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Speed Evaluation on Type 4/2T Primary Collector Road (Case Study: Jalan Ir. H. Juanda, Tegal Regency)

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Abstract

Speed management plays a vital role in ensuring traffic safety on urban roads, especially on high-volume collector roads. Jalan Ir. H. Juanda, a Type 4/2T primary collector road in Tegal Regency, was observed to lack sufficient speed control infrastructure despite its dense activity centers such as schools and sports venues. The purpose of this study is to evaluate vehicle speed characteristics and assess conformity with the Ministerial Regulation PM 111/2015 on speed limits. Data were collected through traffic volume surveys, speed measurements using Smart Speed software, and road inventory observations. The results show an average speed of 48.5 km/h, while the 85th percentile (P85) speeds reached 69 km/h for motorcycles, 54 km/h for cars, and 51 km/h for medium vehicles—indicating that a significant portion of drivers exceed the recommended limits of 40–50 km/h. The calculated free-flow speed was 56 km/h, confirming the road's capacity to support higher speeds under unimpeded conditions. These findings highlight the potential risk of accidents due to speeding, particularly in pedestrian-prone zones. To address this, the study recommends installing speed limit signs, rumble strips, APILL (warning lights), and zebra crossings at critical points. Strengthened law enforcement and educational campaigns are also necessary to cultivate safer driving behavior. This research provides actionable insights for local traffic authorities in designing safer urban road environments.

Keywords: *speed; safety; speed management; traffic volume*

1. Introduction

Vehicle speed is one of the important factors that need to be managed properly in urban areas. When vehicles drive too fast without proper control, the risk of traffic accidents increases, especially on roads that are congested with vehicles and lack of safety facilities. Conditions like this are a real challenge for transportation managers in creating a safe and orderly road environment for all users. Transportation has become an important thing in human life, especially in shortening important things in human life, especially in shortening the time to reach a place. Not only to streamline the time of moving people, but it also helps in moving goods [1]. As a major connecting road with high traffic flows, this section requires an effective speed management approach to improve traffic safety and efficiency [2]. Traffic safety in the city is highly dependent on vehicle speed management.

With the increasing number of vehicles and community activities in Tegal Regency, road infrastructure is under greater pressure, especially on main roads such as Jalan Ir. H. Juanda. These roads are very important because they are designed to transport multiple vehicles and connect users from arterial roads to local roads. However, issues such as decreased safety often arise due to the greater amount of traffic. The behavior of the vehicle on the road is one of the factors that affect this. Speed evaluation on primary collector roads is very important, because uncontrolled vehicle speeds can increase the risk of traffic accidents and reduce the quality of road services. Based on the 2023 Indonesian Road Capacity Guidelines (PKJI), the analysis of travel speed (VT) and degree of saturation (DJ) is the main indicator in assessing the performance of a road section, especially for divided road types such as 4/2T [3].

Jalan Ir. H. Juanda has a high volume of vehicles and vehicle flow. Since there are offices, shops, and sports venues along the road, many vehicles congregate there. In addition to planning, volume, speed, and traffic density are used to evaluate roads. This road has a straight road without speed limit signs, so motorists tend to drive at high speeds, which decreases the comfort of other road users and increases the risk of accidents, especially when there is a conflict between vehicles or interactions with vulnerable road users such as pedestrians and cyclists.

By conducting traffic volume surveys, vehicle speed measurements and road inventory, this study is expected to make a real contribution to improving the safety and security of drivers. Therefore, it is important to evaluate the operational speed on the road section to find out the extent of the actual speed that occurs in the field and whether it is still in accordance with the function of the primary collector road as stipulated in the 2023 PKJI.

2. Research Methods

2.1. Research Location

This research was carried out on the Ir. H. Juanda Road Section, Tegal Regency, which has the status of a city road with a 4/2T road type and has a length of 950 meters and a width of 16 meters. The map of the research location is as follows:

Fig. 1: Research Location Map

2.2. Traffic Volume

Traffic volume data is collected through a traffic survey, which counts vehicles based on the type of vehicle passing through the Ir. H. Juanda Road Section. This data collection was carried out on Friday, June 20, 2025, for six hours in the morning, afternoon and evening hours. According to Government Regulation No. 34 of 2006, primary collector roads are an important part of the road network that serves to connect regional activity centers with local activity centers and serve collector and divider transportation with a certain speed and volume of traffic. According to Government Regulation No. 34 of 2006, primary collector roads must meet technical requirements such as a minimum planned speed of 40 km/h and a minimum road body width of 9 meters [4];[5].

2.3. Vehicle Speed

Vehicle speed data was obtained from several analyses, including the free-flow speed analysis used by PKJI and a real-time survey in the field using Smart Speed software at a certain distance. Distribution velocity analysis includes vehicle velocity in different time intervals, measured under normal traffic conditions. Furthermore, the average speed and 85th percentile speed will be calculated from the data collected. The 85th percentile speed is often used as the basis for determining a safe speed limit (speed limit) on a particular section of road. In the context of speed evaluation, the Decree of the Minister of Public Works No. 14 of 2006 and the Regulation of the Minister of Public Works No. 19 of 2011 regulate the speed and capacity standards of primary collector roads, which are referred to in the In-donesian Road Capacity Regulation (PKJI). PKJI sets the speed of cars on the 2/2-TT road type at around 65 km/h, with adjustments based on field conditions such as road width and side obstacles [6].

2.4. Road Inventory

In free flow velocity analysis, road inventory data includes geometric data of roads, road facilities, traffic, environmental conditions, and data measured directly. The effective width of the road and the level of side resistance are used to calculate the free flow speed correction value obtained from direct observation. To ensure that the speed of the vehicle is within safe and efficient limits, the road speed evaluation of the primary collector type 4/2T usually refers to the PKJI standard. In addition, the actual speed on the road is greatly influenced by the physical components of the road, such as the width of the road body, surface conditions, and intersection settings. Research in various locations shows that the adjustment and improvement of road infrastructure, as well as the enforcement of traffic rules, are indispensable to support the smooth and safety of primary collector roads [9].

2.5. Sampling Technique

The study uses sampling techniques to sample vehicles at specific time intervals on a regular basis to obtain accurate results of vehicle speed conditions in the field. To ensure that the data collected is sufficiently representative of the population of the traffic flow, which will then be used to collect velocity data using the Slovin formula a method of evaluating the effectiveness of signs using the N-Gain Score, which categorizes effectiveness based on changes in vehicle speed before and after passing the speed limit sign [7]. The evaluation of the performance of the primary collector road also needs to consider the level of service (Level of Service / LoS) and the degree of saturation (Degree of Saturation / DS). Morolu Malluluang et al. (2021) stated that primary collector roads with a DS greater than 0.85 indicate almost saturated road conditions and need to be handled to avoid congestion and significant speed decreases [8].

$n = N / (1 + N * e^2)$

Where:

n: is the required sample size.

N: is a measure of the population.

e: is the desired level of error or margin of error (usually expressed in decimal form, e.g. 0.01 to 1%).

2.6 Free Current Speed Analysis Based

According to PKJI 2023, road inventory formulas and data can be used to find free flow speeds. To begin, v_{BD} is calculated based on the type of roadway. Then, v_{BL} is calculated based on the width of the lane or lane based on the type of road. Furthermore, the FV_{BHS} is calculated based on the level of side resistance and whether there are sidewalks or cracks on the road. Finally, FV_{BUK} is calculated based on the size of the city.

2.7 85th Percentile Analysis

The 85th percentile method was used to analyze vehicle speed in this study. 85% of the vehicles observed were moving at the same or lower speeds, and the other 15% were moving faster. These two values indicate a common and safe speed for the majority of riders. The 85th percentile value is calculated by the cumulative frequency-based interpolation method, which is carried out according to the following formula:

$P85 = T_b + (0{,}85n - F/f)p$

Where:

P85 : 85th percentile speed (km/h),

T_B : Lower limit of interval class,

n : Total number of vehicles,

F : Cumulative frequency before the 85th percentile,

f : 85th percentile class frequency,

p : Class interval width

3. Results and Discussion

3.1. Traffic Volume

Table 1: 6-hour traffic volume

Vehicle type	Volume total
Motorbike	6071
Cars	2465
Medium vehicles	65
Non-motorized vehicles	13
Total	8614

From the results of the survey and data processing table 1, it was obtained that the total traffic volume on the Ir. H. Juanda Road section on Friday for 6 hours was 8,614 vehicles. The highest volume is motorcycles with 6.071. This figure shows that the dominant people use motorcycles to carry out activities all day on the Ir. H. Juanda road.

Table 2: Peak hours

TIME	VOLUME	Peak hours
07.00 - 08.00	1364	
08.00 - 09.00	1513	**Peak Hours**
11.00 - 12.00	1287	
12.00 - 13.00	1504	**Peak Hours**
15.00 - 16.00	1453	
16.00 - 17.00	1510	**Peak Hours**

Table 2 shows that there are three main peak hour periods that reflect the daily movement pattern of vehicles, according to the results of a traffic volume survey conducted on Jalan Ir. H. Juanda, Tegal Regency. The morning peak occurred at 08.00 WIB, with 1,513 vehicles per hour, showing the high mobility of people to work and economic activities. The peak of the afternoon occurred at 12.00 WIB, with 1,504 vehicles per hour, mostly due to rest activities, work shift changes, and private vehicle and public transportation traffic. The peak in the afternoon occurred at 17.00 WIB, with private vehicle traffic and public transportation.

3.2. Average Speed Results

Table 3: Average Speed

Vehicle type	Average speed (km/h)
Motorbike	55,95
Cars	46,17
Medium vehicles	43,39
Average total	48,50

Overall, the average speed of all vehicles on the observed road section was 48.50 km/h, according to table 3 of the results of the field survey, which was sampled from 98 motorcycles, 96 cars, and 39 medium vehicles. The average speed of a motorcycle is 55,95 km/h, a cars is 46,17 km/h and a medium vehicle is 43,39 km/h.

3.3. Analysis of free-flow

The results of the road inventory survey show that Jalan MT Haryono is a 4/2 type of road divided with an effective lane width of 4 meters, the distance to the reb to the nearest barrier of 2 meters, and moderate side obstacles around the road. The following calculation uses an analysis of the average free flow velocity of all vehicles from the data.

Table 4: Free Flow Speed Results

V_{BD}	V_{BL}	FV_{BHS}	FV_{BUK}	Free Current Speed
61	-4	0.984	1	56

Table 4 shows the free-flow speed on the Type 4/2T Primary Collector Road with a V_{BD} of 61 km/h and a V_{BL} of -4 km/h. The adjustment factor of the side resistance facing FV_{BHS} is 0.984, and the adjustment factor of the side obstacle in the direction of FV_{BUK} is 1. Based on the formula in PKJI 2023, the free flow speed can be calculated by multiplying the basic value of the V_{BL} free speed that has been adjusted for these factors. The result is a free-flow speed of 56 km/h, which indicates that the vehicle can move in unimpeded conditions at limits appropriate for the primary collector road type.

3.4. Analysis 85th percentile

The 85th percentile (p_{85}) speed analysis was obtained through the processing of data from instantaneous speed surveys that have been grouped into several speed ranges. Furthermore, the data is compiled in the form of frequency distribution and cumulative frequency to facilitate the determination of the velocity position at the 85th percentile. This value is calculated to determine the speed limit exceeded by the fastest 15% of vehicles, which is generally used as the basis for determining operational speeds. More information about the speed distribution and the results of the p_{85} calculation can be seen in table 5.

Analysis 85th Percentile Motorcycle

Table 5: Distribution Table Results

Interval			Frekuensi (f)	Frekuensi kumulatif (fk)
32	-	38	2	2
39	-	45	11	13
46	-	52	24	37
53	-	59	25	62
60	-	66	16	78
67	-	73	17	95
74	-	80	1	96
81	-	88	2	98

The following calculation is to find the 85th percentile of motorcycles.

Table 6: 85th Percentile Results

Location of the 85th percentile	
LOCATION	84
fk	78
fi	17
tb	67
P	7
n	98
P_{85}	69

From the results of the calculations, the 85th percentile speed was obtained at 69 km/h. The distribution of data in the graph can be seen in the following figure.

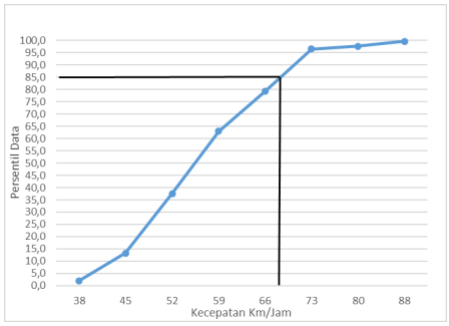

Fig. 2: 85th Percentile Graph

When viewed based on the picture 2 The 85th percentile of motorcycles is located at a speed of 67 km/h. A percentile value of 85 is taken based on the calculation, which is 69 km/h because the calculation method is considered more accurate. It indicates that 85% of motorcyclists who pass on the Ir. H. Juanda road have speeds of up to 69 km/h, while 15% of other motorists have speeds above 69 km/h.

Analysis 85th Percentile Of Cars

Table 7: Distribution Table Results

Location of the 85th percentile	
LOCATION	82
fk	79
fi	9
tb	52
P	8
n	96
P_{85}	54

The following calculation is to find the 85th percentile of cars.

Table 8: Distribution Table Results

Interval			**Frekuensi (f)**	**Frekuensi kumulatif (fk)**
35	-	42	32	32
43	-	50	43	75
51	-	58	11	86
59	-	66	9	95
67	-	74	0	95
75	-	82	0	95
83	-	90	0	95
91	-	98	1	96

From the results of the calculations, the 85th percentile speed was 54 km/h. The distribution of data in the graph can be seen in the following figure.

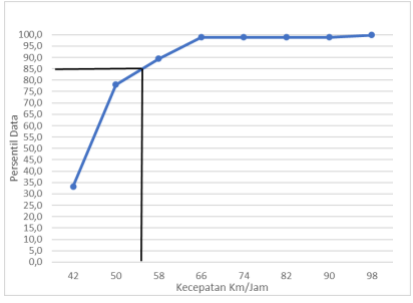

Fig. 3: 85th Percentile Graph

When viewed based on the picture 3 The 85th percentile of cars is located at a speed of 57 km/h. A percentile value of 85 is taken based on the calculation, which is 54 km/h because the calculation method is considered more accurate. It indicates that 85% of motorcyclists who pass on the Ir. H. Juanda road have speeds of up to 54 km/h, while 15 % of other motorists have speeds above 54 km/h.

Analysis 85th Percentile Of Medium Vehicles

Table 9: Distribution Table Results

Interval			Frekuensi (f)	Frekuensi kumulatif (fk)
33	-	36	4	4
37	-	40	8	12
41	-	44	11	23
45	-	48	7	30
49	-	52	5	35
53	-	56	3	38
57	-	60	1	39
33	-	36	4	4

The following calculation is looking for the 85th percentile of medium vehicles.

Table 10: Distribution Table Results

Location of the 85th percentile	
LOCATION	33
fk	23
fi	7
tb	45
P	4
n	39
P_{85}	51

From the calculation results, the 85th percentile speed was 51 km/h. The distribution of data in the graph can be seen in the following figure.

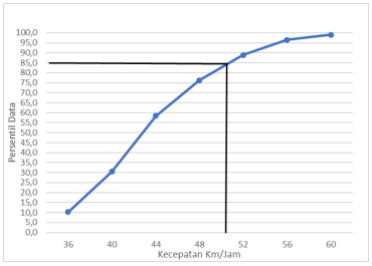

Fig. 4: 85th Percentile Graph

When viewed based on the picture 4 The 85th percentile of cars is located at a speed of 49 km/h. A percentile value of 85 is taken based on the calculation, which is 51 km / h because the calculation method is considered more accurate. It indicates that 85% of motorcyclists who pass on the Ir. H. Juanda road have speeds of up to 51 km/h, while 15% of other motorists have speeds above 51 km/h.

3.5. Speed Analysis Results Comparison

After analysis of the average speed, free current velocity and 85th percentile calculation, a comparison was made between the velocity results to be used as a further analysis.

Table 11: Speed Comparison

Speed analysis	V (km/jam)
Average speed	48,50
Free current speed	56
P85 SM	69
P85 MP	54
P85 KS	51

From the results of the analysis, it was found that the calculation of the 85th percentile had the highest value, which was 69 km/h, showing the maximum speed of the majority of motorcyclists on the road. The free flow speed has a value of 56 km / h that the conditions are unimpeded, the road section is able to support optimal speed. The average speed, which is 48.50 km/h much lower than the free-flow speed, indicates that the actual road conditions are affected by obstacles on the road section.

3.6. Speed Management Recommendations and Handling

Based on the results of the speed analysis on the Ir. H. Juanda road, recommendations and handling can be applied in the form of:

Speed Limit Setting

The results of the analysis showed that the average vehicle drove 48.50 km/h on Jalan Ir. H. Juanda, with a free flow speed of 56 km/h. The high P85 value of some types of vehicles indicates that the driver is driving beyond the safe limit, so handling efforts are needed to control the speed of the vehicle to improve traffic safety. To maintain smooth traffic but reduce the risk of accidents, the maximum speed limit is recommended at 40 km/h, slightly below the P85 value.

Furthermore, the installation of speed limit signs strategically is very important, especially in locations with high activity such as near sports venues, schools, and intersections. Law enforcement also needs to be implemented through periodic patrols or the installation of speed cameras at points prone to violations. In addition, to naturally slow down vehicles on certain sections of the road, you can make road geometric changes such as installing chicane, rumble strips, or speed tables.

Speed Reliance Facility

To improve safety on this road, it is recommended to add speed limit signs at the beginning of the road section and in strategic locations add warning signs such as many pedestrians and reduce speed such as in areas that are often used for exercise. It is hoped that information on signs, such as zebra crosses, in the appropriate places to make it clearer for drivers, will improve pedestrian safety and by re-thickening faded road markings and installing zebra cross markings in locations with many activities such as near sports venues or schools.

Education, Supervision and Law Enforcement

To inform road users of the importance of maintaining a speed that is appropriate to road conditions and the surrounding environment, especially in highly congested areas. Instead, speed signs and the use of speed-monitoring devices, such as speed cameras, should be used to increase surveillance. When it comes to traffic patrols and enforcement of speeding violations, law enforcement is essential.

Traffic Management and Engineering Recommendations

From the results of a study conducted on Jalan Ir. H. Juanda, Slawi, Tegal Regency, it was found that many motorists were still driving at high speeds, especially in areas that were quite densely populated. For this reason, several handling steps are suggested to reduce vehicle speed and improve the safety of road users. One important step is to install school zone signs so that drivers are more vigilant when crossing in vulnerable areas, especially around children who often cross. In addition, the maximum speed limit is recommended to be set at 40 km/h, which is strengthened by the installation of speed limit signs in strategic locations.

In order for drivers to be more aware and automatically reduce speed, it is also recommended to install rumble strips and school safety zone markings. This facility provides vibrations and visual cues that help the driver to slow down the vehicle's speed naturally. On the other hand, traffic regulation is strengthened by the installation of warning traffic lights (two-color APILL) as well as warning signs in intersection areas and accident-prone points. The addition of crossing signs is also important so that pedestrians feel safer when crossing the road. In addition, to avoid conflicts of vehicles in the opposite direction, the U-turn access at certain points is closed. All of these efforts are designed as part of a speed management system that aims to create safer, orderly, and more comfortable roads for all users. Figure 5 illustrates the recommended measures that can be implemented on the road segment to support speed control and enhance traffic safety.

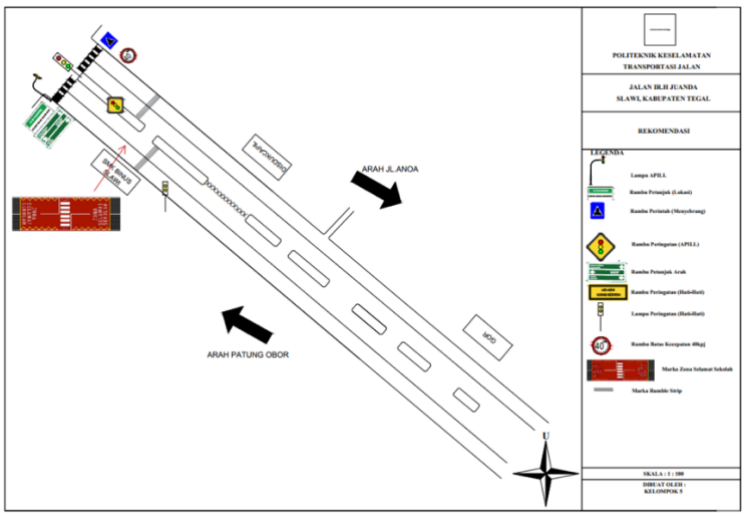

Fig. 5: Recommendations

4. Conclusion

This This study evaluated the speed performance and traffic conditions on Jalan Ir. H. Juanda, a Type 4/2T primary collector road in Tegal Regency, based on traffic volume analysis, speed measurements, and road inventory surveys. The observed total traffic volume over a 6-hour period reached 8,614 vehicles, dominated by motorcycles (6,071 vehicles), indicating high user dependency on two-wheelers in this corridor. The average speed recorded was 48.5 km/h, with motorcycles averaging 55.95 km/h, cars at 46.17 km/h, and medium vehicles at 43.39 km/h. The 85th percentile (P85) speeds were found to be 69 km/h for motorcycles, 54 km/h for cars, and 51 km/h for medium vehicles—indicating that at least 15% of vehicles exceed these values, posing a significant safety concern. Additionally, the calculated free-flow speed was 56 km/h, which suggests that the road has the geometric capacity to support relatively high speeds under uncongested conditions. However, when compared to the Indonesian Ministerial Regulation No. PM 111 of 2015, which recommends maximum speeds of 40 km/h for motorcycles and 50 km/h for four-wheeled vehicles in fast lanes, and 30 km/h for slow lanes, the observed speeds are significantly higher. This discrepancy highlights the urgent need for speed control interventions, particularly in zones near schools, sports facilities, and intersections. Based on these findings, several recommendations are proposed: (1) installation of speed limit signs at strategic points; (2) deployment of physical traffic calming measures such as rumble strips and speed tables; (3) installation of APILL (two-color warning lights) in accident-prone zones; (4) provision of zebra crossings and school zone markings; and (5) increased law enforcement and public awareness campaigns. These integrated measures aim to reduce speeding behavior and improve safety for all road users along urban primary collector roads.

References

[1] Z. N. Raudah, W. Kushartomo, and N. Najid, "Analisis Kapasitas Dan Kecepatan Arus Bebas Berdasarkan Mkji Di Ruas Jalan Gatot Subroto," *JMTS J. Mitra Tek. Sipil*, vol. 4, no. 1, p. 129, 2021, doi: 10.24912/jmts.v0i0.10458.

[2] F. Sholahudin, Y. M. Muna, and M. A. Istianti, "Manajemen Kecepatan Kendaraan di Ruas Jalan MT Haryono, Kota Semarang, Jawa Tengah," *Prax. J. Sains, Teknol. Masy. dan Jejaring*, vol. 7, no. 2, pp. 139–149, 2025, doi: 10.24167/praxis.v7i2.12786.

[3] B. WISNU, "Analisis Pengaruh Fasilitas Memutar Balik Arah Terhadap Kinerja Ruas Jalan Laksda Adisucipto - Simpang Janti," vol. 6, no. 2017, pp. 7–27, 2020.

[4] I. G. Darurat, "Bab Ii Bab Ii : Studi Literatur," pp. 13–30, 2020.

[5] B. A. B. Ii and T. Pustaka, "BAB II Tinjauan Pustaka BAB II TINJAUAN PUSTAKA 2.1," pp. 1–64, 2002.

[6] D. A. Purwanti and A. R. Indra Tjahjani, "ANALISIS PENINGKATAN KAPASITAS JALAN Studi Kasus: Jalan Narogong KM 26 Kabupaten Bekasi (Analysis of Street Improvement in Case Study Narogong Street Section KM 26 Bekasi Regency)," *J. Artesis*, vol. 4, no. 1, pp. 64–69, 2024.

[7] Yulianggi Trisya Pramesti and A. Budiharjo, "Efektivitas Rambu Batas Kecepatan di Jalan Kolektor," *J. Tek.*, vol. 18, no. 2, pp. 73–81, 2020, doi: 10.37031/jt.v18i2.98.

[8] E. M. Malluluang, A. Alwi, and R. . Rustamaji, "ANALISIS TINGKAT PELAYANAN JALAN (LoS) DAN KARAKTERISTIK LALU LINTAS PADA RUAS JALAN GUSTI SITUT MAHMUD KOTA PONTIANAK," *J. Tek. Sipil*, vol. 17, no. 2, 2017, doi: 10.26418/jtsft.v17i2.23892.

[9] G. N. P. J. dan NUR RIZQIH ABDUHU, "Evaluasi Tingkat Pelayanan Jalan Arteri Primer Raya Serang (Kasus: Balaraja Tangerang)," *J. Tek. | Maj. Ilm. Fak. Tek. UNPAK*, vol. 21, no. 2, 2021, doi: 10.33751/teknik.v21i2.3280.

[10] A. Karmakar, S. S. Roy, F. Vercauteren, and I. Verbauwhede, "Efficient finite field multiplication for isogeny based post quantum cryptography," 2017. doi: 10.1007/978-3-319-55227-9_14.

[11] A. M. H. Pardede, M. Zarlis, and H. Mawengkang, "Optimization of Health Care Services with Limited Resources," *Int. J. Adv. Sci. Eng. Inf. Technol.*, vol. 9, no. 4, pp. 1444–1449, 2019, doi: 10.18517/ijaseit.9.4.8348.

[12] A. M. H. Pardede, Y. Maulita, and R. Buaton, "Application modeling ipv6 (internet protocol version 6) on e-id card for identification number for effectiveness and efficiency of registration process identification of population," in *Journal of Physics: Conference Series*, 2018, vol. 978, no. 1. doi: 10.1088/1742-6596/978/1/012017.

[13] S. P. Mohanty, U. Choppali, and E. Kougianos, "Everything you wanted to know about smart cities," *IEEE Consum. Electron. Mag.*, vol. 5, no. 3, pp. 60–70, 2016, doi: 10.1109/MCE.2016.2556879.

[14] W. A. Jabbar, W. K. Saad, and M. Ismail, "MEQSA-OLSRv2: A multicriteria-based hybrid multipath protocol for energy-efficient and QoS-aware data routing in MANET-WSN convergence scenarios of IoT," *IEEE Access*, 2018, doi: 10.1109/ACCESS.2018.2882853.

[15] D. Niyigena, C. Habineza, and T. S. Ustun, "Computer-based smart energy management system for rural health centers," 2016. doi: 10.1109/IRSEC.2015.7455005.

[16] F.-Z. Younsi, A. Bounnekar, D. Hamdadou, and O. Boussaid, "SEIR-SW, Simulation Model of Influenza Spread Based on the Small World Network," *Tsinghua Sci. Technol.*, vol. 20, no. 5, pp. 460–473, 2015.