Simulation and Modeling of Traffic Flow at Intersection in Manggahan, General Trias, Cavite

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ABSTRACT

This study was undertaken at the intersection of Manggahan, General Trias City, Cavite from August 2018 to April 2019 to simulate and create model of its traffic flow. The existing characteristics and parameters that contribute to the traffic flow of the intersection were identified. Data were provided for simulation and model was produced. Parameters were average speed of the vehicles determined under each class, traffic signal time indicated on signal lights, and numbers of classified vehicles passing through the intersection manually counted with the aid of a clicker. These data were then tabulated. Simulation and modeling of data were done per route using MatLab. Optimized time on each leg were determined by choosing the most acceptable model produced on each simulation of data through trial-and-error method increasing and decreasing the value of output by five. The middle part of tabulated number of vehicles was taken and set as target data while the left was treated as input data and the traffic signal time as output. Average optimized speed was determined by including length as parameter. Results revealed that the actual parameters found on the intersection were not optimized. Simulation and training process showed that the traffic signal time for legs of Amadeo and General Trias has an excess of five seconds which can be optimized from thirty-five and thirty to thirty and twenty-five seconds, respectively. Also, legs of Trece Martires and Dasmariñas need five more seconds, requiring signal time of sixty-five and fifty-five seconds, respectively.

Keywords: matlab, model, simulation, speed, traffic flow, traffic time

INTRODUCTION

General Trias City belongs to the highly industrialized cities in the province of Cavite. Vehicles here are seen to get in this city specifically at Manggahan intersection which causes great traffic flow. Manggahan Intersection leads to Tagaytay City through Amadeo, Dasmarinas, General Trias City Proper, and Trece Martires City.

Congestion is caused by different factors such as characteristics of existing parameters, the demand of intersection at a specific time of day, and the volume of vehicles passing through it. Showing these factors and their behavior through a program model, the authority would identify the cause of the heavy flow and the contributions to the problem.

Simulation and modeling of traffic flow at Manggahan intersection would serve as a basis for mitigating the problem of the area in traffic congestion and provide the authorities ideas on how the flow of vehicles would improve. A four-legged signalized intersection in Toronto, Ontario, Canada was subjected to simulation during peak hour conflicts to develop crash predictions and it was found that this process is viable likely with safety performance.

METHODOLOGY

Data Gathering

Parameters. The existing traffic signal time allotted on green lights for each leg was listed. The length of each way that the vehicles take was measured and their Speed was determined by modified class considering five samples of types under its class then averaged. The traffic flow at the intersection was recorded through a camera for two weeks between hours of 11 a.m. and 1 p.m. for the traffic count within the time indicated on traffic signal. It was done through manual counting and the aid of a clicker *(Fransson, 2018)*. Data were then tabulated.

Vehicle Classification. The classifications of the vehicles were provided and modified by the authors as indicated below.

Simulation of the Parameters

Input, Target, and Output Data. The middle part, 18^{th} to 28th row, on the tabulated total number of vehicles was taken and set as target data. Those which were left were treated as input data with the traffic signal time trained as output *(Gupta, 2014, p. 43).* The data were then optimized by calibration. Calibration is a process of refining the model to replicate observed data and observed site conditions to a sufficient level of accuracy in order to satisfy the model objectives *(Arkatkar, Velmurugan, Puvvala, Ponnu, & Narula, 2016, p. 7).*

Table 1. Signal time allotted for each way and length taken by the vehicles

ROUTE	TIME (sec)	LENGTH (m)
Amadeo-Dasmariñas	30	19.2
Amadeo-General Trias	30	35.7
Amadeo-Trece Martires	30	38.1
Damariñas-Amadeo	50	29.1
Dasmariñas- General Trias	50	21.3
Dasmariñas-Trece Martires	50	33.9
General Trias-Amadeo	35	37.1
General Trias-Dasmariñas	35	36.6
General Trias-Trece Martires	35	18.1
Trece Martires-Amadeo	60	29.7
Trece Martires-Dasmariñas	60	33.9
Trece Martires-General Trias	60	24.9

Table 2. Speed of modified vehicular class

VEHICULAR CLASS NUMBER	SPEED ($^{m}/_{s}$)	kph
1 Tricycle and Motorcycles with Side Car	4.16	14.98
2 Jeepneys, Vans and Private Cars	5.46	19.66
3 Light Delivery Trucks, Panel Trucks and Pick-Up Trucks	4.69	16.88
4 Trucks With Three or More Axle and Dual Tired	3.86	13.90
5 Bus	3.79	13.64
AVERAGE	**4.5**	**15.81**

Optimizing Time. A simulation was done per route which provided the input data and target data. Traffic volume and time of signal were set as parameters and served as input and output data, respectively *(Wu, 2017)*. The output data was optimized through the trial-and-error method with intervals of 5, increasing and decreasing, and simulated 10 times to produce a model for each simulation and training.

Optimizing Speed. A simulation was done per route providing the same input and output data used in optimizing time but having the average speed of all vehicles as the output instead. The output data was optimized through the trial-and-error method with intervals of 0.5, increasing and decreasing, and simulated 10 times to produce a model for each simulation and training.

Four Parameters. With the chosen optimized time and average speed, the length of each route was added as the third output optimizing using the same input data and target data concerning traffic volume. The simulation was done per route. Length and time were trained fixed 10 times optimizing only the average speed through trial and error with intervals of 0.5, increasing and decreasing, and produced a model for each simulation of data *(Lu & Liu, 2013, p. 344).*

Analysis of Data Model. On simulating and training of data, the models produced were then analyzed based on the fitting of the validation line, test line, and train line choosing the most acceptable optimized time based on having traffic volume and time as parameters and speed based on simulating four parameters *(Taplin, 2008).*

Optimized Time and Speed. Considering the largest value on optimized time of each way under the specific leg and average, the optimized speed done with four parameters.

RESULTS AND DISCUSSION

Simulation of Parameters

Input, Target, and Output Data. The number of vehicles was summed up per route. The 18th to 28th parts of data were taken and treated as the target data. Those left were treated as input and the signal time for each way was trained as output in optimizing the time. The average speed of all vehicles found at 4.5 mps served as output in optimizing speed with respect to traffic volume only *(Praveen & Arasan, 2013, p. 305).*

Optimizing Time. The first simulation was done at the Amadeo-Dasmariñas route with an output of 35. Through trial-and-error method, increasing and decreasing, with values from 45 down to 15 acceptable and consistent models were produced after ten trainings for value of 20 considering as the optimized time for way of Amadeo-Dasmariñas *(Wu, 2017).*

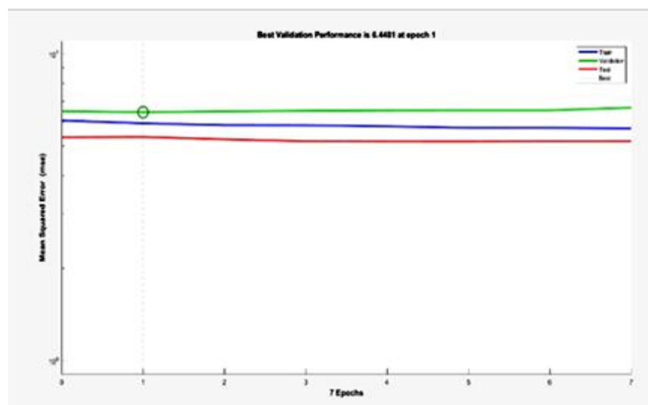

Figure 1. Sample model of training and simulation of time

Data for the Amadeo-General Trias route were trained and simulated with an output of 35. From a value of 35 to values of 40 and 30 an acceptable and consistent model was then produced for 30 as an output considered as the optimized time for the Amadeo-General Trias route.

For the Amadeo-Trece Martires route, the values of 40, 30, 25, 20, 15, and 10 were trained for a trial-and-error value of output and considering 30 as the optimized time for the Amadeo-General Trias route for its models were more consistent and acceptable than the other values.

For Dasmariñas-Amadeo and Dasmariñas-Trece Martires route, values of 40, 45, 55, 60, and 50 were used as output. Based on the models produced, 55 was considered as the optimized time for two routes for its models were more consistent and acceptable. While on Dasmariñas -General Trias route, with an original output of 50 to be optimized, values of 55, 45, 40, 35, 25, 20, 15, and 10 were used on trial-and-error for the value of output then produced an acceptable and more consistent model on the value of 15 considering as the optimized time for Dasmariñas-General Trias route. General Trias-Amadeo route, with an original output of 30 to be optimized, values of 35, 25, 20, and 15 were simulated independently as output and able to produce acceptable and more consistent models on the value of 25 considered as the optimized time for General Trias-Amadeo route. With the same values of 20, 25, and 35, the original output for General Trias-Dasmariñas and General Trias-Trece Martires route, which was 30, was optimized to 20. In optimizing output for Trece Martires-Amadeo route, values of 50, 55, and 65 were used for a trial-and-error and was able to produce an acceptable and more consistent model on the value of 55 considering as the optimized time for Trece MartiresAmadeo route. For Trece Martires-Dasmariñas route, 50, 55, 65, and 70 were tried as the value of output and able to have a more consistent and acceptable model on the value of 65. An optimized output of 10 was considered in the route of Trece Martires-General Trias for its more consistent and acceptable models.

Optimizing Speed. Training and simulating the traffic volume data of each leg with respect to the average speed of all vehicles were treated as output.

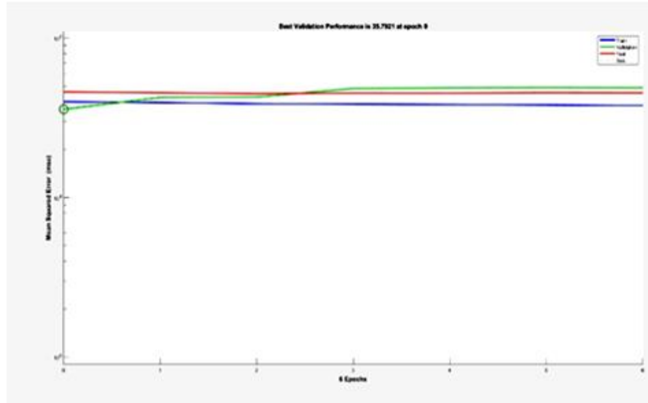

Figure 2. Sample model of training and simulation of speed

On training and simulating data from Amadeo-Dasmariñas and Amadeo-Trece Martires route, the original output of 4.5 was then considered as optimized speed based on its consistent and more acceptable model while 7 as optimized output for Amadeo-General Trias route. Optimizng speed for Dasmariñas-Amadeo and Dasmariñas-Trece Martires route was found at 4.5 then considered through its consistent and more acceptable model and 5 for Dasmariñas-General Trias route. Different values of optimized speed were determined for route of General Trias-Amadeo, General Trias-Dasmariñas and General Trias-Trece Martires values of 7, 8 and 10 respectively. For Trece Martires-Amadeo route, more acceptable and consistent model were produced with output of 4.5 considering as its optimized speed while 8 for Trece Martires-Amadeo and Trece Martires-Dasmariñas route.The chosen optimized speed for each way were then averaged and used in simulating four parameters which aimed to optimize again only the speed with respect to traffic volume, length of way, and optimized time.

Four Parameters. Simulation of data treating the averaged optimized speed value of 6.33, length of each way and optimized time for each way as outputs. In this part, only the speed was being optimized, treating length and optimized time as fixed output.

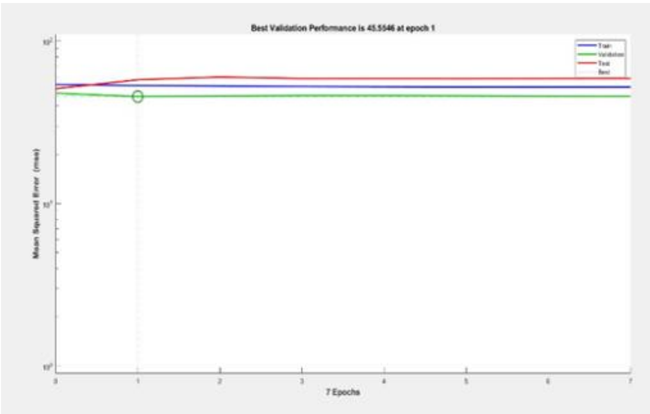

Figure 3. Sample model of training and simulation of speed with four parameters

For route of Amadeo-Dasmariñas, Amadeo-General Trias, and Amadeo-Trece Martires optimized speed values of 5.5, 6 and 6.33 were determined respectively. On route of Dasmariñas-Amadeo, Dasmariñas-General Trias, and Dasmariñas-Trece Martires optimized speed values of 7, 6.33 and 6.5, respectively, were determined.

Values of 6.5, 8 and 7 were determined as optimized speed for ways of General Trias-Amadeo, General Trias-Dasmariñas, and General Trias-Trece Martires respectively. Optimizing the average optimized speed for ways of Trece Martires-Amadeo, Trece Martires-Dasmariñas, and Trece Martires-General Trias, values of 6, 6.5 and 12 were determined respectively.

Analysis of Data Model. Choosing the most acceptable and consistent optimized value on each simulation was done based on the test line, validation line and train line. From the calibrated model from the collected results, the process of checking is known as validation *(Bains, Ponnu, & Arkatkar, 2012, p. 476).* The closer the three were and the more similar path they took, the more acceptable they became having optimized values. When the three lines were unable to fit each other, the validation line and test line served as basis on choosing optimized value. The two line were expected to have same direction and closer.

Optimized Time and Speed. In choosing optimized time for each leg, the largest value from each route was considered and the optimized speed on simulating and training four parameters was averaged and considered as the optimized speed for all vehicles.

Table 3. Signal time allotted for each leg and optimized time provided by simulation

LEG	ALLOTED TIME (sec)	OPTIMIZED TIME (sec)
Amadeo	30	25
Dasmariñas	50	55
General Trias	35	30
Trece Martires	60	65

CONCLUSIONS

Results produced through the model of simulation process imply that the actual existing parameters were not optimized. It was determined that time as parameter greatly affects the flow of vehicles on an intersection when not properly optimized and allocated.

Based on the models, the signal time for legs of Amadeo and General Trias has an excess of 5 seconds which can be optimized to 30 seconds and 25 seconds, respectively. It was also determined that the legs of Trece Martires and Dasmariñas need five more seconds requiring a signal time of 65 seconds and 55 seconds respectively which can be taken from the excess time of Amadeo and General Trias.

RECOMMENDATIONS

For the improvement of the study, the researchers recommend the following:

1. Gather more data of traffic volume more than two weeks of duration to be able to produce more acceptable and consistent model for every training.
2. Evaluate traffic flow on the intersection every month to be able to determine if variation on signal time is required.

ACKNOWLEDGMENTS

The authors would like to acknowledge the CvSU SIMM Laboratory and DOST-PCIEERD for providing the MATLAB software used in simulation and modeling. They would also like to thank their late thesis adviser, Engr. Rico Asuncion, for his guidance, and to their friends and family for their support.

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