PERANCANGAN SISTEM PENGURAI KEMACETAN PADA PERSIMPANGAN JALAN (STUDI KASUS : PERSIMPANGAN SAMSAT KIARACONDONG)

Group Members:

1. Nabil Putra K.U.
2. Faishal Anwar
3. Fakhri Arasyid
4. Rizaldy Rizky R.

THE PROBLEM DESCRIPTION

Traffic Jam at City of Bandung :

- Disrupt and affects the pace of traffic flow

Main Congestion Point :

- Intersection of SAMSAT Kiaracondong road through Soekarno Hatta road

Cause of Congestion :

- Roadside activities, irregular vehicle movements and heavy traffic flow

Impact of Congestion :

- Time loss, environmental impact and social costs

PROPOSED SOLUTIONS

SUMO Based Solution Alternatives

- **OpenStreetMap (OSM):** Open geospatial data for mapping and analyzing traffic conditions.
- **Algorithm:** For optimizing traffic light timing and vehicle flow distribution.

Machine Learning Methods for Traffic Optimization

- **Reinforcement Learning (RL)**: Adaptive learning to manage traffic lights and dynamically determine vehicle routes.
- **Convolutional Neural Network (CNN)**: Analyzing spatial and temporal data to predict congestion and regulate traffic lights.
- **K-Nearest Neighbor (KNN)**: Classifying and predicting traffic density and travel time based on historical data.

SOLUTION LIMITATIONS

Congestion Issues at SAMSAT Kiaracondong

- Severe congestions due to high volume of vehicle for administrative services.
- Located on a main road with heavy traffic flow, long queues and limited road capacity.

Simulation Using SUMO (Simulation of Urban Mobility)

- Traffic dynamics model with real data to analyze congestion.
- Testing solutions such as dedicated vehicle lanes, adaptive traffic light control and vehicle flow re-distribution.

FEATURE SPECIFICATION

NO	General Features	Details
1	Traffic Schedule	A feature used to manage or control traffic schedules, data, or specific activities at designated times. This feature is often found in network management systems, server-based applications or automation tools.
2	Traffic Balancing	A feature used to evenly distribute data traffic across multiple resource, such as servers, network paths, or devices. The goal is to ensure optimal perfomance, prevent overloading of a single resource, and enhance service availability.
3	Speed Control	A feature designed to regulate and limit the speed of vehicles or data traffic on a specific route, whether in the context of physical transportation or data networks. The goal is to enhance safety, efficieny and stability.

DESCRIPTION OF THE SELECTED SOLUTIONS

The Selection of a solution to address traffic congestion in Kiaracondong area is based on seveal key criteria. First and foremost, the effectiveness of the solution is the primary focus, offering various traffic schedulling and balancing algorithm simulation to predict traffic flow and optimize route efficiency. Succesfully to reducing congestion is the main consideration in determining the chosen solution.

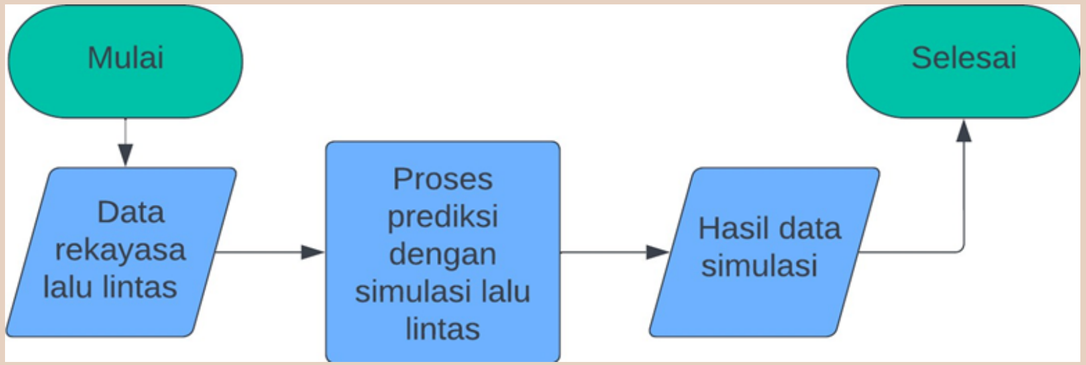
DESCRIPTION OF THE SELECTED SOLUTIONS

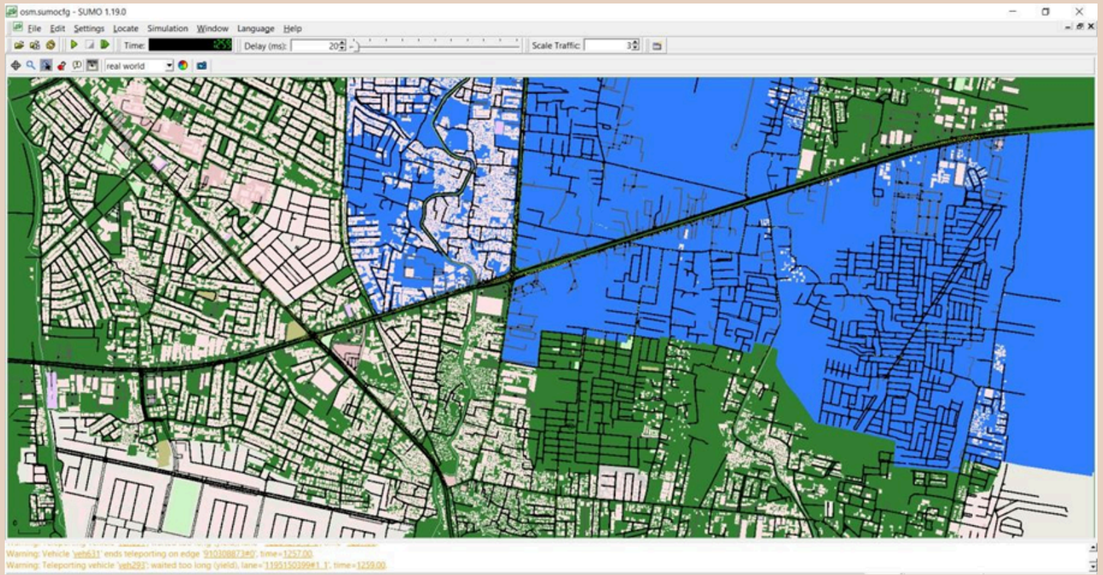
Based on these considerations, Reinforcement Learning was chosen as the most suitable approach for optimizing traffic simulation and management, providing an effective, adaptive, and cost-efficient solution to address congestion challenges in various urban areas.

DESIGN OF THE SELECTED SOLUTION

This simulation servers as the chosen solution using the Simulation of Urban Mobility (SUMO) tool, a program designed to manage vehicle flow by modeling the maps. There are various design explanations.

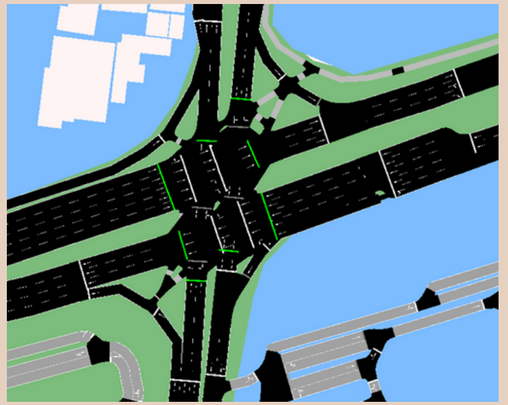
DESIGN OF THE SELECTED SOLUTION

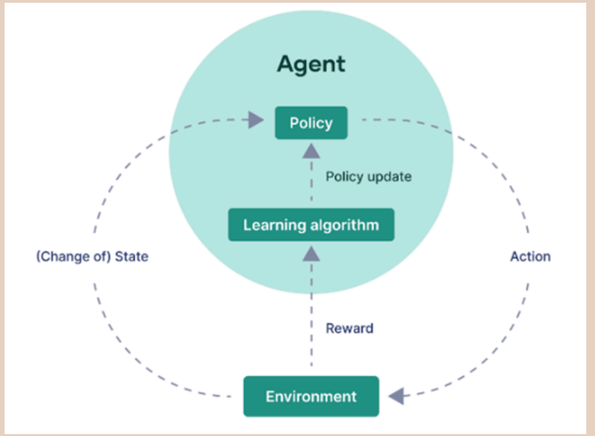


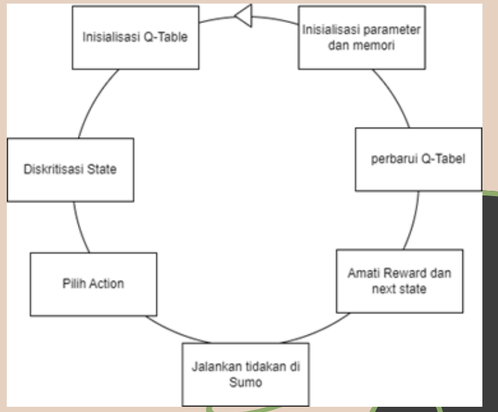


IMPLEMENTATION

The design of the simulation for traffic scheduling and traffic balancing is developed using the SUMO program. The simulation design is based on a section of the road in Kiaracondong area. This simulation will be used to predict traffic flow and apply traffic balancing methods to accelerate route destinations and find alternative routes available in congestion areas. Traffic schduling refers to the regulation or scheduling of traffic, which functions to manage the existing traffic on the highway.





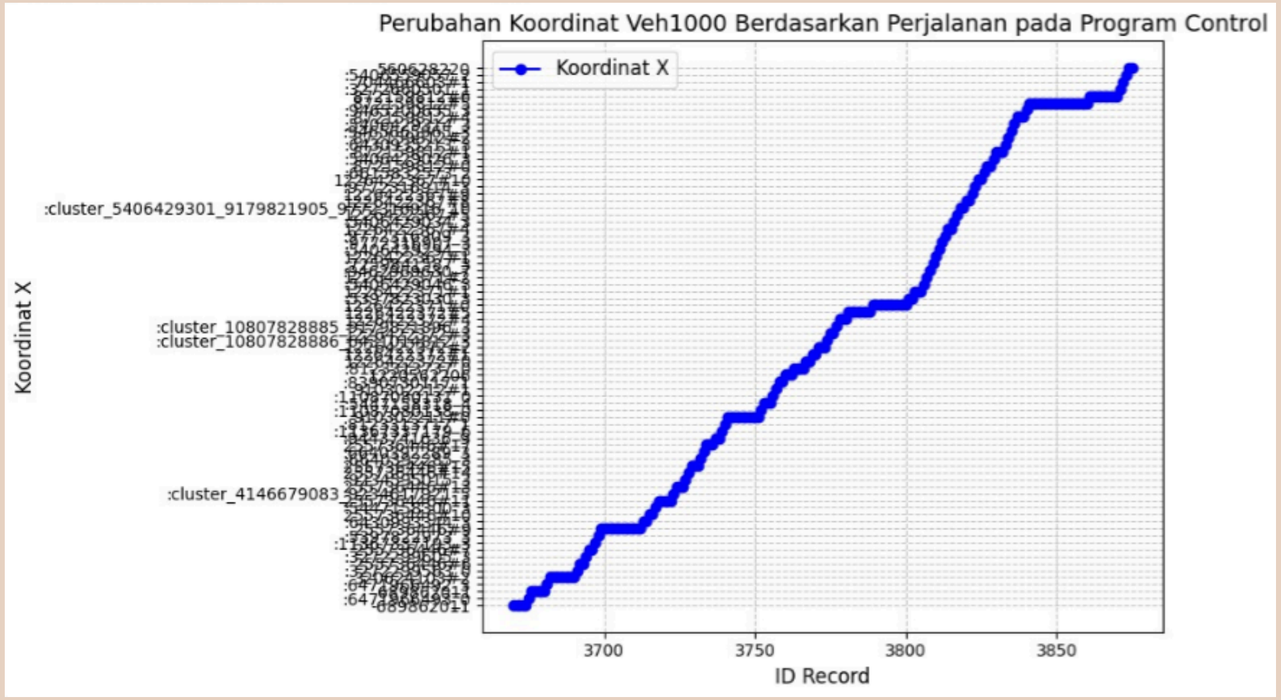


TESTING

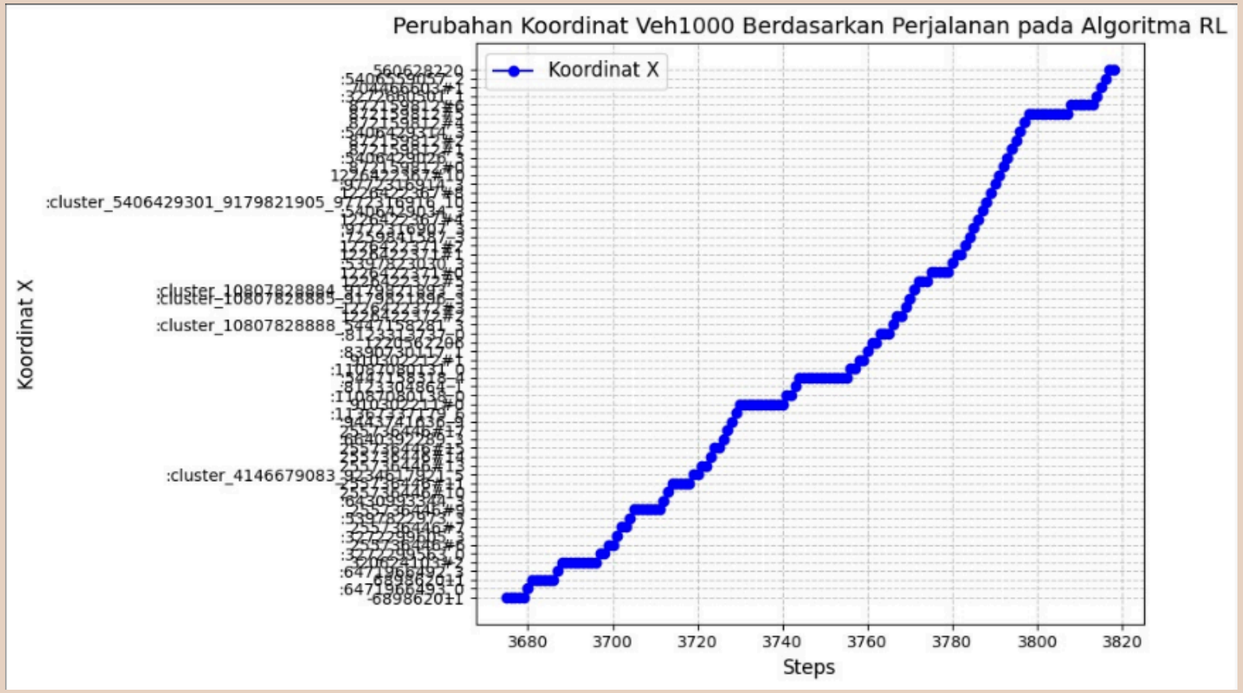
The testing conducted follows the testing scenarios and applies the pre-determined testing parameters. The testing process is carried out as follows:

- Initialization of parameters as specified in the SUMO simulation.
- Running the previously trained Reinforced Learning agent.
- Recording perfomance metrics such as average waiting time, vehicle volume distribution, congestion levels, and travel time.

TEST RESULTS



Before



After

ANALYSIS

The test results show that the Reinforced Learning based solution successfully and significantly reduced traffic congestion and improved traffic flow efficiency at the tested intersections. In the traffic scheduling test, the use of Reinforced Learning successfully reduced the average waiting time and vehicle queue length, while also increasing vehicle throughput. This indicates that Reinforced Learning is capable of dynamically optimizing traffic signal settings, aligning with traffic optimization theories that state real time adaptation to changing traffic conditions is the key in managing complex traffic flow.

CONCLUSION

The implementation of reinforcement learning in traffic management at the SAMSAT Kiaracondong intersection showed significant improvements. The average vehicle waiting time decreased, queues became shorter, vehicle throughput increased, and the distribution of vehicle volume became more even. Congestion reduced, and the average travel time decreased.

- Waiting Time: 120 seconds → 45 seconds
- Queue Length: 250 meters → 100 meters
- Throughput: 800 vehicle/hour → 1200 vehicles/hour
- Vehicle Distribution: 60%-40% → 50%-50%
- Congestion: 8/10 → 4/10
- Travel Time: 180 seconds → 90 seconds

DEVELOPMENT

- Improvement of data infrastructure for more accurate decision-making
- Development of a more efficient RL model (e.g., Deep Q-Network)
- Testing in various locations to assess generalization
- Integration of RL with other traffic control systems
- Application of deep learning techniques for more complex scenarios

THANK YOU

For the attention and cooperation