with exclusive right turns can explain the cause of increase in conflicts as the allowable headway for merging vehicles decreases.

Table 12: Safety Distance Factor validation

			Default	Safety Distance Factor	
No.	Intersection	Time of Day	Simulated Conflicts (optimum)	Simulated (0.5)	percent diff. (error)
2	Silver Star and Hiawassee Rd	AM	24	24	0.00
		PM	47	44	0.06
		Total	71	68	**0.04**
4	Sand Lake Rd and I-Drive	AM	134	132	0.01
		PM	147	150	0.02
		Total	281	282	**0.00**
6	Kirkman Rd and Conroy Rd	AM	21	22	0.05
		PM	56	78	0.39
		Total	77	100	**0.30**
7	John Young Parkway and Colonial Dr.	AM	9	9	0.00
		PM	38	36	0.05
		Total	47	45	**0.04**

In observing the ‘add stop distance’, there is great significant difference between the default number and the change in the variable. The difference error ranges from 19 % to 30 %. However, the change in difference is also a significant decrease in the number of conflicts which does not give us any interest as the objective of this experiment is to obtain the optimum number of conflicts. For further research, a sensitivity analysis may be necessary to further study the effects of the safety distance factor, however it may not be as significant for intersections.

Table 13: Add Stop Distance validation

			Default	Add Stop Distance	
No.	Intersection	Time of Day	Simulated Conflicts (optimum)	Simulated (1.0)	percent diff. (error)
2	Silver Star and Hiawassee Rd	AM	24	23	0.04
		PM	47	29	0.38
		Total	71	52	**0.27**
4	Sand Lake Rd and I-Drive	AM	134	105	0.22
		PM	147	93	0.37
		Total	281	198	**0.30**
6	Kirkman Rd and Conroy Rd	AM	21	10	0.52
		PM	56	53	0.05
		Total	77	63	**0.18**
7	John Young Parkway and Colonial Dr.	AM	9	13	0.44
		PM	38	25	0.34
		Total	47	38	**0.19**

DISCUSSION & CONCLUSION

In Conclusion, VISSIM and SSAM provided acceptable results in relation to calibration and validation for pedestrian safety. In this research, extensive analysis was done in order to determine the optimum threshold by producing 4 sets of combinations of PET and TTC that eventually led to a conclusive total of 55 various combinations for each intersection. It was crucial that an optimum threshold was to be found so that in the process of inserting the VISSIM trajectory files into SSAM, then SSAM would produce a typical number of conflicts that represented the number of conflicts on the field.

However, during the investigation it was observed that various optimum thresholds were being produced from various intersections. Thus, a statistical formula was used to find the difference of observed number of conflicts from the field to the simulated number of conflicts and ultimately find the optimum threshold that would be efficient for all 9 intersection. The threshold came to be a TTC of 2.6 and a PET of 6.7. The reason for investigation and determining this threshold is because the default threshold that SSAM uses is geared towards vehicle-to-vehicle conflicts and not for pedestrian-to-vehicle conflicts.

In Calibrating VISSIM, a GEH statistic was used in order to validate the traffic volume. The GEH statistic is a formula used to evaluate the comparisons of two sets of volumes. The results illustrated that 6 out of the 9 intersections had greater than 75% of GEH less than 5. This was the criteria in the guidelines for use of this statistic. A GEH between 5 and 10 is to be cautioned and a GEH greater than 10 gives plausible reason that the model is erroneous. An evaluation was done to assess if the remaining 3 intersections had a GEH greater than 10 and all 3 intersections reached the acceptance target. Thus, the 3 intersections that did not have a GEH less than 5 are between 5 and 10. This does not give cause for alarm, but gives suggestion that there may be a need for a secondary look at the data.

Overall, the feasibility of VISSIM and SSAM for the assessment of pedestrian safety is acceptable.

RECOMMENDATIONS/FUTURE RESEARCH

From the perspective of a usage in real world application for the assessment of pedestrian safety, there leaves a lot to be desired as far as percentage error. However, that can be rectified by simply more observations and usage of more parameters for sensitivity analysis. As aforementioned, in past research (Ge, Qiao, Menendez 2012), an extensive calibration of VISSIM was conducted in order to pinpoint the most important or sensitive parameters that can affect modelling. As a result, five parameters were deemed to have what they called Total Sensitivity Index (TSI) in which one of the parameters were Safety distance reduction factor which was one of the factors assessed in the results. Thus, it is imperative that more research is needed in calibrating this parameter for further study in pedestrian safety. Also, during the experimentation of this research, it was realized that certain other factors affected the number of conflicts such the pedestrian walking speed, the vehicle speed, and the signal timing. The relevance and significance of the influence of these parameters was not studied as part of this research. Thus, these are areas that can also be observed for future research.

Moreover, more intersections need to be observed for pedestrian assessment. There is great potential for solving the problem of pedestrian fatalities and crashes if the usage of VISSIM and SSAM is introduced for real world application to forecast potential conflicts. However, a bigger data of intersections will statistically have more significance. Greater results will yield from an assessment of 50 intersections as opposed to 9 intersections. With 50 or more intersections, instead of estimating the mean absolute percent error, it can be possible to categorize thresholds based upon the configuration of the intersections such as intersections with exclusive right turns, protected left turns, long crosswalk lengths, etc. This can produce a rich set of data that can possibly generate guidelines for pedestrian safety as it pertains to microsimulation.

During this research, majority of the pedestrian to vehicle conflicts could be found from right turn traffic movements. Thus, further research can be done to evaluate the comparisons between exclusive right turn intersections and non-exclusive right turn intersections to see if there is a significant difference between those two geometric configurations. Also, correlations between accidents and conflicts should be studied. As aforementioned, the highway safety manual has limited information about crash modification functions for pedestrians and that pedestrian fatality is such a rare event that adopting a surrogate safety measure such as pedestrian to vehicle conflicts can be correlated to pedestrian related crashes and fatalities.

Furthermore, a comment was made early on that as the pedestrian volume increases in VISSIM, the SSAM model predicts higher number of conflicts which may put some doubt about the efficiency of SSAM in estimating conflicts. It is worth investigating the use of VISSIM pedestrian-vehicular interaction as a video format and count the conflicts observed and compare them to the field data. In this research, the pedestrians were set as vehicles in order for SSAM to detect the configured pedestrians and count the number of conflicts. However, if the pedestrians are left in the default setting as pedestrians and VISSIM is simulated, then the simulation will be recorded and the user can manually and visually record the number of conflicts in the model itself and compare the results to the field data and also to the results of the pedestrian-vehicle configured simulation from SSAM to see the efficiency of both VISSIM and SSAM as tools to assess pedestrian safety.

APPENDIX A:
TRAFFIC AND PEDESTRIAN VOLUMES (OBSERVED)

Pedestrian Volume (Observed)

Intersection Name	Date	Start Time	From West		From North		From East		From South	
			Southbound	Northbound	Westbound	Eastbound	Southbound	Northbound	Westbound	Eastbound
Orange Ave @ Central Blvd	3/25/2015	9:00 am-10:00 am	36	19	18	17	32	23	13	42
		10:00 am-11:00 am	39	26	20	26	34	34	17	22
		11:00 am-12:00 pm	74	56	37	42	81	57	26	39
		3:00 pm-4:00 pm	65	67	41	11	61	53	40	39
		4:00 pm-5:00 pm	50	47	31	35	68	50	42	27
		5:00 pm-6:00 pm	50	42	39	27	51	69	34	24
Primrose Dr @ Colonial Dr	3/26/2015	9:00 am-10:00 am	4	4	9	5	0	1	1	3
		10:00 am-11:00 am	3	8	2	7	2	0	5	2
		11:00 am-12:00 pm	4	0	14	5	3	1	2	6
		3:00 pm-4:00 pm	3	11	14	15	2	2	3	7
		4:00 pm-5:00 pm	6	5	11	6	1	5	4	5
		5:00 pm-6:00 pm	6	5	14	2	0	1	5	3
Silver Star @ Hiawassee Rd	3/25/2015	9:00 am-10:00 am	12	3	10	13	6	1	10	4
		10:00 am-11:00 am	7	5	7	12	3	1	3	5
		11:00 am-12:00 pm	11	2	9	12	12	3	8	3
		3:00 pm-4:00 pm	13	3	7	6	8	7	7	1
		4:00 pm-5:00 pm	9	3	14	15	17	13	8	11
		5:00 pm-6:00 pm	9	3	7	15	4	6	6	9
Sand Lake Rd @ I-Drive	3/24/2015	9:00 am-10:00 am	13	11	4	15	32	20	14	6
		10:00 am-11:00 am	13	13	4	8	16	20	9	9
		11:00 am-12:00 pm	15	22	9	14	40	39	18	20
		3:00 pm-4:00 pm	16	22	13	9	19	54	6	11
		4:00 pm-5:00 pm	22	25	2	6	24	19	16	16
		5:00 pm-6:00 pm	31	36	9	8	31	34	18	12
Kirkman Rd & Conroy Rd	4/1/2015	9:00 am-10:00 am	2	2	0	1	0	1	5	0
		10:00 am-11:00 am	3	5	4	7	4	3	9	7
		11:00 am-12:00 pm	2	2	4	2	3	0	7	5
		3:00 pm-4:00 pm	4	12	0	1	0	3	5	6
		4:00 pm-5:00 pm	0	0	7	10	7	14	0	0
		5:00 pm-6:00 pm	3	6	3	7	5	11	19	28
JYP @ Colonial Drive	1/27/2016	9:00 am-10:00 am	2	0	3	3	2	0	6	1
		10:00 am-11:00 am	0	3	1	4	1	3	1	1
		11:00 am-12:00 pm	1	4	6	7	1	1	4	1
		3:00 pm-4:00 pm	0	1	3	6	0	1	3	10
		4:00 pm-5:00 pm	1	1	6	2	0	3	9	7
		5:00 pm-6:00 pm	6	6	5	5	3	7	13	13
Michigan Street @ Orange Ave	1/27/2016	9:00 am-10:00 am	3	3	3	0	3	2	3	2
		10:00 am-11:00 am	3	1	3	1	5	0	3	2
		11:00 am-12:00 pm	3	2	1	1	1	2	4	2
		3:00 pm-4:00 pm	1	4	3	4	2	4	5	1
		4:00 pm-5:00 pm	3	3	4	0	4	4	7	2
		5:00 pm-6:00 pm	2	0	1	3	3	4	2	4
Semoran Blvd & Pershing Ave	4/15/2015	9:00 am-10:00 am	2	2	5	4	3	1	0	5
		10:00 am-11:00 am	5	1	2	4	1	2	3	2
		11:00 am-12:00 pm	6	4	0	5	1	2	2	7
		3:00 pm-4:00 pm	6	1	3	2	5	0	2	6
		4:00 pm-5:00 pm	13	8	3	7	4	1	4	6
		5:00 pm-6:00 pm	4	3	3	3	3	7	4	3
Curry Ford Rd @ Semoran Ave	1/27/2016	9:00 am-10:00 am	0	0	0	0	1	4	2	6
		10:00 am-11:00 am	3	1	4	3	1	4	1	2
		11:00 am-12:00 pm	7	7	1	0	4	0	6	6
		3:00 pm-4:00 pm	3	3	4	1	3	4	3	3
		4:00 pm-5:00 pm	3	0	0	1	3	3	1	4
		5:00 pm-6:00 pm	5	4	4	1	0	0	6	8

Traffic Volume (Observed)

Intersection Name	Date	Start Time	Eastbound					Southbound					Westbound				
			Right	Thru	Left	U-Turn		Right	Thru	Left	U-Turn		Right	Thru	Left	U-Turn	
Orange Ave & Central Blvd	3/25/2015	9:00 am-10:00 am	44	103	0	0	147	73	706	90	0	869	0	114	47	0	161
		10:00 am-11:00 am	52	96	0	0	148	46	712	95	0	853	0	106	53	0	159
		11:00 am-12:00 pm	57	120	0	0	177	89	758	109	0	956	0	111	48	0	159
		3:00 pm-4:00 pm	93	116	0	0	209	52	885	102	0	1039	0	123	65	0	188
		4:00 pm-5:00 pm	113	151	0	0	264	62	960	108	0	1130	0	143	64	0	207
		5:00 pm-6:00 pm	85	173	0	0	258	84	798	132	0	1014	0	157	60	0	217
Primrose Dr & Colonial Dr	3/26/2015	9:00 am-10:00 am	31	1171	41	0	1243	10	27	44	0	81	18	1577	89	0	1684
		10:00 am-11:00 am	37	1304	45	0	1386	7	28	40	0	75	18	1532	99	0	1649
		11:00 am-12:00 pm	38	1514	29	0	1581	8	25	41	0	74	22	1682	141	0	1845
		3:00 pm-4:00 pm	31	1790	43	0	1864	10	41	62	0	113	23	1727	138	0	1888
		4:00 pm-5:00 pm	32	1876	30	0	1938	11	38	57	0	106	51	1597	154	0	1802
		5:00 pm-6:00 pm	44	1891	20	0	1955	8	48	62	0	118	32	1712	193	0	1937
Silver Star & Hiawassee Rd	3/25/2015	9:00 am-10:00 am	117	512	149	0	778	104	677	207	0	988	88	475	220	0	783
		10:00 am-11:00 am	130	524	180	0	834	114	478	244	0	836	125	472	221	0	818
		11:00 am-12:00 pm	137	442	183	0	762	98	503	215	0	816	111	454	214	0	779
		3:00 pm-4:00 pm	132	550	265	0	947	129	564	216	0	909	150	660	297	0	1107
		4:00 pm-5:00 pm	145	567	262	0	974	141	580	196	0	917	199	787	273	0	1259
		5:00 pm-6:00 pm	190	591	275	0	1056	173	688	237	0	1098	152	903	335	0	1390
Sand Lake Rd & I-Drive	3/24/2015	9:00 am-10:00 am	289	1105	160	0	1554	309	322	75	0	706	41	704	111	0	856
		10:00 am-11:00 am	259	892	234	0	1385	327	266	95	0	688	50	770	122	0	942
		11:00 am-12:00 pm	280	897	255	0	1432	282	277	91	0	650	81	837	130	0	1048
		3:00 pm-4:00 pm	283	921	229	0	1433	246	286	83	0	615	54	975	148	0	1177
		4:00 pm-5:00 pm	281	952	213	0	1446	311	298	91	0	700	67	1072	110	0	1249
		5:00 pm-6:00 pm	321	894	228	0	1443	349	339	97	0	785	52	977	123	0	1152
Kirkman Rd & Conroy Rd	4/1/2015	9:00 am-10:00 am	130	452	172	5	754	34	894	156	54	1084	212	666	300	0	1178
		10:00 am-11:00 am	81	484	172	4	737	38	703	216	56	957	169	633	241	2	1043
		11:00 am-12:00 pm	113	528	192	5	833	48	861	192	37	1101	161	653	288	2	1102
		3:00 pm-4:00 pm	136	767	185	0	1088	76	1374	364	81	1814	216	714	341	4	1271
		4:00 pm-5:00 pm	167	812	197	0	1176	80	1418	381	64	1879	189	728	331	1	1248
		5:00 pm-6:00 pm	312	931	225	0	1468	71	1523	333	53	1927	191	737	383	0	1311
JYP @ Colonial Drive	1/27/2016	9:00 am-10:00 am	203	1032	383	0	1618	244	1200	305	0	1749	159	625	150	0	934
		10:00 am-11:00 am	172	767	196	0	1135	238	1044	251	0	1533	168	629	154	0	951
		11:00 am-12:00 pm	212	684	216	0	1112	196	866	235	0	1297	169	798	167	0	1134
		3:00 pm-4:00 pm	270	938	241	0	1449	268	1092	263	0	1623	247	960	213	0	1420
		4:00 pm-5:00 pm	291	831	291	0	1413	243	1222	219	0	1684	233	986	234	0	1453
		5:00 pm-6:00 pm	339	926	289	0	1554	280	1347	232	0	1859	273	1050	255	0	1578
Michigan Street @ Orange Ave	1/27/2016	9:00 am-10:00 am	340	467	78	0	885	42	560	192	0	794	405	707	161	0	1273
		10:00 am-11:00 am	370	410	63	0	843	48	573	225	0	846	246	533	141	0	920
		11:00 am-12:00 pm	329	398	77	0	804	54	639	260	0	953	305	476	133	0	914
		3:00 pm-4:00 pm	318	559	91	0	968	69	764	339	0	1172	274	552	150	0	976
		4:00 pm-5:00 pm	328	636	74	0	1038	55	866	389	0	1310	276	495	125	0	896
		5:00 pm-6:00 pm	233	757	82	0	1072	52	893	426	0	1371	262	532	112	0	906
Semoran Blvd & Pershing Ave	4/15/2015	9:00 am-10:00 am	35	166	78	0	279	80	1363	179	0	1622	322	176	197	0	695
		10:00 am-11:00 am	36	138	75	0	249	88	1362	203	0	1653	291	154	175	0	620
		11:00 am-12:00 pm	65	192	82	0	339	84	1478	224	0	1786	271	161	195	0	627
		3:00 pm-4:00 pm	59	297	112	0	468	87	1498	352	0	1937	389	201	224	0	814
		4:00 pm-5:00 pm	49	346	139	0	534	122	1688	409	0	2219	325	217	228	0	770
		5:00 pm-6:00 pm	62	436	129	0	627	123	1813	364	0	2300	376	238	233	0	847
Curry Ford Rd @ Semoran Blvd	1/27/2016	9:00 am-10:00 am	68	323	268	0	659	213	1417	155	0	1785	264	635	180	0	1079
		10:00 am-11:00 am	89	321	243	0	653	181	1498	168	0	1847	264	538	275	0	1077
		11:00 am-12:00 pm	111	345	262	0	718	146	1156	175	0	1477	228	422	302	0	952
		3:00 pm-4:00 pm	102	554	312	0	968	199	1366	247	0	1812	234	423	320	0	977
		4:00 pm-5:00 pm	139	643	307	0	1089	185	1571	296	0	2052	234	457	300	0	991
		5:00 pm-6:00 pm	100	732	257	0	1089	105	1076	229	0	1410	234	428	297	0	959

APPENDIX B:
TRAFFIC AND PEDESTRIAN VOLUME (SIMULATION)

Pedestrian Volume (Simulation)

Intersection Name	Date	Start Time	From West		From North		From East		From South	
			Southbound	Northbound	Westbound	Eastbound	Southbound	Northbound	Westbound	Eastbound
Orange Ave @ Central Blvd	3/25/2015	9:00 am-10:00 am	45	24	25	22	41	31	16	56
		10:00 am-11:00 am	48	34	28	33	43	44	22	30
		11:00 am-12:00 pm	90	71	47	53	99	74	31	52
		3:00 pm-4:00 pm	80	85	53	15	76	70	50	52
		4:00 pm-5:00 pm	63	60	40	45	83	66	53	37
		5:00 pm-6:00 pm	63	53	49	35	65	90	43	33
Primrose Dr @ Colonial Dr	3/26/2015	9:00 am-10:00 am	6	5	11	6	0	1	1	4
		10:00 am-11:00 am	4	11	2	9	4	0	7	2
		11:00 am-12:00 pm	6	0	18	6	5	1	3	8
		3:00 pm-4:00 pm	4	16	18	18	4	2	4	9
		4:00 pm-5:00 pm	8	7	13	7	2	7	6	7
		5:00 pm-6:00 pm	8	7	18	3	0	1	7	4
Silver Star @ Hiawassee Rd	3/25/2015	9:00 am-10:00 am	17	4	12	15	8	2	14	6
		10:00 am-11:00 am	10	7	9	14	4	2	3	7
		11:00 am-12:00 pm	15	3	11	14	17	5	10	4
		3:00 pm-4:00 pm	17	4	9	7	10	9	9	1
		4:00 pm-5:00 pm	12	4	18	18	23	18	10	16
		5:00 pm-6:00 pm	13	4	9	18	6	8	8	12
Sand Lake Rd @ I-Drive	3/24/2015	9:00 am-10:00 am	18	15	6	20	41	26	17	7
		10:00 am-11:00 am	17	18	6	10	22	26	11	11
		11:00 am-12:00 pm	20	30	11	18	50	49	22	25
		3:00 pm-4:00 pm	21	29	18	12	26	66	7	13
		4:00 pm-5:00 pm	28	32	4	8	31	24	20	21
		5:00 pm-6:00 pm	39	46	11	10	40	43	21	14
Kirkman Rd & Conroy Rd	4/1/2015	9:00 am-10:00 am	2	2	0	1	0	1	7	0
		10:00 am-11:00 am	4	7	5	9	6	4	13	10
		11:00 am-12:00 pm	2	2	5	2	4	0	10	7
		3:00 pm-4:00 pm	6	15	0	1	0	4	7	8
		4:00 pm-5:00 pm	0	0	9	12	9	18	0	0
		5:00 pm-6:00 pm	4	8	4	9	7	14	24	37
JYP @ Colonial Drive	1/27/2016	9:00 am-10:00 am	3	0	4	4	2	0	7	1
		10:00 am-11:00 am	0	4	1	5	1	5	2	1
		11:00 am-12:00 pm	2	6	8	9	1	2	5	1
		3:00 pm-4:00 pm	0	1	4	8	0	2	3	12
		4:00 pm-5:00 pm	2	1	8	2	0	5	11	9
		5:00 pm-6:00 pm	8	8	7	7	4	9	15	16
Michigan Street @ Orange Ave	1/27/2016	9:00 am-10:00 am	4	4	4	0	4	2	4	3
		10:00 am-11:00 am	4	1	4	2	7	0	4	3
		11:00 am-12:00 pm	4	2	1	2	2	2	5	3
		3:00 pm-4:00 pm	1	5	4	6	3	5	7	1
		4:00 pm-5:00 pm	4	3	5	0	5	5	10	3
		5:00 pm-6:00 pm	3	0	1	4	4	5	3	6
Semoran Blvd & Pershing Ave	4/15/2015	9:00 am-10:00 am	2	3	7	5	4	2	0	7
		10:00 am-11:00 am	7	1	3	5	1	3	5	2
		11:00 am-12:00 pm	8	6	0	6	1	3	4	9
		3:00 pm-4:00 pm	8	1	4	3	6	0	4	8
		4:00 pm-5:00 pm	18	10	4	10	5	2	6	8
		5:00 pm-6:00 pm	5	4	4	4	4	9	6	4
Curry Ford Rd @ Semoran Ave	1/27/2016	9:00 am-10:00 am	0	0	0	0	2	5	2	8
		10:00 am-11:00 am	4	1	5	4	2	6	1	3
		11:00 am-12:00 pm	9	9	1	0	5	0	8	8
		3:00 pm-4:00 pm	4	4	5	2	4	5	3	4
		4:00 pm-5:00 pm	4	0	0	2	4	4	1	6
		5:00 pm-6:00 pm	7	5	5	2	0	0	8	10

Traffic Volume (Simulation)

Intersection Name	Date	Start Time	Eastbound					Southbound					Westbound					Northbound				
			Right	Thru	Left	U-Turn		Right	Thru	Left	U-Turn		Right	Thru	Left	U-Turn		Right	Thru	Left	U-Turn	
Orange Ave & Central Blvd	3/25/2015	9:00 am-10:00 am	52	26	0	0	78	90	883	107	0	1080	0	141	56	0	197	0	0	0	0	0
		10:00 am-11:00 am	62	117	0	0	179	57	890	115	0	1062	0	132	63	0	195	0	0	0	0	0
		11:00 am-12:00 pm	68	146	0	0	214	110	940	133	0	1183	0	137	57	0	194	0	0	0	0	0
		3:00 pm-4:00 pm	112	141	0	0	253	67	1095	122	0	1284	0	154	77	0	231	0	0	0	0	0
		4:00 pm-5:00 pm	139	185	0	0	324	78	1190	130	0	1398	0	178	77	0	255	0	0	0	0	0
		5:00 pm-6:00 pm	104	213	0	0	317	101	991	163	0	1255	0	195	73	0	268	0	0	0	0	0
Primrose Dr & Colonial Dr	3/26/2015	9:00 am-10:00 am	37	1465	55	0	1557	12	38	53	0	103	23	1938	108	0	2069	121	33	74	0	228
		10:00 am-11:00 am	44	1630	59	0	1733	9	38	48	0	95	21	1887	123	0	2031	134	25	53	0	212
		11:00 am-12:00 pm	47	1886	38	0	1971	9	34	50	0	93	28	2068	174	0	2270	182	35	82	0	299
		3:00 pm-4:00 pm	38	2220	56	0	2314	12	56	76	0	144	30	2119	170	0	2319	208	32	102	0	342
		4:00 pm-5:00 pm	39	2325	40	0	2404	14	50	69	0	133	64	1958	192	0	2214	276	31	99	0	406
		5:00 pm-6:00 pm	54	2342	27	0	2423	11	63	75	0	149	40	2103	241	0	2384	318	41	80	0	439
Silver Star & Hiawassee Rd	3/25/2015	9:00 am-10:00 am	142	633	175	0	950	125	823	266	0	1214	105	591	276	0	972	213	528	122	0	863
		10:00 am-11:00 am	160	645	206	0	1011	154	585	309	0	1048	151	583	275	0	1009	189	479	141	0	809
		11:00 am-12:00 pm	165	549	211	0	925	120	621	274	0	1015	135	564	268	0	967	253	657	163	0	1073
		3:00 pm-4:00 pm	160	678	304	0	1142	160	688	274	0	1122	182	815	373	0	1370	238	779	210	0	1227
		4:00 pm-5:00 pm	177	698	296	0	1171	173	704	252	0	1129	246	971	342	0	1559	271	1000	226	0	1497
		5:00 pm-6:00 pm	232	729	312	0	1273	209	837	303	0	1349	189	1115	419	0	1723	266	1019	238	0	1523
Sand Lake Rd & I-Drive	3/24/2015	9:00 am-10:00 am	360	1371	195	0	1926	388	397	98	0	883	53	869	133	0	1055	105	251	310	0	666
		10:00 am-11:00 am	324	1106	287	0	1717	406	331	123	0	860	64	949	148	0	1161	110	355	384	0	849
		11:00 am-12:00 pm	345	1116	311	0	1772	357	342	116	0	815	100	1030	157	0	1287	134	364	425	0	923
		3:00 pm-4:00 pm	349	1143	282	0	1774	312	352	106	0	770	68	1200	181	0	1449	145	396	663	0	1204
		4:00 pm-5:00 pm	348	1188	259	0	1795	390	366	118	0	874	84	1330	135	0	1549	155	453	638	0	1246
		5:00 pm-6:00 pm	394	1105	280	0	1779	436	415	126	0	977	63	1198	149	0	1410	177	525	948	0	1650
Kirkman Rd & Conroy Rd	4/1/2015	9:00 am-10:00 am	157	555	215	0	927	43	1098	182	0	1323	263	838	369	0	1470	99	1287	290	0	1676
		10:00 am-11:00 am	99	594	216	0	909	48	859	253	0	1160	212	798	295	0	1305	191	1095	339	0	1625
		11:00 am-12:00 pm	140	652	239	0	1031	58	1055	224	0	1337	202	821	353	0	1376	118	1276	432	0	1826
		3:00 pm-4:00 pm	165	941	230	0	1336	94	1694	419	0	2207	268	894	417	0	1579	250	1565	426	0	2241
		4:00 pm-5:00 pm	208	1001	242	0	1451	100	1730	439	0	2269	235	917	406	0	1558	269	1542	410	0	2221
		5:00 pm-6:00 pm	385	1132	275	0	1792	83	1866	394	0	2343	234	926	469	0	1629	462	1538	417	0	2417
JYP @ Colonial Drive	1/27/2016	9:00 am-10:00 am	254	1284	467	0	2005	304	1470	372	0	2146	198	760	190	0	1148	249	1441	180	0	1870
		10:00 am-11:00 am	215	954	243	0	1412	295	1289	307	0	1891	208	765	196	0	1169	288	1219	281	0	1788
		11:00 am-12:00 pm	265	848	267	0	1380	247	1077	284	0	1608	212	970	211	0	1393	234	1049	297	0	1580
		3:00 pm-4:00 pm	333	1163	298	0	1794	332	1344	323	0	1999	307	1168	264	0	1739	255	1262	333	0	1850
		4:00 pm-5:00 pm	365	1032	357	0	1754	300	1497	269	0	2066	289	1201	287	0	1777	316	1485	330	0	2131
		5:00 pm-6:00 pm	420	1147	356	0	1923	347	1659	284	0	2290	339	1276	311	0	1926	305	1716	307	0	2328
Michigan Street @ Orange Ave	1/27/2016	9:00 am-10:00 am	429	568	100	0	1097	54	705	237	0	996	506	867	200	0	1573	99	1225	384	0	1708
		10:00 am-11:00 am	466	502	82	0	1050	63	722	279	0	1064	307	661	174	0	1142	120	928	429	0	1477
		11:00 am-12:00 pm	415	486	100	0	1001	69	799	322	0	1190	380	590	164	0	1134	153	920	405	0	1478
		3:00 pm-4:00 pm	403	682	116	0	1201	86	956	421	0	1463	340	682	185	0	1207	178	985	453	0	1616
		4:00 pm-5:00 pm	414	777	95	0	1286	66	1076	481	0	1623	345	613	152	0	1110	181	1036	439	0	1656
		5:00 pm-6:00 pm	294	923	105	0	1322	63	1109	530	0	1702	326	658	137	0	1121	220	1079	444	0	1743
Semoran Blvd & Pershing Ave	4/15/2015	9:00 am-10:00 am	44	199	100	0	343	102	1689	221	0	2012	393	219	250	0	862	117	1589	91	0	1797
		10:00 am-11:00 am	46	164	96	0	306	108	1686	249	0	2043	354	191	220	0	765	108	1561	94	0	1763
		11:00 am-12:00 pm	82	233	106	0	421	104	1829	277	0	2210	329	202	243	0	774	114	1571	104	0	1789
		3:00 pm-4:00 pm	74	365	145	0	584	111	1852	433	0	2396	476	248	286	0	1010	220	2075	128	0	2423
		4:00 pm-5:00 pm	61	421	176	0	658	154	2090	504	0	2748	397	268	288	0	953	224	2058	157	0	2439
		5:00 pm-6:00 pm	75	537	162	0	774	148	2228	451	0	2827	457	296	297	0	1050	242	2201	168	0	2611
Curry Ford Rd @ Semoran Blvd	1/27/2016	9:00 am-10:00 am	88	391	330	0	809	258	1761	185	0	2204	331	782	212	0	1325	206	1760	191	0	2157
		10:00 am-11:00 am	115	387	297	0	799	219	1874	203	0	2296	322	665	332	0	1319	189	1417	140	0	1746
		11:00 am-12:00 pm	141	419	317	0	877	184	1451	211	0	1846	281	522	366	0	1169	247	1381	150	0	1778
		3:00 pm-4:00 pm	125	675	383	0	1183	249	1704	296	0	2249	287	521	389	0	1197	353	1483	184	0	2020
		4:00 pm-5:00 pm	169	782	375	0	1326	232	1958	357	0	2547	287	564	363	0	1214	350	1533	179	0	2062
		5:00 pm-6:00 pm	127	889	310	0	1326	132	1345	277	0	1754	288	529	359	0	1176	422	1698	185	0	2305

APPENDIX C: GEH STATISTIC

Traffic Volume (GEH statistic)

Intersection Name	Date	Start Time	Eastbound					Southbound					Westbound					Northbound				
			Right	Thru	Left	U-Turn		Right	Thru	Left	U-Turn		Right	Thru	Left	U-Turn		Right	Thru	Left	U-Turn	
Orange Ave & Central Blvd	3/25/2015	9:00 am-10:00 am	1.15	9.59			6.51	1.88	6.28	1.71		6.76		2.39	1.25		2.69					
		10:00 am-11:00 am	1.32	2.03			2.42	1.53	6.29	1.95		6.75		2.38	1.31		2.71					
		11:00 am-12:00 pm	1.39	2.25			2.65	2.11	6.25	2.18		6.94		2.33	1.24		2.63					
		3:00 pm-4:00 pm	1.88	2.21			2.89	1.94	6.67	1.89		7.19		2.63	1.42		2.97					
		4:00 pm-5:00 pm	2.32	2.62			3.50	1.91	7.01	2.02		7.54		2.76	1.55		3.16					
		5:00 pm-6:00 pm	1.95	2.88			3.48	1.77	6.45	2.55		7.16		2.86	1.59		3.28					
Primrose Dr & Colonial Dr	3/26/2015	9:00 am-10:00 am	1.03	8.10	2.02		8.39	0.60	1.93	1.29		2.29	1.10	8.61	1.91		8.89	2.30	1.10	1.20		2.77
		10:00 am-11:00 am	1.10	8.51	1.94		8.79	0.71	1.74	1.21		2.17	0.68	8.59	2.28		8.91	2.27	1.05	0.85		2.58
		11:00 am-12:00 pm	1.38	9.02	1.55		9.25	0.34	1.66	1.33		2.08	1.20	8.91	2.63		9.37	2.73	1.06	1.62		3.34
		3:00 pm-4:00 pm	1.19	9.60	1.85		9.85	0.60	2.15	1.69		2.73	1.36	8.94	2.58		9.40	2.76	1.51	1.65		3.52
		4:00 pm-5:00 pm	1.17	9.80	1.69		10.00	0.85	1.81	1.51		2.47	1.71	8.56	2.89		9.19	3.22	1.54	1.68		3.91
		5:00 pm-6:00 pm	1.43	9.80	1.44		10.00	0.97	2.01	1.57		2.68	1.33	8.95	3.26		9.62	3.41	1.49	1.64		4.06
Silver Star & Hiawassee Rd	3/25/2015	9:00 am-10:00 am	2.20	5.06	2.04		5.85	1.96	5.33	3.84		6.81	1.73	5.02	3.56		6.38	2.96	4.67	1.89		5.83
		10:00 am-11:00 am	2.49	5.00	1.87		5.83	3.46	4.64	3.91		6.91	2.21	4.83	3.43		6.32	2.83	4.37	2.02		5.58
		11:00 am-12:00 pm	2.28	4.81	1.99		5.61	2.11	4.98	3.77		6.58	2.16	4.88	3.48		6.36	3.17	5.26	2.38		6.58
		3:00 pm-4:00 pm	2.32	5.17	2.31		6.03	2.58	4.96	3.71		6.68	2.48	5.71	4.15		7.47	2.92	5.73	2.67		6.96
		4:00 pm-5:00 pm	2.52	5.21	2.04		6.02	2.55	4.89	3.74		6.63	3.15	6.21	3.93		7.99	3.19	6.28	2.64		7.52
		5:00 pm-6:00 pm	2.89	5.37	2.16		6.36	2.60	5.40	4.02		7.18	2.83	6.67	4.33		8.44	3.22	6.42	2.92		7.76
Sand Lake Rd & I-Drive	3/24/2015	9:00 am-10:00 am	3.94	7.56	2.63		8.92	4.23	3.96	2.47		6.28	1.75	5.88	1.99		6.44	2.05	2.98	3.59		5.09
		10:00 am-11:00 am	3.81	6.77	3.28		8.43	4.13	3.76	2.68		6.18	1.85	6.11	2.24		6.75	2.11	3.68	3.92		5.77
		11:00 am-12:00 pm	3.68	6.90	3.33		8.49	4.20	3.69	2.46		6.10	2.00	6.32	2.25		6.99	2.27	3.80	4.13		6.05
		3:00 pm-4:00 pm	3.71	6.91	3.32		8.52	3.95	3.70	2.37		5.89	1.79	6.82	2.57		7.51	2.45	4.02	4.93		6.81
		4:00 pm-5:00 pm	3.78	7.21	2.99		8.67	4.22	3.73	2.64		6.20	1.96	7.44	2.26		8.02	2.27	4.25	4.69		6.71
		5:00 pm-6:00 pm	3.86	6.67	3.26		8.37	4.39	3.91	2.75		6.47	1.45	6.70	2.23		7.21	2.52	4.69	5.82		7.88
Kirkman Rd & Conroy Rd	4/1/2015	9:00 am-10:00 am	2.25	4.59	3.09		5.97	1.45	6.46	2.00		6.89	3.31	6.27	3.77		8.02	2.12	6.87	3.79		8.11
		10:00 am-11:00 am	1.90	4.74	3.16		6.00	1.52	5.58	2.42		6.24	3.12	6.17	3.30		7.65	3.06	6.14	3.65		7.76
		11:00 am-12:00 pm	2.40	5.10	3.20		6.49	1.37	6.27	2.22		6.76	3.04	6.19	3.63		7.78	2.23	6.66	4.09		8.12
		3:00 pm-4:00 pm	2.36	5.95	3.12		7.12	1.95	8.17	2.78		8.76	3.34	6.35	3.90		8.16	3.12	7.61	4.13		9.20
		4:00 pm-5:00 pm	2.99	6.28	3.04		7.59	2.11	7.86	2.86		8.56	3.16	6.59	3.91		8.28	3.20	7.28	4.10		8.94
		5:00 pm-6:00 pm	3.91	6.26	3.16		8.03	1.37	8.33	3.20		9.00	2.95	6.55	4.17		8.29	4.20	7.21	4.12		9.30
JYP @ Colonial Drive	1/27/2016	9:00 am-10:00 am	3.37	7.41	4.07		9.09	3.62	7.39	3.64		9.00	2.92	5.13	3.07		6.63	3.48	7.30	2.66		8.50
		10:00 am-11:00 am	3.09	6.37	3.17		7.76	3.49	7.17	3.35		8.65	2.92	5.15	3.17		6.70	3.67	6.83	3.32		8.43
		11:00 am-12:00 pm	3.43	5.93	3.28		7.59	3.43	6.77	3.04		8.16	3.12	5.78	3.20		7.29	3.09	6.39	3.54		7.93
		3:00 pm-4:00 pm	3.63	6.94	3.47		8.57	3.70	7.22	3.51		8.84	3.61	6.38	3.30		8.03	3.58	6.73	3.75		8.47
		4:00 pm-5:00 pm	4.09	6.59	3.67		8.57	3.46	7.46	3.20		8.82	3.47	6.50	3.28		8.06	3.86	7.38	3.71		9.10
		5:00 pm-6:00 pm	4.16	6.86	3.73		8.85	3.78	8.05	3.24		9.46	3.77	6.63	3.33		8.31	3.94	7.93	3.61		9.54
Michigan Street @ Orange Ave	1/27/2016	9:00 am-10:00 am	4.54	4.44	2.33		6.73	1.73	5.77	3.07		6.75	4.73	5.70	2.90		7.95	2.01	6.90	3.80		8.13
		10:00 am-11:00 am	4.70	4.31	2.23		6.73	2.01	5.86	3.40		7.05	3.67	5.24	2.63		6.91	2.41	6.04	3.95		7.60
		11:00 am-12:00 pm	4.46	4.19	2.44		6.56	1.91	5.97	3.63		7.24	4.05	4.94	2.54		6.88	2.55	5.81	4.02		7.51
		3:00 pm-4:00 pm	4.48	4.94	2.46		7.08	1.93	6.55	4.21		8.02	3.77	5.23	2.70		6.99	2.76	6.12	4.09		7.86
		4:00 pm-5:00 pm	4.46	5.30	2.28		7.28	1.41	6.74	4.41		8.17	3.92	5.01	2.29		6.76	2.74	6.33	4.06		8.00
		5:00 pm-6:00 pm	3.76	5.73	2.38		7.23	1.45	6.83	4.76		8.44	3.73	5.17	2.24		6.75	3.05	6.43	4.14		8.23
Semoran Blvd & Pershing Ave	4/15/2015	9:00 am-10:00 am	1.43	2.44	2.33		3.63	2.31	8.35	2.97		9.15	3.76	3.06	3.55		5.99	2.14	8.21	2.10		8.74
		10:00 am-11:00 am	1.56	2.12	2.27		3.42	2.02	8.30	3.06		9.07	3.51	2.82	3.20		5.51	2.13	8.10	2.18		8.65
		11:00 am-12:00 pm	1.98	2.81	2.48		4.21	2.06	8.63	3.35		9.49	3.35	3.04	3.24		5.55	2.17	8.13	2.28		8.71
		3:00 pm-4:00 pm	1.84	3.74	2.91		5.06	2.41	8.65	4.09		9.86	4.18	3.14	3.88		6.49	2.83	8.70	2.52		9.49
		4:00 pm-5:00 pm	1.62	3.83	2.95		5.08	2.72	9.25	4.45		10.62	3.79	3.28	3.74		6.23	2.29	7.13	2.25		7.82
		5:00 pm-6:00 pm	1.57	4.58	2.74		5.55	2.15	9.23	4.31		10.41	3.97	3.55	3.93		6.59	1.38	4.12	1.43		4.56
Curry Ford Rd @ Semoran Blvd	1/27/2016	9:00 am-10:00 am	2.26	3.60	3.59		5.54	2.93	8.63	2.30		9.38	3.88	5.52	2.29		7.10	2.47	8.29	2.34		8.95
		10:00 am-11:00 am	2.57	3.51	3.29		5.42	2.69	9.16	2.57		9.87	3.39	5.18	3.27		6.99	2.35	7.63	2.31		8.30
		11:00 am-12:00 pm	2.67	3.79	3.23		5.63	2.96	8.17	2.59		9.05	3.32	4.60	3.50		6.66	2.93	7.50	2.31		8.37
		3:00 pm-4:00 pm	2.16	4.88	3.81		6.56	3.34	8.63	2.97		9.70	3.28	4.51	3.66		6.67	3.40	7.78	2.31		8.78
		4:00 pm-5:00 pm	2.42	5.21	3.68		6.82	3.25	9.21	3.38		10.32	3.28	4.74	3.46		6.72	3.30	7.87	2.51		8.88
		5:00 pm-6:00 pm	2.53	5.51	3.15		6.82	2.48	7.73	3.02		8.65	3.34	4.62	3.42		6.64	3.56	8.27	2.54		9.34

Traffic Volume (GEH calculation)

Intersection Name	Date	Start Time	Percentage (GEH<5)	Avg.	Percentage (GEH<10)	Avg.
Orange Ave & Central Blvd	3/25/2015	9:00 am-10:00 am	71.43	83.33	100	100
		10:00 am-11:00 am	85.71		100	
		11:00 am-12:00 pm	85.71		100	
		3:00 pm-4:00 pm	85.71		100	
		4:00 pm-5:00 pm	85.71		100	
		5:00 pm-6:00 pm	85.71		100	
Primrose Dr & Colonial Dr	3/26/2015	9:00 am-10:00 am	83.33	83.33	100	100
		10:00 am-11:00 am	83.33		100	
		11:00 am-12:00 pm	83.33		100	
		3:00 pm-4:00 pm	83.33		100	
		4:00 pm-5:00 pm	83.33		100	
		5:00 pm-6:00 pm	83.33		100	
Silver Star & Hiawassee Rd	3/25/2015	9:00 am-10:00 am	75.00	79.17	100	100
		10:00 am-11:00 am	91.67		100	
		11:00 am-12:00 pm	91.67		100	
		3:00 pm-4:00 pm	75.00		100	
		4:00 pm-5:00 pm	75.00		100	
		5:00 pm-6:00 pm	66.67		100	
Sand Lake Rd & I-Drive	3/24/2015	9:00 am-10:00 am	83.33	81.94	100	100
		10:00 am-11:00 am	83.33		100	
		11:00 am-12:00 pm	83.33		100	
		3:00 pm-4:00 pm	83.33		100	
		4:00 pm-5:00 pm	83.33		100	
		5:00 pm-6:00 pm	75.00		100	
Kirkman Rd & Conroy Rd	4/1/2015	9:00 am-10:00 am	75.00	69.44	100	100
		10:00 am-11:00 am	75.00		100	
		11:00 am-12:00 pm	66.67		100	
		3:00 pm-4:00 pm	66.67		100	
		4:00 pm-5:00 pm	66.67		100	
		5:00 pm-6:00 pm	66.67		100	
JYP @ Colonial Drive	1/27/2016	9:00 am-10:00 am	66.67	66.67	100	100
		10:00 am-11:00 am	66.67		100	
		11:00 am-12:00 pm	66.67		100	
		3:00 pm-4:00 pm	66.67		100	
		4:00 pm-5:00 pm	66.67		100	
		5:00 pm-6:00 pm	66.67		100	
Michigan Street @ Orange Ave	1/27/2016	9:00 am-10:00 am	75.00	73.61	100	100
		10:00 am-11:00 am	75.00		100	
		11:00 am-12:00 pm	83.33		100	
		3:00 pm-4:00 pm	75.00		100	
		4:00 pm-5:00 pm	66.67		100	
		5:00 pm-6:00 pm	66.67		100	
Semoran Blvd & Pershing Ave	4/15/2015	9:00 am-10:00 am	83.33	84.72	100	100
		10:00 am-11:00 am	83.33		100	
		11:00 am-12:00 pm	83.33		100	
		3:00 pm-4:00 pm	83.33		100	
		4:00 pm-5:00 pm	83.33		100	
		5:00 pm-6:00 pm	91.67		100	
Curry Ford Rd @ Semoran Blvd	1/27/2016	9:00 am-10:00 am	75.00	77.78	100	100
		10:00 am-11:00 am	75.00		100	
		11:00 am-12:00 pm	83.33		100	
		3:00 pm-4:00 pm	83.33		100	
		4:00 pm-5:00 pm	75.00		100	
		5:00 pm-6:00 pm	75.00		100	

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