

TRAFFIC CONGESTION TRACKING APPLICATION USING OBJECT DETECTION AND GEOLOCATION TECHNOLOGY

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Abstract

Traffic congestion occurs when traffic does not move smoothly and may even reach a standstill. This congestion is frequently caused by a lack of information regarding current traffic conditions, leading to excess vehicles beyond the road's capacity in terms of length and width. Various efforts have been made by the traffic management sector, such as the Area Traffic Control System (ATCS). This research aims to create an Android application that offers real-time traffic updates for the streets of Bandung city in Indonesia, particularly for drivers. This research produces a mobile Android application that can track traffic jams from the results of the CCTV ATCS object detection process using Tensorflow, Realtime traffic jam reports from drivers and geolocation technology. The research methodology employed descriptive research and the waterfall model approach for software development. The study's results showed that 94% of users found the application helpful in obtaining traffic information and route recommendations. Object detection technology on CCTV allowed for an 88% accuracy in determining the congestion level. The application facilitated Bandung City Transportation Department (DISHUB) in acquiring traffic information with an effectiveness of 91.33% and successfully provided weather prediction support for 94.67% of the surveyed routes. Further research is needed to maximize the object detection computing process using cloud computing technology.

Keywords: Area traffic control system, CCTV, Global positioning system, Mobile Android, Traffic congestion tracking.

1. Introduction

Congestion is one of the traffic problems that often occur in developing countries [1], including Indonesia. This congestion causes a build-up of vehicles on the road, thus hampering the smooth flow of traffic on frequently used roads. In several big cities in Indonesia, traffic jams have become a problem every driver faces, especially at certain times, such as when going to the office or returning. When the weekend and holidays arrive, traffic jams often occur on the roads [2]. The cause of traffic jams is a lack of information about traffic jams, which increases the number of vehicles [3] that exceed the capacity of the length and width of the road, traffic accidents [4], and events outside of travel plans [5]. This causes congestion on a road frequently used by motorists.

The local government has carried out various initiatives, including actions taken by the Bandung City Transportation Department (DISHUB Bandung). DISHUB is a government agency responsible for transportation affairs and is critical in managing the transportation sector. Within the DISHUB Bandung scope are several divisions, including one known as Area Traffic Control System (ATCS). ATCS is a traffic management system that utilizes information technology that minimize congestion at crossroads [6], especially in the Bandung City area. This system of ATCS aims to increase the efficiency of the traffic network on the road by optimizing and coordinating traffic arrangements at each intersection [7].

To overcome the problem of traffic jams, one step is to involve the critical role of the community in sharing information about traffic jams in the surrounding area [8], as well as the role of technology that can provide real-time information using CCTV ATCS to ensure the level of congestion on the road using a vehicle object detection from video approach [9]. It is hoped that this information will help drivers find alternative routes monitored by CCTV so that the information obtained can be helpful for traffic officers in their assignments to move quickly to the location and take the action before the traffic jam gets worse. To support success in reducing congestion in the city of Bandung in Indonesia, requires technology that is easily accessible using smart mobile communication devices [10].

Intelligent communication tools or Android-based smartphones are communication tools that are easy to use and can be taken anywhere. Android technology is also the smartphone with the most users [11]. Android is equipped with various built-in features, one of which is geolocation technology using Global Positioning System (GPS) [12]. GPS is an electronic navigation device that receives data from satellites [13], which function to calculate our position on Earth. After obtaining permission, we use the library from Google Play Services Fused Location Providers to regulate how location sensors are accessed [14]. The GPS feature on Android allows users to track the position of particular objects or map certain positions on a Google Maps digital map. This allows users to search for locations they want to visit, making it easier to find location points [15].

Based on the facts and data on the problem above, the DISHUB Bandung needs a public mobile android application with several features that can help motorists to get information about traffic congestion based on surrounding conditions, utilise real-time CCTV data and view reports on the road. The objectives of this research to make it easier for the public, especially motorists, to obtain information that detects traffic density and supporting CCTV information at ATCS intersections in Bandung and can find recommendations for alternative routes monitored by CCTV ATCS Bandung.

This research can also make it easier for the Bandung City Transportation Department to obtain information about traffic congestion outside the DISHUB Bandung monitoring by creating a reporting feature that involves the public.

2. Method

The method used in developing research software uses the Pressman version of waterfall, which has several stages in building an application communication, planning, modelling, development, and submission stages [16].

2.1. System architecture

System or software architecture is a comprehensive framework that describes its components' shape, structure, and compatibility [17]. The following is the system architecture that has been created in Fig. 1 application system architecture:

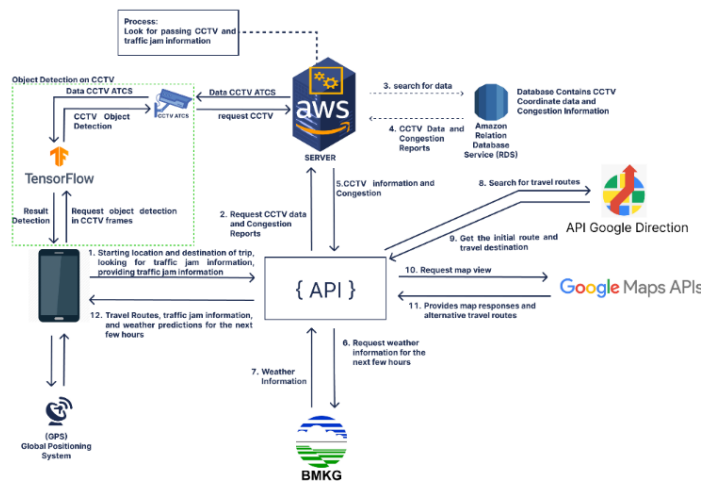


Fig. 1. Application system architecture.

Information process regarding Fig.1:

- i). Android requests information about routes and traffic jams and directly monitors road conditions and weather predictions for the next few hours.
- ii). The application requests the server regarding CCTV and congestion report information.
- iii). The server searches CCTV data and reports traffic jams.
- iv). Obtain CCTV data information, then conduct an object detection process to detect traffic density and obtain congestion reports.
- v). Provides CCTV data response and traffic jam reports.
- vi). Request to get the weather around you.
- vii). The BMKG API provides weather information for the next few hours.
- viii). Search for travel routes using the Google Direction API.
- ix). Get the initial route and travel destination.
- x). Make map requests on the Google Maps API.
- xi). Provide map responses and alternative travel routes.

- xii). Displays travel routes, traffic jam information, and weather predictions for the next few hours.

2.2. Google Maps direction API method

Google Direction API is a service that provides travel route information, distance, and time to reach the destination [18]. The following uses the Google Maps Direction API in the traffic jam tracking application. In the case of traveling from UNIKOM to Bandung Square. The following are the results of the route obtained and information on the route the driver will take. The parameters that used for obtaining route information from the Google Maps Directions API are detailed in Table 1.

Table 1. Google maps direction API parameters.

Parameter Name	Parameter Code	Data Type
Departure Location	origins	Text or latitude and longitude coordinates
Destination Location	Destinations	Text or latitude longitude coordinates
API Key	key	Text
Travel Type	mode	Text
Alternative Route	alternatives	Boolean (true false)
Avoidance	avoid	Text
Country	regions	Text
Language	languages	Text

2.3. Object detection method

The object detection method can see in Fig. 2.

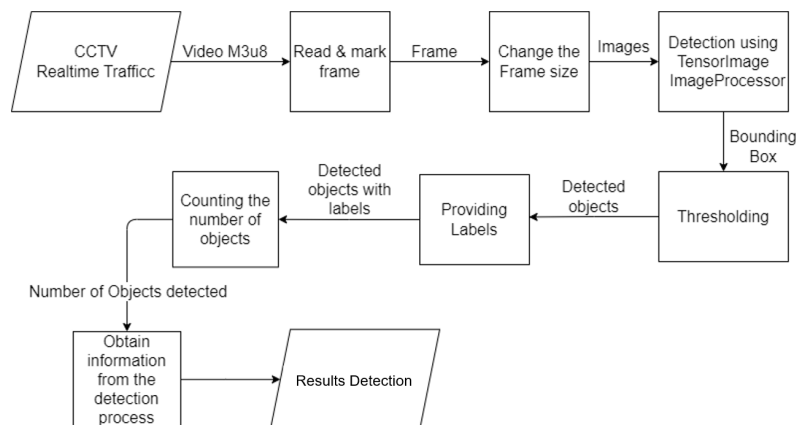


Fig. 2. Object detection process.

The object detection method in this research is using TensorFlow. TensorFlow is a deep learning suite that acts as a library for free and open-source data science that can be used for object detection [19]. There is the TensorFlow object detection API, which is a tool that helps create, train, and implement object detection models [20]. The use of TensorFlow in this application focuses on how it works to detect objects on CCTV that appear in the Traffic Congestion Tracking Application. The

following is the process of object detection on CCTV, which will be explained in Fig. 2 Object detection process.

2.4. Geolocation method

The geolocation method in this research uses a Fused Location Provider. A Fused location provider is a library that obtains location information without worrying about the type of location source selected. Location information can be obtained from satellite GPS, the internet via base stations or Wi-Fi networks connection [21]. This library automatically selects data sources based on accuracy and battery efficiency requirements [22]. The following is the application process for obtaining user location information sources in Fig. 3.

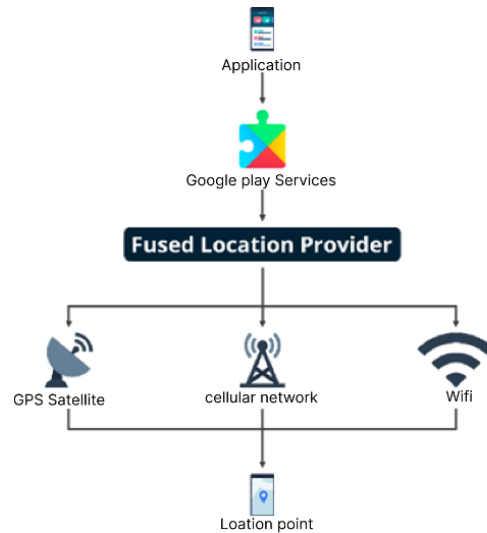


Fig. 3. Fused location provider.

2.5. Weather technology

The Meteorology, Climatology, and Geophysics Agency (BMKG) is a technology provided to observe and understand meteorological, climate, air quality, and geophysical phenomena [23]. Apart from that, BMKG also provides reliable meteorological, climate, air quality, and geophysical data, information, and services [24]. In this context, systems providing APIs can ideally change the data within the API without affecting its users. This allows users to access and utilize BMKG information more efficiently and reliably, supporting a better understanding of meteorological and geophysical conditions in certain regions.

2.6. CCTV area traffic control system

Area Traffic Control System, better known as ATCS, is an information technology-based traffic control system in a particular area that aims to optimize network performance on roads by optimizing and coordinating traffic lights and CCTV, currently at 74 distribution points at every intersection. CCTV file type *.m3u is playlist metadata that references *.mp3 files and provides additional metadata for playlist items. Each track and location have its path [25].

2.7. Distance between two location method

To calculate the distance between two location points using the haversine formula [26]. The haversine formula is an essential equation in map navigation systems. This haversine formula will produce a short distance between two location points [27], giving a great circle distance [28]. The following is the haversine formula:

$$x = (\text{lon}2 - \text{lon}1) \cos\left(\frac{\text{lat}1 + \text{lat}2}{2}\right) \quad (1)$$

$$y = \text{lat}2 - \text{lat}1 \quad (2)$$

$$d = R\sqrt{x^2 + y^2} \quad (3)$$

where x = Latitude (Longitude), y = Longitude (Latitude), R = Earth Radius = 6371 km, and 1 degree = 0.0174532925

3. Results and Discussion

The results and discussion stages are essential phases in this research. At this stage, we will present the complete results of the tests carried out, as well as conduct an in-depth discussion of the findings obtained in this research.

3.1. Recommended routes

The Google maps direction API implementation aims to understand the research process carried out in obtaining a travel route. The following is an analysis of parameters on google maps direction.

Determine the starting location and destination of the trip with the starting location of UNIKOM Dago and the trip destination Alun-alun Bandung as a requirement in getting the route, namely that you must have a starting location and a location to the destination. After determining the two points, you will get a travel route based on the vehicle selected and an estimate of each route. This route will be a reference for drivers to get to their destination. The following are the routes obtained by car in Table 2 regarding recommended travel routes.

Table 2. Travel route by car.

Route	ESTIMATED TIME
1	17 minutes
2	20 minutes
3	23 minutes
Number of Routes	3 Routes

Recommended route traffic information will be passed, such as the amount of traffic information and the number of CCTVs passed. This data is obtained based on the route chosen using a car. The following is Table 3, explaining the amount of information that the driver will pass.

Table 3. Travel information. Transportation type: car.

Selected route	Number of CCTV passes	The number of reports passed
Route 1	13	7
Route 2	15	7
Route 3	12	4

Based on the route chosen by the driver, CCTV data will be obtained that the driver passes after selecting the travel route. The following is the CCTV data that the driver will pass based on route one selected in Table 4 regarding the CCTV data that the driver will take when traveling to the destination location: 107.604102. Table 5 is the following report data that motorists will pass based on route one selected.

Table 4. CCTV data will be pass.

CCTV name	Latitude	Longitude
Dipati Ukur Unikom	-6.886861	107.615029
Djuanda-Cikapayang	-6.898954	107.61269
Aceh Wastu Kencana	-6.910342	107.608956
Sudirman-Otista	-6.920816	107.604102
Simpang Dago 3	-6.885060	107.613632
Simpang Dago 2	-6.885000	107.613650
Simpang Dago 1	-6.885092	107.613667
Jl-Taman-Panda	-6.914188	107.610251
Tb-Ismail	-6.884918	107.615498
Asia Africa 01	-6.915975	107.608920
Asia Africa-Bri Tower	-6.921042	107.606520
Kepatihan Balong Gede	-6.923367	107.607990
Viaducts	-6.915086	107.607462

Table 5. Report data will be pass.

Report address	Latitude	Longitude
Citarum, Bandung Wetan	-6.886861	107.615029
Jl. Dago L. Siliwangi Coblong	-6.898954	107.61269
Coblong District, Bandung City	-6.910342	107.608956
Citarum Bandung Wetan	-6.920816	107.604102
Jalan Penghulu Haji Hasan Mustopa	-6.885060	107.613632
Jl. Ir. H. Juanda, Citarum, Bandung Wetan	-6.885000	107.613650
Babakan Ciamis, District. Bandung Well	-6.885092	107.613667

3.2. Object detection

The characteristics of the number of vehicles detected are a benchmark in determining the decision-making characteristics of whether a road is smooth or not. This figure is the result of the average ability of the application to detect objects. The following are the characteristics of congestion in Table 6.

Table 6. Characteristics of congestion.

Category	Information	Number of Objects
The traffic flow is smooth.	Number of Vehicles < 15	Inconsistent
The traffic flow is smooth.	Number of Vehicles > 15 and ≤ 25	Tends to be consistent
There was a traffic jam.	Number of Vehicles > 25	Consistent

The following are the results of the analysis of each CCTV based on three predetermined characteristics so that from the number of vehicles detected, the application can decide on the status of traffic flow, which has been validated based on the number or number of vehicles and movement on the road monitored by CCTV. Analysis results in Table 7.

Table 7. Analysis results based on congestion characteristics.

CCTV name	Amount				Total	Status
	Car	Motorcycle	Bus	Truck		
Soekarno Hatta – Toha	15	8	2	0	25	There was a traffic jam
PH H Mustofa – Hero	9	5	0	0	14	Crowded. Smooth
Simpang 5 Asia Africa	3	2	0	0	5	Monitored Smoothly

3.3. Weather conditions on the road

Implementation of the BMKG API, which is used as supporting information when traveling, so that with the BMKG API technology, the application can provide data in the form of weather forecasts on the road that will be traversed. The following is the response obtained when receiving information about the weather in Table 8.

Table 8. Weather data on roads.

GPS Status	User Position	Time	Weather information
Active	Jl. Dipati ukur Bandung	09.30	Sunny Cloudy
Active	Bandung stone fruit	05.00	Moderate rain
Active	Jl. Tubagus Ismail Bandung	06.00	Cloudy

3.4. Report validity

To get more accurate reports and minimize errors in information about traffic jams, validation is needed so that reports are more accurate, namely by determining the number of reporters who report on the road, and then the report can be said to be valid or invalid [29]. The congestion reporting categories used as a decision value for a report in Table 9.

Table 9. Report characteristics.

Category	Information
Valid	Number of Reporters > 3 & Distance = 10 meters
Invalid	Number of Reporters < 3 & Distance > 10 meters

The result of the congestion report status can be seen in Table 10.

Table 10. Congestion report status.

Street Address	Incident	latitude	longitude	Status
Jl. Dago 84-72, Lb. Siliwangi, Coblong District	Congestion	-6.896878	107.612836	Valid
Coblong District	Congestion	-6.895137	107.612928	Valid
Coblong District	Congestion	-6.899199	107.618883	Valid
Jl. A. Yani 355-367, Sukamaju, District	Congestion	-6.912516	107.653379	Invalid
Jl. Tamansari to Jl. Siliwangi	Congestion	-6.90782	107.63378	valid
Jl. Tamansari to Jl. Siliwangi	Congestion	-6.90746	107.63356	valid
Jl. Pasteur No.38, Pasir Kaliki, Kec. Cicendo,	Congestion	-6.261493	106.8106	Invalid

3.5. Application implementation result

System Implementation is a stage for implementing a design based on user needs in the Congestion Tracking application. So, at this stage, the system can be used and evaluated to ensure the achievement of the research objectives. The Android smartphone specifications are processor Exynos 850 Octa-Core 2.0 GHz, RAM 4 GB, ROM 128 GB, Screen 6.6 inches, GPS, Camera and LTE network.

The Home page displays the interface on Fig. 4(a) when the user has successfully logged in. On this page, the researcher intends to display all information, such as weather, maps, and the latest report information. The location search page displayed the interface implementation. The researcher intends to provide CCTV information and traffic jam reports into a marker, and users can search for travel destinations that can see in Fig. 4(b)

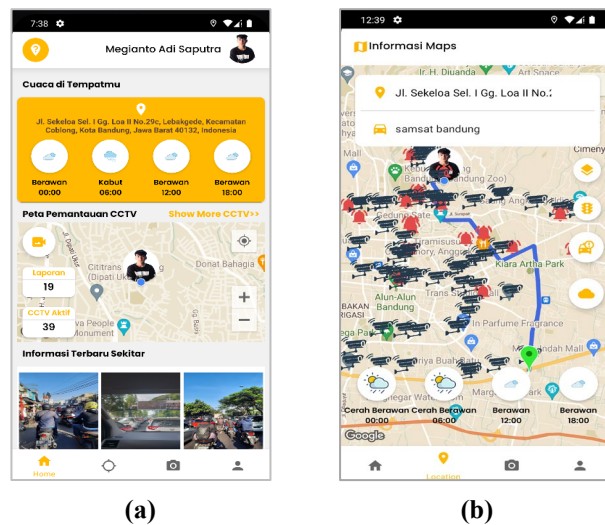


Fig. 4. (a) Home page interface and (b) Search location page interface.

The page in Fig. 5(a) for choosing vehicle used and Fig. 5(b) for choosing a recommended route displays the interface implementation. At this page, the researcher intends to provide options to allow users to get an alternative route. The road conditions page is the result of the interface implementation. On Fig. 5(c) the researcher intends to provide information on traffic jams and CCTV reports based on the road the user will pass.

The CCTV list page is the result of the implementation of the interface. In the Fig. 6(a) the researcher intends to display a list of active CCTVs to make it easier for users to find the CCTV they want to search. In the Fig. 6(b) the researcher intends to provide information about CCTV and find out the level of congestion on roads monitored by CCTV by object detection of the number of vehicles.

The Fig.7(a) the researcher intends to provide a display for users to report local congestion. This report list can see in Fig.7(b). At the Fig.7(c). the researcher intends to provide detailed information about traffic jams.

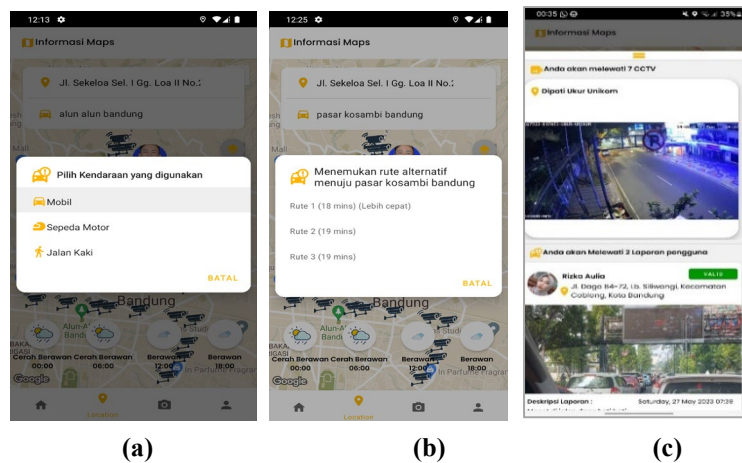


Fig. 5. (a) Vehicle select interface, (b) Recommended route interface, and (c) Travelled Road information interface.

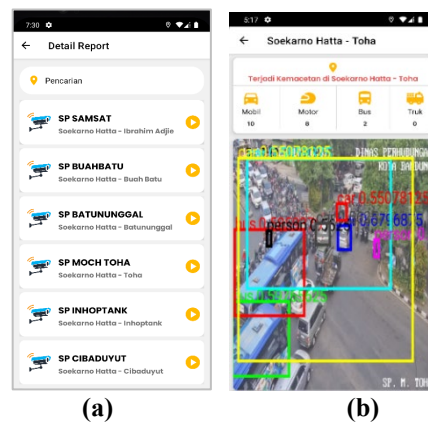


Fig. 6. (a) CCTV list interface and (b) Traffic density detection interface.

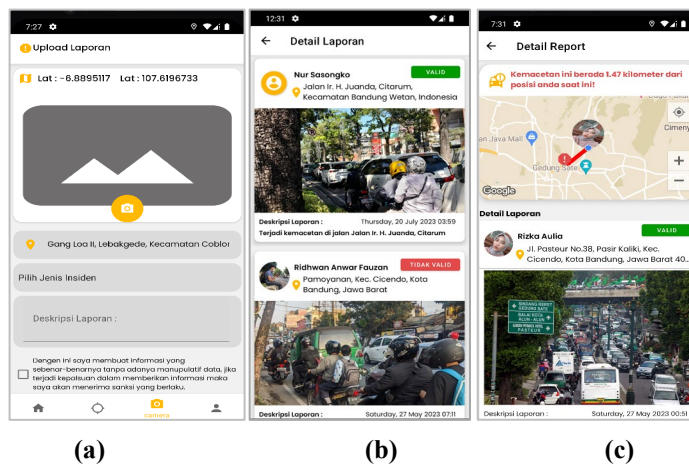


Fig. 7 (a). Interface for creating reports, (b) Report list interface, and (c) Report details interface.

3.8. Testing result for riders

Acceptance testing is carried out to determine the response from users. This test carried out by giving questionnaires to drivers in Bandung. With responses from users, researchers will be able to determine the level of success of the application being built and whether it has met the needs of the community, especially motorists. Questionnaire calculations were carried out using a Likert scale. The Table 12 following are the results of tests carried out on drivers.

Table 12. Congestion information test results.

Question	Percentage Value Result Scale
This application can make it easier for drivers to get traffic jam information.	94%
This application can make it easier for the public, especially motorists, to get recommendations for alternative routes monitored by CCTV ATCS Bandung	94%
The existence of a feature that can detect traffic jams using object detection on CCTV that appears can help drivers determine the level of congestion.	88%
With a traffic jam reporting feature outside of CCTV ATCS monitoring, it is intended that the Bandung City DISHUB can take action in traffic jams, making it easier for motorists to report traffic jams around them.	91,33%
The weather prediction support feature can make it easier to see weather conditions when travelling.	94,67 %

4. Conclusion

Based on the results of program implementation, discussions, and testing that have been carried out on this research, it can be concluded that this research makes it easy for the public, especially motorists to get information about traffic density, alternative route recommendations, CCTV monitoring, and weather predictions. This application also supports the DISHUB Bandung in monitoring traffic including areas that are difficult to monitor directly. Thus, this application becomes a valuable tool for improving Bandung's mobility and travel experience. Based on the results of object detection observations, it found that the method used is quite heavy, so it is necessary to use a smartphone device with high specifications. Future research will be studied for object detection processing can use cloud computing technology so that when the object detection process is carried out in the cloud, reducing the burden on the smartphone during implementation.

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References

1. Ali, A; Ayub, M; Shiraz, M.; Ullah, N.; Gani, A.; and Queshi, M.A. (2021). Traffic efficiency models for urban traffic management using mobile crowd sensing: A survey. *Sustainability*, 13(2), 1-18.
2. Chen, L.; Ren, Q.; and Zeng, J. (2023). CSFPre: Expressway key sections based on CEEMDAN-STSGCN-FCM during the holidays for traffic flow prediction. *PLoS One*, 18(4), 1-22.

3. Sarker, V.K.; Gia, T.N.; Ben-Dhaou, I.; and Westerlund, T. (2020). Smart parking system with dynamic pricing, edge-cloud computing and LoRa. *Sensor*, 20(17), 1-22.
4. Robi, P.A.; Asro, A.; and Indra, I. (2023). Classification of traffic congestion in Indonesia using the naive bayes classification method. *Journal of World Science*, 2(6), 877-888.
5. Wang, Z.; and Huang, W. (2020). A social media based approach for route planning during urban events. *IEEE Access*, 8(1), 207589-207598.
6. Mustika, M.E.S.; Choiriyah, I.U.; and Riyadh, A.U.B. (2022). The implementation of e-government in the sector transportation (studi on area traffic control system program resources in Sidoarjo district). *Jurnal Kebijakan dan Manajemen Publik (JKMP)*, 10(1), 54-63.
7. Tania, N.; and Rachmawati. R. (2022). Area traffic control system (ATCS) for supporting urban traffic management in DKI Jakarta. *Proceeding of the International Conference on Electric Vehicular Technology (ICEVT)*, Bali, Indonesia, 103-108.
8. Kumar, R.; Kori, N.; and Chaurasiya, V.K. (2023). Real-time data sharing, path planning and route optimization in urban traffic management. *Multimedia Tools and Applications*, 82(23), 36343-36361.
9. Nazarov, F.M.; Eshtemirov, B.S.; and Yarmatov, S.S. (2022). Technologies for identifying vehicles standing at traffic lights based on video data. *Central Asian Journal of Mathematical Theory and Computer Sciences*, 3(12), 52-59.
10. Seng, K.P.; Ang, L.M.; Ngharamike, E.; and Peter, E. (2023). Ridesharing and crowdsourcing for smart cities: Technologies, paradigms and use cases. *IEEE Access*, 11(1), 18038-18081.
11. Junaidi, J.; Irviani, R.; Muslihudin, M.; Hidayat, S.; Maseleno, A.; Gumanti, M.; and Fauzi, A.N. (2018). Application program learning based on android for students experiences. *International Journal of Engineering and Technology*, 7(2), 194-198.
12. Fachria, E.; and Suardi, J. (2024). Location-based service (LBS) application design as Jeneponto district tourist information media. *KnE Engineering*, 6(1), 252-259.
13. Verma, Y.K.; Jagadeesh, M.; Kumar, P.M.; Younis, H.I.; and Adhikari, M.S. (2023). Design of real-time GPS tracker using esp-8266 with blynk application. *Proceeding of the 2023 International Conference on IoT, Communication and Automation Technology (ICICAT)*, Gorakhpur, India, 1-6.
14. Kimm, H.; and Flynn, D. (2022). Android application for tracking pedestrian movements in realtime with firebase. *Proceeding of the 2022 IEEE Cloud Summit*, Fairfax, VA, USA. 91-96.
15. Setiawan, E.B; and Fatoni, T. (2021). Driving safety application using wearable device and mobile technology. *Journal of Engineering Science and Technology (JESTEC)*, 16(4), 3343-3357.
16. Kusaini, G. (2022). System quality development and analysis seminar management information web-based in department of education electronic engineering and information. *Jurnal Manajemen Informatika Medicom*, 11(1), 7-13.

17. Sievi-Korte, O.; Beecham, S.; and Richardson, I. (2019). Challenges and recommended practices for software architecting in global software development. *Information and Software Technology*, 106(1), 234-253.
18. Nugraha, K.A. (2023). Real-time bus arrival time estimation API using websocket in microservices architecture. *International Journal on Advanced Science, Engineering and Information Technology*, 13(3), 1018-1024.
19. Srivastava, S.; Gangwar, A.; Mishra, R.; and Singh, S. (2022). Sign language recognition system using tensorflow object detection API. *Communications in Computer and Information Science*, 1534(1), 634-646.
20. Aningtiyas, P.R.; Sumin, A.; and S. Wirawan, A. (2020). Object detection application development using tensorflow object detection API by utilizing MobileNet V2 SSD as a pre-trained model. *Scientific Journal of Computing*, 19(3), 421-430.
21. Zhao, Z.; Wang, T.; Zhang, Y.; Wang, Z. and Geng, R. (2023). Geo-visualization of spatial occupancy on smart campus using wi-fi connection log data. *ISPRS International Journal of Geo-Information*, 12(11), 1-14.
22. Gurram, B.; and Giri, N. (2016). Improving localization accuracy of android's fused location provider API using Kalman filter. *Proceeding of the International Conference on Computer Communication and Informatics*, Coimbatore, India. 1-4.
23. Hazmi, A.; Hamid, M.I.; Fernandez, R.; Andre, H.; Pratama, R.W.; and Emeraldi, P. (2023). The correlation between lightning and various weather parameters in the Padang monsoon system. *Indonesian Journal of Electrical Engineering and Computer Science*, 31(1), 1-9.
24. Prasetyo, A.; Irawan, D.; Sensuse, D.I.; Lusa, S.; Wibowo, P.A.; and Yulfitri, A. (2023). Evaluation of e-service quality impacts customer satisfaction: One-gate integrated service application in Indonesian weather agency. *International Journal of Advanced Computer Science and Applications*, 14(1), 145-152.
25. Barakabitze, A.A.; Barman, N.; Ahmad, A.; Zadtootaghaj, S.; Sun, L.; Martini, M.G.; and Atzori, L. (2019). QoE management of multimedia streaming services in future networks: A tutorial and survey. *IEEE Communications Surveys and Tutorials*, 22(1), 526-565.
26. Akbar, I.; and Gautama, E. (2023). Locating identification the nearest social security organizing agency for health recipient hospital using the haversine formula and black box method. *International Journal of Advances in Scientific Research and Engineering*, 9(3), 25-36.
27. Jabid, T.; Rizvy, N.H.; Mow, F.T.Z.; Shosy, T.Z.; Ali, M.S.; Islam, M.; and Hasan, M. (2023). An intelligent road accident reduction system using device-to-device communication. *Indonesian Journal of Electrical Engineering and Computer Science*, 30(3), 1729-1739.
28. Tarmizi, R.I.; Hamidah, M.N.; and Arizal, A. (2023). Webgis application for searching nu mosque in east java using the haversine method. *Journal of Electrical Engineering and Computer Sciences*, 7(2), 1311-1320.
29. Suryadjaja, P.; Hutagalung, M.; and Sutarto, H. (2020). Modeling traffic flows with fluid flow model. *International Journal of Informatics, Information System and Computer Engineering (INJIISCOM)*, 1(1), 1-12.