



Bicycle lanes development plan in Mataram city

Baiq Musfiatin, Buan Anshari, I Dewa Made Alit Karyawan

Abstract

Mataram City Government established a bicycle lane at Udayana Street as an alternative for all community to shift their motorized transport by bicycle as a daily transport and to support the NTB Cycling program from NTB Provincial Government. To accommodate changing mode of transportation from motorbikes or cars to bicycles, it is necessary to develop bicycle lanes in Mataram City. Vissim software used to forecast the impact of bicycles lane development at 9 provincial roads as the study area. From the analysis after implementation of bicycles lane development, there is a decrease in level of service based on Volume per Capacity Ratio. In addition, at signal intersection show an increase in queue length and vehicle delays. To minimize the impact of bicycles lane development, mitigation is carried out by rearranging the intersection cycle time. And the result is a reducing of CO, NOx and VOC emissions, fuel consumption, vehicle queue lengths and vehicle delays.

Keywords

Bicycle lanes planning; non motorized transport; vissim

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Home > Archives > **Vol 2 (2021)**

Vol 2 (2021)

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Table of Contents

Articles

Non-destructive testing (NDT) in industry 4.0: A brief review Ali Sophian	PDF 1-9
The differences of satisfaction between national health insurance and general patients in public hospital, Wangaya Denpasar Made Karma Maha Wirajaya, Putu Ayu Laksmi, Ni Nyoman Dwi Sutrisnawati	PDF 10-19
Communal wastewater treatment plant design with up-flow anaerobic filter processing technology in Rumak Village, Kediri Sub-district, West Lombok Gagassage Nanaluh De Side, Lalu Auliya Aqraboeilitaqa	PDF 20-27
Cyclic voltammetry of LSCF-cathodes formed using combustion method with sucrose as propellant Mohd Hafiz Yaakob, Lee Sin Ang, Zaidi Ab Ghani, Noor Hafizah Uyup, Nor Hafizah Che Ismail	PDF 28-35
Combination of automatic microneedling therapy with human dermal fibroblast conditioned media (hDF-CM) for atrophic acne scars Dedianto Hidajat, Niti Wedayani	PDF 36-47
Government intervention in reducing the disparity of grain and rice prices in the domestic market of West Lombok Regency Suparmin Suparmin	PDF 48-55
Mechanical characterization of powder metallurgy products with aluminum waste materials using multi stage pressing method I Made Mara, IGAK Chatur Adhi W, Made Wijana, I Made Nuarsa, AA Alit Triadi	PDF 56-62
Experimental study on the effect of variations in the mass of the waste exhaust valve ballast and the distance of the waste exhaust valve on the performance of the ram hydraulic pump Angky Puspawan, Agus Suandi, Yovan Witanto, Agus Nuramal, Nurul Iman Supardi, Emilio Oktori, Ariska Afriansah	PDF 63-71
Conversion of bamboo waste from chopstick industry to activated charcoal J. Pramana Gentur Sutapa, Theo Rezky Arie Ramba	PDF 72-87
Performance comparison of ant colony system and firefly algorithm for traveling salesman problem Cipta Ramadhani, Muhamad Irwan, Muhamad Syamsu Iqbal	PDF 88-93
The developed online mathematics learning tools in the phase of one to one evaluation for probability topic in vocational high school Syalendra Putra, Saleh Haji	PDF 94-101
Towards sustainable rural communities: Utilizing the terroir approach in agro ecology Fitrio Ashardiono	PDF 102-109
Suitability of ultra-high performance fibre reinforced concrete (UHPFRC) for cast-in-situ applications A.M.T. Hassan, G.H. Mahmud, S.W. Jones	PDF 110-114
The role of porang flour and oyster mushroom in providing quality vegetarian meatball Zainuri Zainuri, Yeni Sulastri, Dian Novita Sari Kurniawati, Dewa Nyoman Adi Paramartha	PDF 115-120
As a synergy of the Pemenang-Gili Indah cruise protection system, the passenger cognitive chart for accidents Ida Ayu Oka Suwati Sideman	PDF 121-128
Growth and yield response of shallots applied with growth regulators benzyl amino purine (GR BAP) and liquid bioactivator of trichoderma harzianum fungus I Made Sudantha, I G.P. Muliarta Aryana, Suwardji Suwardji, Irfan Jayadi, I Made Anggayuda Pramadya	PDF 129-140
Design of wireless data transmission tool using XBee Noveri Lysbetti Marpaung, Edy Ervianto, Rahyul Amri, Nurhalim Nurhalim, Dedy Nurahmadin	PDF 141-147
Utilization of YouTube application in lectures to improve pedagogic competency of PGSD UNIB students in the period of covid-19 pandemic Neza Agusdianita, Hasnawati Hasnawati, Nani Yuliantini, Panut Setiono, Dwi Anggraini, Yuda Septian Kurniawan	PDF 148-155
Analysis of the causes and prevention of runaway excursions Ratih Sekartadji, I Dewa Made Alit Karyawan	PDF 156-166
Optimization production capacity by improving transfer chute to control material flow and prevent belt conveyor off centerline in mining plant Sabri Bahrun, Mohd Shahrizan Yusoff, Azmi Hassan, Mohamad Sazali Said	PDF 167-177

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- [Other Journals](#)

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INFORMATION

- [For Readers](#)
- [For Authors](#)
- [For Librarians](#)

The production of biochar by pyrolysis from <i>Jatropha Curcas</i> L. husk: Optimization via response surface methodology	PDF 178-186
Zaidi Bin Ab Ghani, Lee Sin Ang, Mohd Hafiz Yaakob, Nor Hafizah Che Ismail, Noor Hafizah Uyup, Izmal Nurhaqem Mohamed Khamil	
Preparation of activated carbon from wood bark by using H₃PO₄	PDF 187-195
Zaidi Bin Ab Ghani, Lee Sin Ang, Mohd Hafiz Yaakob, Nor Hafizah Che Ismail, Noor Hafizah Uyup, Siti Hadijah Abdul Halim	
Digital image processing using Matlab and imageJ	PDF 196-202
Eduwin Saputra, M. Lutfi Firdaus	
The ability of elementary school teachers to algebra: The impact of the implementation of the horizontal-vertical mathematical approach in State Elementary School 67 in Bengkulu City. (Community Service Activities)	PDF 203-210
Saleh Haji, Hari Sumardi, Yumiati Yumiati	
Analysis of benzodiazepine metabolite in the urine of Wisma Anggrek Resident, Mutiara Sukma Psychiatric Hospital, West Nusa Tenggara	PDF 211-214
Lale Budi Kusuma Dewi, Yunan Jiwintarum, Ida Bagus Rai Wiadnya, I Komang Sudarsana	
Antidiabetic activity of <i>Phaseolus vulgaris</i> L. extract on the diabetic rat : Fasting blood glucose levels and insulin expression in pancreatic β cells	PDF 215-221
Nurhidayati Nurhidayati, Novrita Padauleng, Herpan Syafii Harahap, Yayuk Andayani, Dyke Gita Wirasistya, Anak Agung Ayu Niti Wedayani, Rizka Vidya Lestari, Putu Suwita Sari	
Application of induction heating in the biodiesel production process using oscillatory flow reactor	PDF 222-230
Suryanto Suryanto, Jumadi Tangko	
Nanomaterial-based colorimetric sensors for melamine and polymers analysis : A review	PDF 231-251
Rima Mayesmy Harahap, M. Lutfi Firdaus	
Classification of location landslides areas with direct measurement and remote sensing in Central Lombok	PDF 252-256
M.S. Yadnya, I.W. Sudiarta, W. Wedashwara	
Modelling ultra high performance fibre reinforced concrete UHPFRC slabs using concrete damage plasticity model	PDF 257-263
G.H. Mahmud, A.M.T. Hassan, S.W. Jones	
Digital transformation: building human capital and personal branding as opportunities for competitive advantage	PDF 264-272
Ni LuhPutu Surya Astitiani, Ni Made Widnyani	
Tsunami inundation maps in Mataram City based on tsunami modeling	PDF 273-278
Ricko Kardoso, Agastya Ardha Chandra Dewi	
The overview of antibiotic prophylaxis usage in The Surgical Department of General Hospital of West Nusa Tenggara Province within 2018	PDF 279-286
Dewi Septianingsih, Candra E. Puspitasari, Dewi Suryani	
The generative traits and genetic parameters of soybean under drought stress at various growth phases	PDF 287-297
Kisman Kisman, A.F. Hemon, S.M. Dewi	
How zoom dominate market share on video conferencing platform	PDF 298-309
Ida Bagus Ketut Widiartha	
Residual effects of herbicides on the growth and yield of shallot that are planted as a following crop after maize planting	PDF 310-321
M. Taufik Fauzi, I Ketut Ngawit	
Literature review accuracy code of neoplasm diagnosis based on icd-10	PDF 322-327
Oktamianiza Oktamianiza, Deni Maisa Putra, Rahmadani Rahmadani	
Analysis of patient's satisfaction on national health insurance (BPJS-K) towards health services at Mataram University Hospital	PDF 328-339
Putu Sri Sundari Rijasa, Wahyu Sulistya Affarah, Hamsu Kadriyan	
Communication radio utilization as data transmitter of earthquake victim's condition in evacuation point	PDF 340-346
Reno Siska Syafflina, Zaini Zaini	
Performance evaluation of Amarsvati Condominium Hotel building structure using pushover analysis based on Indonesia Newest Seismic Code	PDF 347-356
Jamalullael Jamalullael, Suparjo Suparjo, Ni Nyoman Kencanawati	
Developing inquiry-based lesson plan on work and energy	PDF 357-362
Endang Susilawati, Agustinasari Agustinasari	
True drip irrigation performance on discharge variation and distance of lateral pipes	PDF 363-371
I Dewa Gede Jaya Negara, Lalu Wirahman W., Humairo Saidah, Ni Ketut Widhiasti	
Implementation of blended learning in elementary schools	PDF 372-376
Desak Made Anggraeni, Ferdinandus Bele Sole	
Identification of 13th July 2019 Sumbawa earthquake source using double difference method	PDF 377-384
Rian Mahendra Taruna, Danis Istiqomah Irianti, Ardhianto Septiadhi, Anggitya Pratiwi	
Effect of polypropylene fibers on unrestrained early age shrinkage of concrete and long-term performance subjected to fire	PDF 385-395
Suryawan Murtiadi, Akmaluddin Akmaluddin, Ni Nyoman Kencanawati	
Numerical modelling of double shear timber connection using wood dowel fastener with adhesive coated	PDF 396-401
Rahmad Hidayat, Buan Anshari, Aryani Rofaida, Pathurahman Pathurahman, Suparjo Suparjo	
Adsorption energy of amide-kaolinite systems using supramolecular method: A study on the basis set effect	PDF 402-412
Zaidi Ab Ghani, Norlin Shuhaime, Zalina Zainal Abidin, Mohd Hafiz Yaakob, Lee Sin Ang	
New atrial fibrillation in patient with suspect pulmonary embolism due to COVID-19	PDF 413-418
Yusra Pintaningrum, Tiara Kusuma, Rina Lestari	
Miscellaneous of direct normal solar irradiation on Rinjani Mountain: it's impact on local climate	PDF 419-431
Mahrup Mahrup, M. Ma'shum, I. Yasin, Fahrudin Fahrudin	
Ecotourism suitability in the use zone of Teluk Bumbang Conservation Area	PDF 432-443
Sitti Hilyana, Tasrif Kartawijaya, Nurliah Nurliah, Soraya Gigentika, Hernawati Hernawati	
Analysis of the relationship between comfort level of Schoology assisted learning on the understanding physics concepts	PDF 444-453
Rakhmatul Ummah, Dwi Sulisworo, Nurulhuda Abd Rahman	

Evaluation of the BPJS primary care (P-Care) application on health services in primary health care: systematic review	PDF
Made Karma Maha Wirajaya, Vitalia Fina Carla Rettobjaan	454-459
Parasitoid of fall armyworm larvae, spodoptera frugiperda (Lepidoptera: Noctuidae) on mize at Lombok Island	PDF
Bambang Supeno, Tarmizi Tarmizi, Hery Haryanto, Ni Made Laksmi Ernawati	460-466
Analysis of satisfaction in user gojek application: systematic review	PDF
Vitalia Fina Carla Rettobjaan, Made Karma Maha Wirajaya	467-474
Assessment of factors influencing adoption of devops practices in public sector and their impact on organizational culture	PDF
Mohammed Mubarkoot	475-483
Growth and yield of peanuts (Arachis hypogaeaL.) on intercropping with sorghum (Sorghum bicolor L.)	PDF
Akhmad Zubaidi, Syastika Yuniarti, Kisman Kisman, Dwi Ratna Anugrahwati	484-488
Effects of ginger and Sumbawa honey drinks on cough frequency in children with respiratory tract infection	PDF
Ari Khusuma, Arini Pradita Roselyn, Annisa Agata	489-492
Overview of removal of urban litter in Malaysia: Debris trapper	PDF
M.A.Z Mohd Remy Rozainy, A.W Khairi, S. Hamzah, J. Ikhsan	493-500
The effectiveness of online practicum in agriculture during the pandemic in Syiah Kuala University	PDF
Nasyatul Ula, Muhammad Ramadhani, Syifa Sabrina, Vira Afriliyandha	501-511
Development of homemade hybrid-RT-LAMP Lateral Flow Assay as an alternative kit for detection of SARS-CoV-2 under certain conditions	PDF
Sulaiman N Depamede, Made Sriasih	512-518
Sago business development scenario in North Luwu Regency, South Sulawesi	PDF
Makkarennu Makkarennu, Muh Alif Caesar Ghifari, Supratman Supratman	519-533
Level of application of health protocols for agricultural students Syiah Kuala University	PDF
Istamara Firda, Ira Wahyuni, Afta Pratiwi Br Barus, Jasaf Wanida	534-539
Electric and magnetic fields around the tower due to lightning-strikeusing lightning current simulation	PDF
Ni Made Seniari, I Made Ginarsa, Ida Bagus Fery Citarsa, Supriyatna Supriyatna, Ida Ayu Sri Adnyani	540-551
Performance of micro grid system with an automatic transfer switch for photovoltaic and small wind turbines: a case study at the laboratory of renewable energy, the University of Mataram	PDF
Abdul Natsir, Sultan Sultan, Infa Andrian	552-561
Leucaena (L. leucocephala) – an environmentally friendly solution to the low cattle productivity in the dry land	PDF
Dahlanuddin Dahlanuddin	562-566
The effect of the thermal processing on the changes of physical and mechanical behaviour of peat soil in West Donggala, Central Sulawesi	PDF
Sukiman Nurdin, Stephanus Aleksander, Astri Rahayu, Sriyati Ramadhani, Irdhiani Irdhiani	567-579
Bicycle lanes development plan in Mataram city	PDF
Baiq Musfiatin, Buan Anshari, I Dewa Made Alit Karyawan	580-588
Teaching material development educational statistics with SPSS	PDF
Batdal Niati, Annajmi Annajmi	589-597
Yield performance of irrigated aerobic red rice intercropped with peanut under long-term application of organic wastes	PDF
Ni Wayan Dwiani Dulur, Wayan Wangiyana, Nihla Farida, I Gusti Made Kusnarta	598-605
Compression behaviour on axial and lateral forces of pipe composite epoxy with jute fibres reinforced	PDF
I.D.G Ary Subagia, K. Adi Atmika, I.G.A. N. Putranata	606-613
Marketing strategy of roti X product during the Covid-19 pandemic	PDF
Dharma Widada, Masayu Widiastuti	614-621
A simple model of the influence of gender on the driving behavior of students motorcycle riders on traffic violations and accidents in a Mataram city using a structural equation model	PDF
I Wayan Suteja, I A O Suwati Sideman, I Dewa Made Alit Karyawan, I Gede Putu Warka	622-632
Review of Lembar sea port performance based on aspect of port performance indicator's	PDF
I Wayan Suteja, I A O Suwati Sideman, I Gede Putu Warka	633-637
Application of hybrid solar dryer for supporting community business on the new normal era	PDF
Rahmat Sabani, Sukmawaty Sukmawaty, Murad Murad, Ansar Ansar, Amuddin Amuddin	638-648
Design of facial expreshion using convolutional neural network	PDF
Muhammad Sya'roni Mujahidin, Misbahuddin Misbahuddin, Toufani Rizal Alfarisi	649-652
Physical characteristic of mangosteen (Garcinia mangostana L.)	PDF
Rosyid Ridho	653-658
The effect of using LEDs (Light-Emitting Diodes) as lighting systems in greenhouse on Lettuce (Lactusa Sativa L.)	PDF
Rosyid Ridho	659-672
Colorimetric analysisof citric acid using silver nanoparticles (AgNPs)	PDF
Wangi Pusva Kartini, M. Lutfi Firdaus	673-678
Numerical modelling of double shear timber connection using bamboo dowel fastener with adhesive coated	PDF
Wini Lestari, Buan Anshari, Jauhar Fajrin, Pathurahman Pathurahman, Suparjo Suparjo	679-684
Untapped bioenergy resources around us: Case studies of West Sumatra	PDF
Fadjar Goembira	685-689
Analysis of Katon weir water availability to planting patterns and regional water supply systems of Katon irrigation, Janapria sub district, Central Lombok	PDF
Salehudin Salehudin, L. Wirahman W, Rohani Rohani, Hasyim Hasyim	690-697
Poverty data modelling in West Nusa Tenggara Province using panel data regression analysis	PDF
Shilvia Aodia, Nurul Fitriyani, Marwan Marwan	698-708
Impact of cold-immersion time to the preservation of galah bamboo (Gigantochloaatter (Hassk.) Kurz ex Munro) in extract of gadung (Dioscoreahispida Dennst.) tuber	PDF
Febriana Tri Wulandari, Radjali Amin	709-718

[Survey on knowledge, attitude, and behavior related to the covid-19 pandemic in West Nusa Tenggara](#)

[PDF](#)
719-725

Wahyu Sulistya Affarah, Putu Suwita Sari, Pujiarohman Pujiarohman, Joko Jumadi, Ruli Ardiansyah, Khairus Febrian Fitrahady

[The role of family planning field officers in the implementation of family planning program during the covid-19 period in Monjok Subdistrict Selaparang Mataram City](#)

[PDF](#)
726-733

Ana Pujianti Harahap, Aulia Amini, Rizkia Amilia, Indriyani Makmun

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Bicycle lanes development plan in Mataram city

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Abstract. Mataram City Government established a bicycle lane at Udayana Street as an alternative for all community to shift their motorized transport by bicycle as a daily transport and to support the NTB Cycling program from NTB Provincial Government. To accommodate changing mode of transportation from motorbikes or cars to bicycles, it is necessary to develop bicycle lanes in Mataram City. Vissim software used to forecast the impact of bicycles lane development at 9 provincial roads as the study area. From the analysis after implementation of bicycles lane development, there is a decrease in level of service based on Volume per Capacity Ratio. In addition, at signal intersection show an increase in queue length and vehicle delays. To minimize the impact of bicycles lane development, mitigation is carried out by rearranging the intersection cycle time. And the result is a reducing of CO, NOx and VOC emissions, fuel consumption, vehicle queue lengths and vehicle delays.

Keywords: Bicycle lanes planning; non motorized transport; vissim

1. Introduction

1.1. Background

Bicycles as an alternative to non-motorized transport have various advantages, including not creating air and noise pollution, being more economical in terms of price and not requiring fuel. Creating an integrated friendly environmental transportation system can reduce exhaust emissions produced by private vehicles, providing a good effect on public health. Economically, bicycle maintenance is much cheaper than other modes of transportation. These three aspects are the concept of sustainability which cannot be separated from one another, Jeffrey [1]. The provision of bicycle infrastructure has an important role, by building the right infrastructure people are tend to use bicycles more often, Ekblad [2]. In December 2019, the Mataram City Government established a bicycle lane as an alternative to the community in carrying out activities along Udayana Street. The formation of cycling communities

in Mataram City shows the high enthusiasm of the community in changing their lifestyle, to maintain the urban air quality and awareness of the importance of health. To support the program of the NTB Provincial Government in NTB Cycling and also accommodate the changes of transportation mode of the community from using motorbikes or cars to bicycles, it is necessary to develop bicycle lanes in Mataram City.

1.1. Research purposes

In general, this study aims to determine how the impact of bicycle lanes planning on the performance of roads and intersections in the study areas, the impact of mitigation at the APILL intersection toward network performance after the application of the bicycle lanes and what is needed by motorized vehicle users to switch to using a bicycle.

2. Research methods

This research located at 9 provincial roads in Mataram City as seen in Table 1.

Table 1 Road section of the Research Location

No	Street Name	Lenght of Path
1	Langko	2,3 Km
2	Pejanggik	1,92 Km
3	Bung Hatta	0,96 Km
4	Bung Karno	1,09 Km
5	Sriwijaya	1,32 Km
6	Majapahit	2,05 Km
7	Majapahit 2	1,00 Km
8	Yos Sudarso	0,85 Km
9	Airlangga	1,58 Km

Performance data of the existing roads and intersections were obtained from the Traffic Counting and CTMC surveys, while to find out the origin of the trip, Home Interview survey was carried out. In addition, secondary data in the form of geometric road data, land use and road networks were collected as input data in the Visum and Vissim programs to conduct forecasting after the development of bicycle lanes was applied to the roads that were being the study area.

3. Results and discussion

The roads study area are under the authority of the provincial government, the street of Yos Sudarso, Langko, Pejanggik, Majapahit and Sriwijaya are the secondary arterial roads, while street of Airlangga, Bung Hatta and Bung Karno are the primary collector roads.

3.1. Eksisting roard sections performance

Table 2. Exsisting Road Section Performance

No	Name	Type	Capacity	Volume	VCR	LOS
			(smp/hour)	(smp/hour)		
1	St. Langko	3/1 UD	4293.77	2467	0.57	C
2	St. Pejanggik	3/1 UD	4293.77	2475	0.58	C

3	St.Bung Hatta	4/2 D	5239.93	986	0.19	A
4	St.Bung Karno	4/2 D	5239.93	1481	0.28	A
5	St.Sriwijaya	4/2 D	5239.93	1890	0.36	B
6	St.Majapahit	4/2 D	5239.93	2744	0.52	B
7	St.Majapahit 2	2/1 UD	3122.74	1994	0.64	C
8	St.Yos Sudarso	4/2 D	6245.49	3281	0.53	B
9	St.Airlangga	4/2 D	4756.75	1808	0.38	B

From Table 2, the roads which have the best service levels are Bung Hatta and Bung Karno Street with rank A Level of Service or free traffic flow conditions with high speed and low traffic volume. Next are street of Sriwijaya, Yos Sudarso, Airlangga and Majapahit with rank B service level or steady flow, but the operating speed is starting to be limited by traffic conditions. Meanwhile, street of Langko, Pejanggik and Majapahit 2 (the crossroad Seruni to Ampenan) shows the C rank level of service or the flow is stable but the speed and movement of the vehicle is controlled. To do forecasting, model validation is carried out to prove whether the model that will be used to forecast travel in the plan year can be used or not. The validation model used is Chi square test. The decision is accepted (Ho is accepted) based on the calculation. While is obtained from the Z-test table. From Table 3 it can be concluded that the model can be used because it is in accordance with the existing conditions with a 95% confidence level. After the validation test is carried out, the model can be used as an application for forecasting.

Table 3. Validation model test

No	Name	Type	Survey		
			Volume (smp/hour)	Model Volume (smp/hour)	
1	St. Langko	3/1 UD	2467	2467	0.00
2	St. Pejanggik	3/1 UD	2475	2475	0.00
3	St.Bung Hatta	4/2 D	986	986	0.00
4	St. Bung Karno	4/2 D	1481	1481	0.00
5	St.Sriwijaya	4/2 D	1890	1890	0.00
6	St.Majapahit	4/2 D	2744	2744	0.00
7	St.Majapahit 2	2/1 UD	1994	1994	0.00
8	St.Yos Sudarso	4/2 D	3281	3281	0.00
9	St.Airlangga	4/2 D	1808	1808	0.00
				Chi Hitung	0.00
				Chi Tabel	3.33
				Conclusion	Ho Accepted

After distributing the survey form to 400 respondents who live in the 11 predefined zones, 276 data on vehicle users in each zone that definitely changed modes by bicycle were obtained, the origin of the respondents' travel destinations are shown in Table 4.

Table 4. Matrix Origin Destination (O/D Matrix)

OD	1	2	3	4	5	6	7	8	9	10	11	Total
1	0	0	3	5	4	0	0	0	1	9	7	29
2	0	0	0	0	5	1	2	0	0	14	8	30
3	0	0	0	3	4	0	0	0	0	5	27	39
4	0	0	0	0	7	1	0	0	0	4	16	28

5	0	0	0	0	0	2	4	5	0	7	14	32
6	0	0	0	0	4	0	5	1	0	2	13	25
7	0	0	0	0	2	2	0	1	0	3	23	31
8	2	0	0	0	1	2	5	0	0	3	4	17
9	0	0	0	0	0	0	3	2	0	11	1	17
10	0	0	0	0	0	0	0	0	0	0	24	24
11	0	0	0	0	0	0	0	0	0	4	0	4
Total	2	0	3	8	27	8	19	9	1	62	137	276

Desire line map made from the matrix of the origin destination, as a results of the home interview survey from the people activity. Based on the data obtained, most of the respondents in all zones carried out many activities to zone 11, namely Mataram 3, where the area is the center of office and school activities. The second highest activity attraction or destination area is in zone 10, namely Selaparang 3, which is in Dasan Agung Village with the center of activity being dominated by offices and schools.

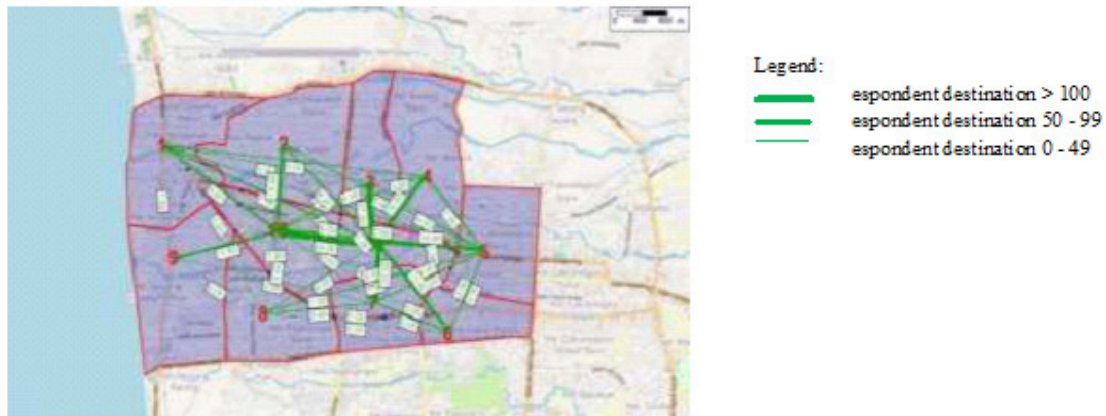


Figure 1. Desire Line of Potential Bicycle user

3.2. Intersection performance with traffic signaling devices (APILL) existing

From Table 5, it can be seen that the performance at each APILL intersection is in the form of queues, delays, spent fuel consumption, and the amount of pollution produced. It can be seen in the table that the higher traffic delay value at the intersection, the higher fuel consumption is spent and the higher pollution produced.

Table 5. Intersection Performance APILL Existing

No	Node	Emissions CO (gram)	Emissions NOx (gram)	Existing		Queue (m)	Delay (s)
				Emissions VOC (gram)	Fuel Consumption (US Gallon)		
1	BI Intersection	1415.69	275.44	328.10	20.25	42.43	68.91
2	Gubernur Intersection	607.45	118.19	140.78	8.69	37.86	49.67
3	Air Mancur Intersection	1464.05	284.85	339.31	20.94	53.95	80.46

4	Aston Intersection	819.13	159.37	189.84	11.72	38.00	59.11
5	Bung Karno Intersection	459.68	89.44	106.54	6.58	14.56	24.82
6	Mc D Intersection	1545.28	300.65	358.13	22.11	47.60	69.10
7	Epicentrum Intersection	1508.54	293.51	349.62	21.58	89.79	90.12
8	Seruni Intersection	729.82	142.00	169.14	10.44	36.65	12.30
9	AMM Intersection	283.06	55.07	65.60	4.05	40.25	19.27
10	Airlangga Intersection	245.75	47.81	56.96	3.52	44.97	26.99

3.3. Existing Road Network Performance

On 9 provincial roads in one road network in Mataram City which is become the study area, the existing condition of the speed to travel the roads on the network is 24 km / hour. As shown in Table 6, the total distance traveled was 2,556.99 km and the total time required was 812445.20 seconds.

Table 6. Existing Road Network Performance

Network Speed (km/hour)	Total Distance (km)	Total time (Second)
24.00	2556.99	812445.20

3.4. The impact of bicycle lanes application on intersection performance

Table 7. The Road Section performance after the application of bicycle lanes

No	Name	Type	Capacity	Volume	VCR	LOS
			(smp/hour)	(smp/hour)		
1	St. Langko	3/1 UD	3844.88	2451	0.64	C
2	St.Pejanggik	3/1 UD	3844.88	2432	0.63	C
3	St.Bung Hatta	4/2 D	4367.28	963	0.22	A
4	St.Bung Karno	4/2 D	4367.28	1458	0.33	A
5	St.Sriwijaya	4/2 D	4367.28	1844	0.42	B
6	St.Majapahit	4/2 D	4367.28	2701	0.62	C
7	St.Majapahit 2	2/1 UD	2691.41	1951	0.72	C
8	St.Yos Sudarso	4/2 D	5382.83	3265	0.61	C
9	St.Airlangga	4/2 D	4490.18	1756	0.39	B

At the comparison before and after the bicycle lane operates there are some changes in the level of road service, especially on roads that have high side obstacles. For example, street of Majapahit and Yos Sudarso, which were originally in the rank B Level of Service, after the bicycle lane was implemented the service level became C.

3.5. Impact of Bicycle Path Application on Intersection Performance

Table 8. Intersection performance after Bicycle Lanes Application

No	Node	Emissions CO (gram)	Emissions NOx (gram)	Oprations		Queue (m)	Delay (s)
				Emissions VOC (gram)	Fuel Consumption (US Gallon)		
1	BI Intersection	1419.66	276.21	329.02	20.31	41.52	68.60
2	Gubernur Intersection	612.58	119.19	141.97	8.76	37.75	56.21
3	Air Mancur Intersection	1360.86	264.77	315.39	19.47	55.63	70.13
4	Aston Intersection	740.20	144.02	171.55	10.59	38.46	57.66
5	Bung Karno Intersection	537.06	104.49	124.47	7.68	20.07	31.47
6	McD Intersection	1660.66	350.72	360.41	23.73	42.96	62.69
7	Epicentrum Intersection	1501.14	292.07	347.90	21.48	100.97	105.44
8	Seruni Intersection	742.70	144.50	172.13	10.63	39.42	14.47
9	AMM Intersection	280.59	54.59	65.03	4.01	51.75	20.21
10	Airlangga Intersection	239.68	46.63	55.55	3.43	46.32	29.67

The implementation of bicycle lanes has effect the performance of intersections as illustrated in Table 8, there is an increase in queue length at 7 intersections, namely the Air Mancur Pajang, the Aston, Bung Karno, the Epicentrum, the Seruni, AMM and Airlangga Intersections. Increased time delays also occurred at 6 intersections, whice are the Governor's intersection, Bung Karno intersection, Epicentrum intersection, Seruni intersection, AMM intersection and Airlangga intersection.

3.6. The Impact on Road Network Performance

If bicycle lanes are implemented on the study area, there will be an increase in speed on the network and a decrease in the total distance as shown in Table 9. The total travel time has also decreased; originally the travel time on the network was 812445.20 seconds, after the implementation of the bicycle lanes it became 780266.10 second. Meanwhile, the speed on the network, which was originally 24 km / hour, has increased to 24.25 km / hour.

Table 9. Performance of the Road Network after the Application of Bicycle Paths

Network speed (km/hour)	Total distance (km)	Total time (detik)
24.25	2506.36	780226.10

3.7. Mitigation of intersection with APILL

After mitigation measures againts the impact of operating the bicycle lanes, there is an improvement in the overall performance indicator of the intersection as in Figure 2, namely the total amount of CO for

all intersections produced was reduced from the conditions during operation 9095.13 grams to 8978.82 grams, the total number of NOx, VOCs, vehicle fuel consumption, total queue and total vehicle delay in all intersections reduced from 1797.19 grams to 1746.95 grams for NOx, 2183.42 grams to 2080.94 grams for VOCs, 130.09 US gallons to 128.44 US gallons for vehicle fuel consumption, 474.85 meters to 444.65 meters of total queue, and 500.75 seconds to 500.44 seconds of total vehicle delay.

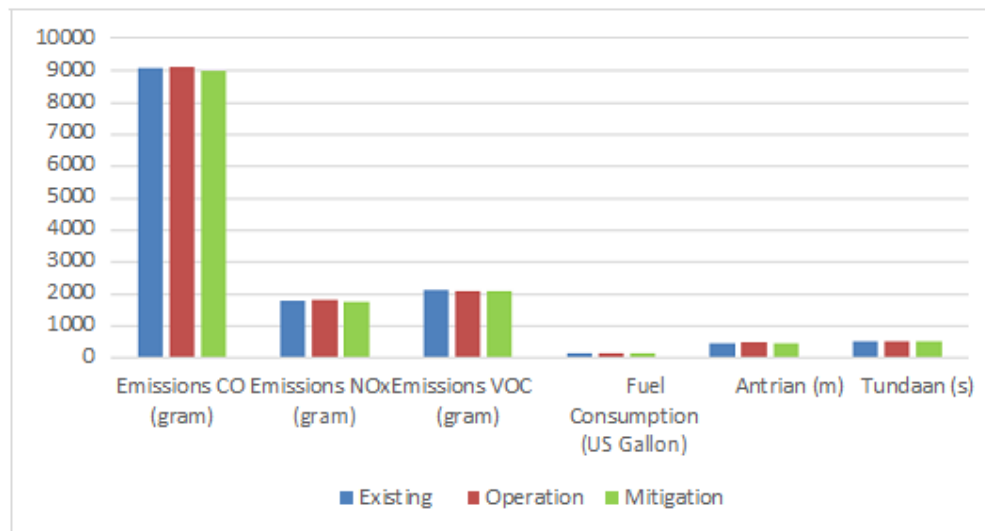


Figure 2. Intersection Service Level in Existing Condition, Bicycle Path Operation and Mitigation

3.8. Network performance with APILL cycle time change mitigation

The mitigation taken to maximize the performance of the transportation system, by change the traffic light cycle time. And the result is an increase in network speed and a reduction in time for all vehicles to travel in network system, but there is an additional mileage in the network system. Comparison of service levels in the network system before, after the implementation of the bicycle lanes and after mitigation at the APILL intersection can be seen in Figure 3.

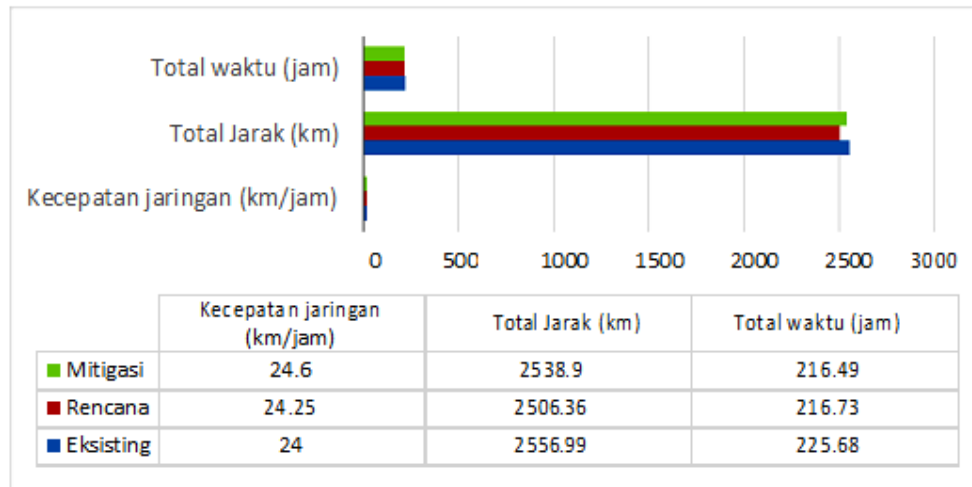


Figure 3. Network System Service Level in Existing Conditions, Bicycle lanes Operation and Mitigation.

4. Conclusion

- The impact of the bicycle lanes development plan policy on provincial roads which became the study area when the bicycle lane was operating was that there was a change in Level of Service (LOS) from B to C, namely on Majapahit street and Yos Sudarso street. At the APILL intersection where the bicycle lane passes, there was an increase in queue length at all intersections except McD intersection, BI intersection and Governor's junction where vehicle queues drop down to 4.6, 0.9 and 0.11 meters respectively. Whereas in the network system there was an increase in speed from 24 km / hour to 24.25 km / hour, a decrease in the total distance from 2556.99 km to 2506.36 km and a total travel time from 225.68 hours to 216.73 hours.
- Mitigation was carried out by resetting the intersection cycle time, at the BI, Governor, McD, Epicentrum, Seruni, AMM and Airlangga intersections. By resetting the APILL cycle at the 7 intersections, there was an increase in service as indicated by reduced CO, NOx and VOC emissions besides fuel consumption, vehicle queue lengths and vehicle delays were also reduced.

Recommendation

- Providing bicycle lanes with traffic signs, socializing the provision of safe parking facilities and changing clothes at the office, parking facilities in public areas and integrating bicycle routes with public transportation so that cyclists can travel longer.
- Regulate parking on roads that have bicycle lanes and provide traffic signs that regulate parking restrictions on bicycle lanes.
- Giving priority to cyclists in the crossing area by carrying out traffic management and engineering in the form of providing wider zebra crossings so that they can be used together with pedestrians, so that cyclists can cross safely and not cut off the flow of motorized vehicles that will turn left.

- Together with law enforcement officials, periodic monitoring and evaluation of the use of bicycle lanes.
- Issue local regulations that support the safety and security of bicycle users in road traffic

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