EasyChair Preprint

№ 4055

A Formulation of Neural Network Diagram Based on Origin-Destination Matrix Focusing on Traffic Management Optimization on Paranaque City

Ethan Roy Gabriel, Paul Diony Tolentino and
Cymon Francis Yan

August 18, 2020

A Formulation of Neural Network Diagram Based on Origin-Destination Matrix Focusing on Traffic Management Optimization on Paranaque City

E.R.B. Gabriel[1], P.D.S. Tolentino[1], and C.F.A. Yan[1,*]

[1]School of Civil, Environmental, & Geological Engineering,
Mapúa University, Muralla St., Intramuros, Manila 1002, Philippines

[1]royygab13@gmail.com
[1]pauldionyst@gmai.com
[1] cymonfrancisayan@gmail.com
**Corresponding Author E-mail: [1]geoffrey.cueto@yahoo.com*

Abstract—Urban challenges like traffic congestion and a failed transportation system are some of the leading problems in the Philippines in the past decades in which these affect the daily lives of the Filipino citizens. In this paper, the researchers evaluate the overall transportation system of Parañaque City by identifying the existing problems and providing solutions. This study also considers the extensive analysis of origin-destination matrix, vehicle count, population and etc. as these help the researchers formulate a Neural Network strategy.Through the analysis of data and information, the researchers have determined the factors affecting the transportation system and also the congested areas around the city. The avenues of Dr.Arcadio Santos, Quirino and Baclaran are the congested areas wherein these are caused by various factors such as lack of discipline, violators, increase in car ownership, population growth, and the lack of public (parking) space as well. And as part of the paper, the researchers propose or recommend some solutions that may solve the transportation problems in Parañaque City.

Keywords: *Parañaque City, traffic congestion, neural network strategy, OD matrix, peak hour volume*

I. INTRODUCTION

Philippines was ranked second country to have the worst traffic in the world according to the information provided by the TomTom Traffic Index. The growth in population is directly proportional to the volume of traffic flow. This causes the roads in PH, especially in big cities like Parañaque to be more congested as the years go by. In lieu with this the researchers chose to focus on the optimization of traffic light system as means to address this problem.

Traffic light system is one of the factors of traffic congestion in a given road. All roads may differ due to factors such as (1) traffic volume (2) Pedestrian flow (3) Passenger Car Unit values and (4) Physical characteristics of the road.
Nowadays, there are many types of traffic signals that are being used to control the flow of traffic. With all the advancement in today's technologies it is not next to impossible to develop a program that could help with the congestion of roads in the Philippines. The researchers decided to do this study about the optimization of actuated traffic controls and machine learning strategy.

Main objective of the study is to propose a flow diagram using neural network strategy that can help lessen traffic congestion in most congested areas during peak hours in Parañaque,

Specific objectives are as follows:

To construct a solution focused on using neural network strategy that aims to lessen traffic congestion in Parañaque City;

To determine the peak hour volume using traffic volume count provided by Parañaque City Hall;

To formulate an origin-destination matrix to assess the most congested areas in Parañaque City.

Due to the rapid growth of the population in the Philippines, the rate of congestion among roads in PH are also rapidly increasing. The problem is as the years go by there are a lot of changes that contribute to the volume of traffic flow but very minimal changes were made to how the system works. In simpler terms, the system cannot cope up with the changes in the volume of traffic.

This research is focused on the optimization of actuated traffic controls and machine learning strategy assuming that the motorists on the road are law abiding citizens. The research assessed the flow of traffic in Parañaque City during peak hours. Peak hours are validated through given data provided by the authorities in Paranaque City Hall.

Traffic Congestion is a common problem in the Philippines. As of 2019, Philippines loses Php 5.4 Billion daily due to traffic. Based on a study by Urban Planning Specialist, Felino Palafox Jr., it is stated that persons with at least 40 years of economic life who commute 5-6 hours per day, waste almost 28,000 to 40,000 hours of their life. In years, people lose at least nine to fifteen years just because they are stuck in traffic. Life expectancy for both men and women in the Philippines is 69.3 years according to World Health Organization last 2018.

Parañaque City, being one of the most crowded cities in the country, has been experiencing worst traffic congestions in almost every road. Parañaque administration proposed numerous road schemes to lessen traffic, these include deploying traffic enforcers around the city, removing illegal vendors on the road, and using actuated traffic controls in some areas of the city.

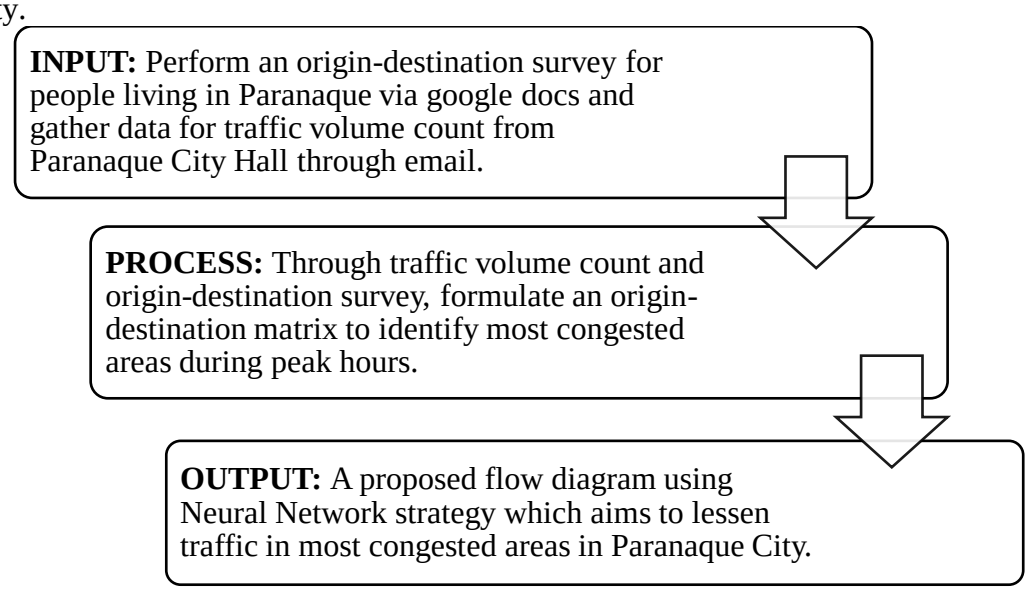
Despite the Paranaque administration’s effort in lessening the traffic in their city, traffic congestion is still present most especially during peak hours. Through this research, proposing a new strategy like machine learning techniques can help lessen the commuter’s travel time. Furthermore, this research will be able to provide and improve the system used in traffic controls in the country. This will also provide additional information to future researchers who has interest in conducting a similar study, or a study related to traffic control optimization, machine learning strategies, and actuated traffic controls.

II. METHODOLOGY

This study gathered data focused on traffic volume count in Parañaque City during peak hours from Parañaque City Hall which certain traffic measure are implied.

Traffic congestion in Metro Manila is one of the worst traffic worldwide which can cost up to Php 5.4 Billion per day. Time spent in traffic also loses at least nine to fifteen years of every commuter's life given he spends 40 economic years. These reasons have led the researchers to propose a new strategy to help ease traffic congestion in Parañaque City.

This study aims to propose a flow diagram using neural network strategy that can help lessen traffic congestion in most congested areas during peak hours in Parañaque City.



Research Setting

The researchers chose Paranaque City since this is one of the most improved cities in National Capital Region and traffic congestion is almost present to city's every road. Despite the effort of the government to lessen traffic congestion in the area, there has been no concrete solution to solve this problem. This city is the prime location for executive villages, malls, hospitals, and is also located near Ninoy Aquino International Airport.

Research Instrument

The researchers used the available datum from various books and websites that are relevant to this study along with countless local and foreign articles. Survey using Google Docs for the Origin-Destination Matrix was also distributed to gather required information for this study. The acquired datum of traffic count and alike from the MMDA and Paranaque City Hall are also one of the resources that was utilized by the researchers.

Data Gathering Procedure

Data are gathered from MMDA and respective authorities in Paranaque City Hall which handle all the traffic concerns of the city. Traffic volume count in Paranaque is collected in Manila City Hall. For the Origin-Destination Survey, Google docs was used to gather information about where people come and go in the City of Parañaque.

Based on the provided data and information, machine learning strategy which is focused on Neural network worked on a diagram with specified time and date to further assess its meaning and interdependency.

III. RESULTS AND DISCUSSION

Traffic Volume Count

Area 55 (Valley 1)					
April 6, 2018 Friday	From Baclaran into Valley 1	From Sucat into Valley 1	From Valley 1 out to Baclaran	From Valley 1 out to Sucat	Total per hour
8:00-9:00	257	250	272	285	1064
9:00-10:00	303	302	352	221	1178
10:00-11:00	298	283	339	229	1149
11:00-12:00	281	364	410	359	1414
BREAK					
1:00-2:00	285	244	252	257	1038
2:00-3:00	297	297	357	304	1255
3:00-4:00	302	312	345	247	1206
4:00-5:00	299	305	375	299	1278
Total per day	2322	2357	2702	2201	9582

Table 1: *Traffic Volume Count for Area 55 (Valley 1)*

Table 1 manifests the traffic volume count last April 2018 at Area 55 of Valley 1. This data shows the routes from Valley 1 to Baclaran and vice versa. It is also included in the table the data for Valley 1 to Sucat and vice versa. A total of 2,322 vehicles from Baclaran to Valley 1 were counted, 303 of those vehicles occurred during 9:00 to 10:00 am, this data is less than the route of Valley 1 to Baclaran which accumulated 2,702 vehicles in total, most of the vehicles were seen during 11:00 to 12:00 pm. This represents that there were more vehicles who went to Baclaran than Valley 1, having a difference of 380 vehicles. In different circumstances, the route of Sucat to Valley 1 garnered 2,357 vehicles, 364 out of 2,357 vehicles left Sucat to Valley 1 during 11:00 am to 12:00 pm. Meanwhile, there were only 2,201 vehicles left Valley 1 to Sucat. Most vehicles (359) passed by Valley 1 to Sucat route at 11:00 am to 12:00 pm. As stated above, during 11:00 am to 12:00 pm, most vehicles leave Valley 1 to either Sucat or Baclaran and vice versa. There were 1,414 in total who travelled and used Area 55 of Valley 1 at that hour. To sum it up, 9,582 vehicles were counted last April 6, 2018.

Area 59 (South to Multi)									
April 18, 2018 Wednesday	Private	Motorcycle	Truck	Taxi	Tricycle	Closed van	UV Express	Jeep	Total per hour
8:00-9:00	30	10	2	0	18	5	0	0	66
9:00-10:00	20	20	1	0	22	10	0	0	73
10:00-11:00	36	35	13	2	26	12	1	0	125
11:00-12:00	54	21	9	4	25	4	0	0	117
BREAK									
1:00-2:00	64	23	5	4	15	8	0	0	119
2:00-3:00	57	34	5	2	11	11	0	0	120
3:00-4:00	48	22	7	9	9	7	0	0	102
4:00-5:00	24	36	3	4	11	21	0	0	99
Total per day	333	201	45	25	137	78	1	1	821

Table 2: *Traffic Volume Count for Area 59 (South to Multi)*

Table 2 describes the data gathered for the traffic volume count at Area 59 – from South to Multi last April 18, 2020 A total of 333 private vehicles were calculated along Area 59 of South to Multi route – this number holds the record for the most numbered mode of transportation which was used during that day. On the contrary, there were only 1 for each UV express and jeep passed by the provided area. Jeepneys are rarely seen in Multi to South since this area bounds exclusive subdivisions like Multinational Village. This also explains why the most common type of transportation present in this area are private cars and motorcycles. Wednesday was the chosen day because every Wednesday, Paranaque City celebrates Baclaran Day. Most people tend to travel to attend mass in Baclaran Church which results to more transportation modes on the road. The two modes of transportation were considered having the least numbered mode of transportation used on the said day. There were 125 vehicles in total which used the South to Multi route during 10:00 to 11:00 am, while there were only 66 vehicles which passed by the same area at 8:00 to 9:00 am, and most of the vehicles were private cars. In summary, there were 821 vehicles drove the South to Multi route last April 18, 2018.

Area 59 (North to Multi)									
April 18, 2020 Wednesday	Private	Motorcycle	Truck	Taxi	Tricycle	Closed van	UV Express	Jeep	Total per hour
8:00-9:00	125	326	7	6	16	21	2	0	503
9:00-10:00	115	241	7	5	8	39	0	2	417
10:00-11:00	120	164	14	12	15	24	0	0	349
11:00-12:00	161	127	12	7	20	28	0	0	355
BREAK									
1:00-2:00	164	119	10	13	16	16	0	0	338
2:00-3:00	157	157	11	11	14	31	0	0	381
3:00-4:00	165	204	7	17	9	25	0	0	427
4:00-5:00	185	242	7	18	10	37	0	0	499
Total per day	1192	1580	75	89	108	221	2	2	3269

Table 3: *Traffic Volume Count for Area 59 (North to Multi)*

Table 3 shows the traffic volume count at Area 59 – from North to Multi. This data was accumulated last April 18, 2020. This manifested that the most numbered mode of transportation which has passed by the route North to Multi is the motorcycle. A total of 1,580 motorcycles were counted along the specified area. On the other hand, the least numbered mode of transportation are the UVs and Jeepneys, both transportation gathered the same count which is 2. Most vehicles passed by North to Multi route at 8:00 to 9:00 am having a data of 503 vehicles in total, followed by 4:00 to 5:00 pm with 499 vehicles. This reading show that most vehicles were seen during these hours since office hours usually starts at 8:00 am and ends at 5:00 pm. Meanwhile, 355 vehicles were counted during 11:00 am to 12:00 pm; this hour reports the least number of vehicles passed by Area 59 of North to Multi route. On that day, 3,269 vehicles passed by Area 59 of North to Multi route.

Origin-destination Matrix

Origin \ Destination	B. F. Homes	Bacl-aran	Don Bosco	Don Galo	La Huerta	Marcelo Green	Mer-ville	Moon walk	San Antonio
B.F Homes (1)	7	5	1	0	1	1	0	0	3
Baclaran (10)	0	3	0	0	0	1	0	0	0
Don Bosco (6)	2	0	8	0	2	0	0	0	1
Don Galo (14)	1	0	2	0	2	1	0	0	2
La Huerta (15)	1	0	1	0	1	0	0	0	0
Marcelo Green (9)	0	0	1	0	0	0	1	0	1
Merville (11)	1	3	4	0	0	0	0	1	1
Moonwalk (3)	0	1	0	0	1	0	0	0	0
San Antonio (4)	4	1	1	0	4	0	0	0	1
San Dionisio (5)	0	0	0	1	2	0	0	0	0
San Isidro (2)	3	3	0	0	3	0	0	0	3
San Martin De Porres (13)	0	0	0	0	0	1	1	0	0
Sto. Nino (8)	0	2	0	0	0	0	0	1	0
Sun Valley (7)	4	2	7	0	0	0	0	0	0
Tambo (12)	0	1	0	1	1	0	0	0	0
Vitalez (16)	1	0	3	0	0	0	0	1	0
TOTAL	24	21	28	2	17	4	2	3	12

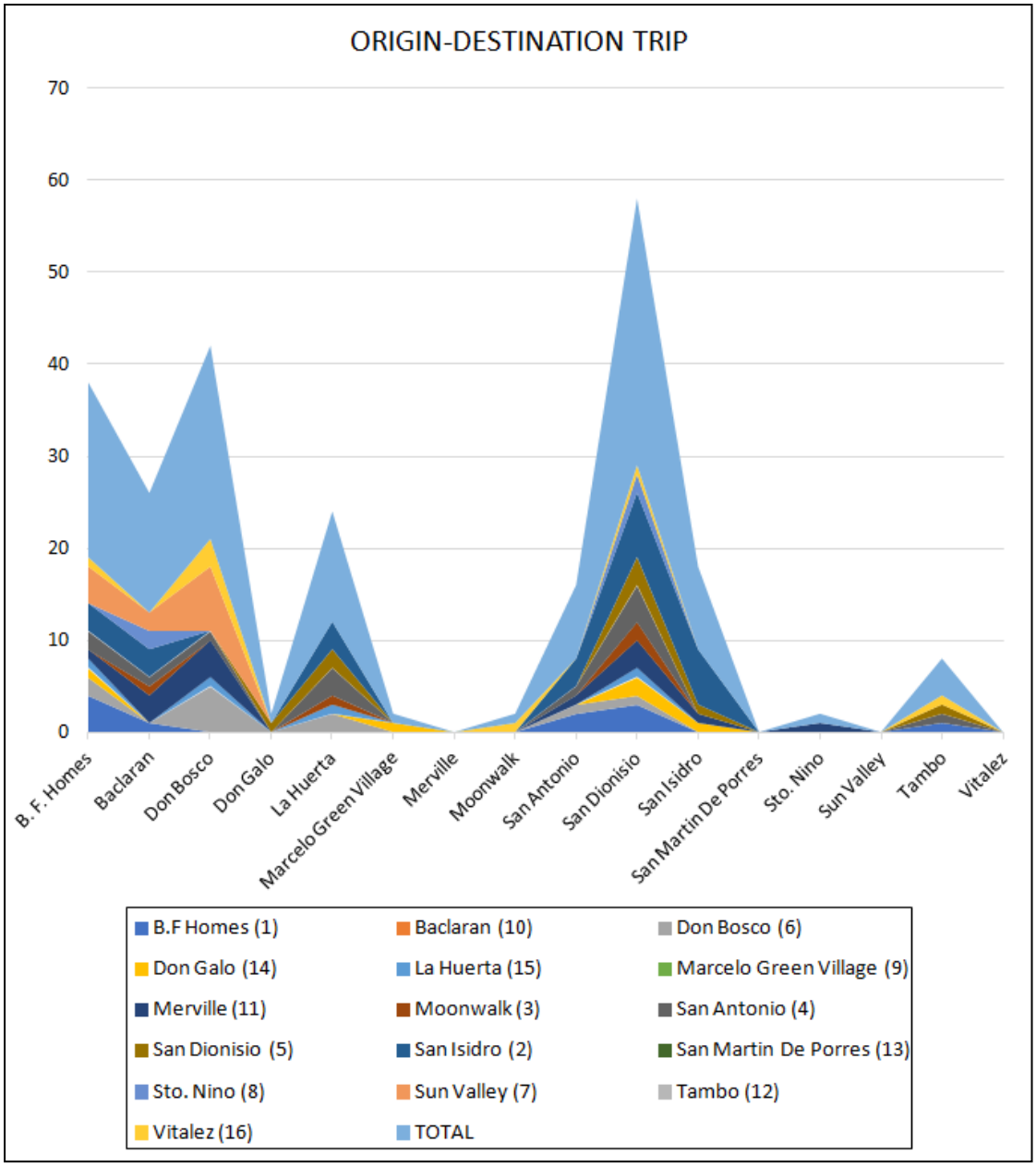
Table 4: *Origin-Destination Trips of Different Barangays in Parañaque City*

Table 4 shows the Origin-Destination Matrix of 9 barangays in Parañaque City. These numbers are based on the Origin-Destination Survey conducted and were distributed using google docs.

Origin \ Destination	San Dionisio	San Isidro	San Martin de Porres	Sto. Nino	Sun Valley	Tambo	Vitalez	TOTAL
B.F Homes (1)	7	2	0	0	0	1	0	28
Baclaran (10)	2	0	0	0	0	0	0	6
Don Bosco (6)	1	0	1	0	0	0	0	15
Don Galo (14)	2	1	0	0	0	0	0	11
La Huerta (15)	1	0	0	0	0	0	0	4
Marcelo Green (9)	0	0	0	0	0	0	0	3
Merville (11)	3	1	1	1	0	0	0	16
Moonwalk (3)	2	0	0	0	0	0	0	4
San Antonio (4)	5	0	0	0	0	1	0	17
San Dionisio (5)	3	1	0	0	0	1	0	8
San Isidro (2)	7	6	0	0	0	0	0	25
San Martin De Porres (13)	0	0	0	0	1	0	0	3
Sto. Nino (8)	2	0	0	0	0	0	0	5
Sun Valley (7)	0	0	0	0	0	0	0	13
Tambo (12)	0	0	0	0	0	0	0	3
Vitalez (16)	1	0	0	0	0	1	0	7
TOTAL	36	11	2	1	1	4	0	168

Table 5: *Origin-Destination Trips of Different Barangays in Parañaque City*

Table 5 shows the continuation of Origin-Destination Matrix of 7 barangays in Parañaque City. These numbers are based on the Origin-Destination Survey conducted and were distributed using google docs.



Graph 1: *Origin-Destination Matrix*

Graph 1 represents the summary of all the recorded trips per barangay based on the results of the Origin-Destination Matrix with their respective color-coded destination zones. Barangays B.F. Homes, Baclaran, Don Bosco, Don Galo, La Huerta, Marcelo Green, Merville, Moonwalk, San Antonio, San Dionisio, San Isidro, San Martin de Porres, Sto. Nino, Sun Valley, Tambo, and Vitalez were the areas that were observed in assessing the origin and destination trips of the residents living within Parañaque City. The number of origin and destination trips represents the rows and columns respectively.

Barangay B.F. Homes which has a total of 28 origins of the respondents garnered the highest record. San Isidro was the second highest record of a total of 25 origins to be followed by San Antonio which has 17 origins. In addition, 16 origins was recorded for Merville, 15 origins for Don Bosco, 13 for Sun Valley, 11 for Don Galo, 8 for San Dionisio, 7 for Vitalez, 6 for Baclaran, 5 for Sto. Nino, and 4 for La Huerta and Moonwalk. Marcelo Green, San Martin de Porres, and Tambo have the lowest origins which has a total of 3 only.

For the destination trips, barangay San Dionisio has 36 trips which is the highest while Vitalez being the lowest with 0 trips. Don Bosco has a total of 28 destination trips which garnered the second highest to be followed by B.F. Homes which has a total of 24 destination trips. Barangays Baclaran, La Huerta, San Antonio, San Isidro, Marcelo Green, Tambo, Moonwalk, Merville, San Martin de Porres, Sto. Nino, and Sun Valley have a total of 21, 17, 12, 11, 4, 3, 2, and 1 destination trips respectively. In addition, the total number of the origin (row) and destination (column) were the same which were both 168 trips.

IV. CONCLUSION AND RECOMMENDATION

The past administration regarding the transportation system of the City of Parañaque became the source of strength to the city's traffic office in achieving their current status which happened to be more flexible and adaptive. However, there are still existing problems needed to be eradicated such as irregular loading and un-loadings of public transportations like buses and UV Express, obstructions on roads, lack of public spaces due to increase in car ownership and illegal parking, and traffic violators such as those reckless drivers who keep on swerving and beating the red light at night.

The researchers believed that these problems were mainly caused by the lack of discipline of the people. Furthermore, Barangay B.F. Homes was considered as the common origin zone of most respondents because of having the largest number in terms of population density in all barangays. Subsequently, Barangay San Dionisio generated a lot of destination trips to most respondents because of its numerous establishments such as malls particularly (SM), hospitals, schools, and workplaces that were built around it.

Moreover, the avenues of Dr.Arcadio Santos and Quirino, and Baclaran were found to be the most congested areas. These areas served as the national or main roads to leading barangays that have generated a lot of destination trips because of the various landmarks around.

In addition, the increase in number of vehicles particularly private vehicles piling up around the areas happens because of lack of parking spaces. Therefore, the researchers found out that these support the reason why traffic congestion happens within these locations especially during peak hours which is from 7:00 in the morning to 12 noon and 5:00 in the afternoon until 7:00 in the evening.

The proposed neural network flowchart is a step by step flowchart that is flexible enough to be able to successfully observe, analyze, and test the datum that will be inputted.

The researchers highly suggest the next researchers of the same topic to use an updated datum for a more accurate result. It is also important to analyze each road individually for every road is unique and there are different factors to consider for each. Since this paper proposes the use of machine learning for traffic optimization it is also important to be updated on the different available technologies. Based from the researchers' experience with machine learning, there are still lots of room for improvement with this method for traffic optimization. So, it would be best if future researchers are also able to use updated technologies for this.

REFERENCES

[1] Ribeiro, Isabel et. al., "Global optimization and complementarity for solving a semi- actuated traffic control problem" (2011) *https://www.sciencedirect.com/science/article/pii/S187704281101425X?fbclid=IwAR2-j_1VMx-aMmyABAIK6I0dXIuQ5VuWL0LroZ61m_te3GJMJR-tWzF88tk*

[2] Head, Larry, et. al., "Multi-modal traffic signal control with priority, signal actuation and coordination" (2014) *https://www.sciencedirect.com/science/article/pii/S0968090X14001144?fbclid=IwAR2Eonfnp69laC_YNQ-owPXNw-UKiNDjiT72Yfdjc7yQHF9GXlNDx5HGwgw*

[3] Lin, Dong, et al. "Modeling of Real-Time Signal Timing for Multi-Intersection in Urban Traffic Network." *2009 Fourth International Conference on Digital Information Management*, 2009, doi:10.1109/icdim.2009.5356789.

[4] Alba, Michelle et. al., "Machine Learning Techniques Aim to Reduce Traffic" (2016) https://www.engineering.com/Education/EducationArticles/ArticleID/13111/Machine-Learning-Techniques-Aim-to-Reduce-Traffic.aspx

[5] Liu, Ximin, et al. "Macroscopic Model for Interrupted Traffic Flow of Signal Controlled Intersection." *2009 ISECS International Colloquium on Computing, Communication, Control, and Management*, 2009, doi:10.1109/cccm.2009.5268043.

[6] Thupae, Ratanang, et. al. " Machine Learning Techniques for Traffic Identification and Classification in SDWSN: A Survey" (2018) *https://www.researchgate.net/publication/329207704_Machine_Learning_Techniques_for_Traffic_Identification_and_Classification_in_SDWSN_A_Survey*

[7] Sunil, Ghane, et. al. "Using AI and Machine Learning Techniques for Traffic Signal Control Management- Review" (2017) *https://www.ijert.org/research/using-ai-and-machine-learning-techniques-for-traffic-signal-control-management-review-IJERTV6IS110065.pdf*

[8] Zheng, X., & Recker, W. (2013). *An adaptive control algorithm for traffic-actuated signals*. Transportation Research Part C: Emerging Technologies, 30, 93–115. doi: 10.1016/j.trc.2013.02.007

[9] Lee, K. M., Yoo, J., Kim, S.-W., Lee, J.-H., & Hong, J. (2019). Autonomic machine learning platform. *International Journal of Information Management*, *49*, 491–501. doi: 10.1016/j.ijinfomgt.2019.07.003

[10] Hong, T., Wang, Z., Luo, X., & Zhang, W. (2020). State-of-the-art on research and applications of machine learning in the building life cycle. *Energy and Buildings*, *212*, 109831. doi: 10.1016/j.enbuild.2020.109831
[11] Wu, J., Liu, P., Qin, X., Zhou, H., & Yang, Z. (2019). Developing an actuated signal control strategy to improve the operations of contraflow left-turn lane design at signalized intersections. *Transportation Research Part C: Emerging Technologies*, *104*, 53–65. doi: 10.1016/j.trc.2019.04.028
[12] Natafgi, M. B., Osman, M., Haidar, A. S., & Hamandi, L. (2018). Smart Traffic Light System Using Machine Learning. 2018 IEEE International Multidisciplinary Conference on Engineering Technology (IMCET). doi: 10.1109/imcet.2018.8603041
[13] Savrasovs, M., & Pticina, I. (2017). Methodology of OD Matrix Estimation Based on Video Recordings and Traffic Counts. *Procedia Engineering*, *178*, 289-297. doi:10.1016/j.proeng.2017.01.116
[14] Baek, S., Lim, Y., Rhee, S., & Choi, K. (2010). Method for estimating population OD matrix based on probe vehicles. *KSCE Journal of Civil Engineering, 14*(2), 231-235. doi:10.1007/s12205-010-0231-4
Berelson, B. (1974). *Content Analysis.* Retrieved from https://www.ischool.utexas.edu/~palmquis/courses/content.htmlon September 28, 2018
[15] Christopher, E. &Raynault, E. (2013).*How Does Transportation Affect Public Health?.* Retrieved from https://www.fhwa.dot.gov/publications/publicroads/13mayjun/05.cfm on September 28, 2018
[16] Ciriaco C. (2018, February 14). *Paranaque Starts Contactless Traffic Apprehension Scheme.* Retrieved from https://businessmirror.com.ph/paranaque-starts-contactless-traffic-apprehension-scheme/ on September 27, 2018
[17] Crossman A. (2017, December 03). *An Introduction to Socioeconomic Status.*Retrieved from https://www.thoughtco.com/socioeconomic-status-3026599 on October 2, 2018
[18] Ding L. & Zhang N. (n.d.). *A Travel Mode Choice Model Using Individual Grouping Based On Cluster Analysis.* Retrieved from https://core.ac.uk/download/pdf/82535818.pdf on October 2, 2018sss
[19] Downs, A. (2004). *Traffic: Why It's Getting Worse, What Government Can Do.* Retrieved from https://www.brookings.edu/research/traffic-why-its-getting-worse-what-government-can-do/ on September 28, 2018
[20] Francisco, K. (2016). *Creating Sustainable Transport Systems: PH's Progress So Far.* Retrieved from https://www.rappler.com/science-nature/environment/127075-philippines-sustainable-transportation-strategy on September 19, 2018
[21] Islam K. & Ahmed S. (n.d). *Reducing traffic congestion level of Dhaka City using policy based algorithm in SUMO.* Retrieved from http://dspace.bracu.ac.bd/xmlui/bitstream/handle/10361/8916/13301012%2C13301082_CSE.pdf?sequence=1&isAllowed on September 28, 2018
[22] Lidasan H., Esapada I., &Richmund M. (2009).*A Needs Assessment of Transport Planning and Traffic Management of Local Cities: The Case of the Philippines*. Retrieved from

https://www.researchgate.net/publication/228465340_A_Needs_Assessment_of_Transport_Planning_and_Traffic_Management_of_Local_Cities_The_Case_of_the_Philippines on September 29, 2018
[23] Macapagal, D. (1964). *Republic Act No. 4136.*Retrieved from http://www.officialgazette.gov.ph/1964/06/20/republic-act-no-4136/ on September 28, 2018
[24] MeenaKumari, S &Geethanjali, N. (2010).*A Survey on Shortest Path Routing Algorithms for Public Transport Travel.*Retrieved from https://www.researchgate.net/publication/238722629_A_Survey_on_Shortest_Path_Routing_Algorithms_for_Public_Transport_Travelon September 28, 2018
[25] Penados M., Mondejar G., Notaga M.A.&Villeza A. (2004). *A Thesis on Traffic Management Along EDSA and Quezon Avenue.* Retrieved fromhttps://www.scribd.com/document/325901639/A-Study-on-Traffic-Management-Along-EDSA-in-Metro-Manila-2 on October 3, 2018
[26] Porter M. (n.d.). *Social Progress Index.*Retrieved from https://www.isc.hbs.edu/research-areas/Pages/social-progress-index.aspx on October 2, 2018