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Traffic Management System Along and Within the Vicinity of Northwest Samar State University (NwSSU)

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Abstract — This research focused on the traffic management system along and within the vicinity of Northwest Samar State University following the identification of a traffic problem in the area based on a traffic map of Calbayog City. It covered traffic counting through recorded video, and traffic measures simulated using a traffic simulation tool called Simulation of Urban Mobility (SUMo) with a goal of improving traffic flow in the area. An experimental research design was employed to assess traffic interventions such as a one-way lane configuration along Cajurao Street, a static traffic light system (TLS) at the Cajurao-Gomez intersection, and their combination—on dependent variables such as time loss and waiting time. Results revealed that peak hours occur during the arrival and departure of students and employees. Furthermore, simulation results showed that implementing a one-way, two-lane configuration along Cajurao Street reduced the time loss and waiting time of the traffic network. However, implementation of a static traffic light system at the Cajurao-Gomez intersection simulated the highest waiting time and time loss for the network. The simulation results also showed that the baseline scenario led to better performance in terms of emission and fuel consumption. Implementation of a static traffic light system at the Cajurao-Gomez intersection led to the highest emissions. The one-way lane configuration on Cajurao Street usually resulted in the lowest emissions for several pollutants on early weekdays. The combined intervention of a one-way lane configuration and a static traffic light system increased emissions compared to the one-way street configuration alone, especially at the end of the week. Lastly, the implementation of a one-way, two-lane configuration along Cajurao Street may be done to improve the traffic flow in the area.

Keywords* — *SUMO, traffic, simulation, one-way, emission

I. Introduction

Numerous global studies and literature acknowledge the high and concentrated traffic volume around schools, often attributed to the synchronized schedules of school and work activities. This phenomenon has been recognized globally, as evidenced in countries such as China (Liu et al., 2022; Sun et al., 2021; Zhou et al., 2021), the USA (Monast et al., 2022; Rick, 2023), Vietnam (Hiep et al., 2020), Nigeria (Iro & Pat-Mbano, 2022; Istifanus et al., 2024), Saudi Arabia (Shokry et al., 2024), Indonesia (Amelia et al., 2023), and Thailand (Banyong et al., 2020; Prakayaphun et al., 2023).

This global pattern is also evident in the Philippines, as one of East Asia's fastest-urbanizing countries (The World Bank Group, 2017). This phenomenon of concentrated and high traffic volume around schools is also acknowledged in various locations across the Philippines, including Davao City (Rebuta, 2024; Rellon et al., 2024), Vigan City (Cadaoas, 2019), Metro Manila (Rivera & Castro, 2023), Manila (Morales et al., 2024), Dagupan City (Zamora & Fillone, 2017), Zamboanga City (Moreno, 2023), and Batangas City (Hintural et al., 2016).

Given the significant population increase in Region VIII (Eastern Visayas), with Calbayog City ranking as the second most populous and experiencing rapid growth (Philippine Statistics Authority, 2021), and as it is centrally located and surrounded by three neighboring schools, the traffic situation around Northwest Samar State University (NwSSU) is likely intensified.

According to the Google Traffic Map data for 2025, the area around Northwest Samar State University (NwSSU) in Calbayog City experiences traffic ranging from moderately slow (yellow) to slow (red) during school hours. This congestion, compounded by the city's growing population, leads to increased travel times and time loss impacting the commuters and the students.

These reasons led the researcher to study the traffic management along and within the vicinity of Northwest Samar State University.

The study will benefit not only the stakeholders of the NwSSU by improving the traffic flow but also the other schools neighboring the university. Furthermore, the findings could serve as a valuable model for addressing similar traffic challenges in other educational institutions within the region.

Key roads bordering the main campus of NwSSU, such as Gomez St., Cajurao St., Pajarito St., Umbria St., and Rueda St., were studied during the academic year 2024-2025. This work is limited to the study of vehicular traffic flow of all vehicle types along and within the vicinity of the main campus.

Literature Review

Conceptual Literature

Urban road networks in many countries are severely congested, resulting in increased travel times, a greater number of stops, unexpected delays, higher travel costs, inconvenience to drivers and passengers, increased air and noise pollution, and a higher number of traffic accidents. Increasing traffic network capacities by building more roads is very costly as well as environmentally destructive (Teodorović & Janić, 2022).

Traffic management is the organization, arrangement, guidance, and control of both stationary and moving traffic, including pedestrians, cyclists, and all types of vehicles. Its aim is to provide for the safe, orderly, and efficient movement of persons and goods, and to protect, and where possible, enhance the quality of the local environment on and adjacent to roads (Han & Luk, 2019). These strategies are particularly important in areas with high population density or significant institutions, such as universities, where traffic patterns can be concentrated during peak hours.

Traffic management strategies, such as lane configuration, have proven effective. Modifying existing two-way streets into one-way streets can alleviate traffic congestion (Alkaissi, 2023; Ginting & Widyaningsih, 2022; Zhang et al., 2020; Zhu et al., 2019). Similarly, the regulation of traffic signals dramatically reduced traffic congestion, leading to better conditions for both drivers and the environment (Belleza et al., 2023; Kim et al., 2023; Liu & Song, 2022; Malhotra, 2019).

To evaluate the impact of these strategies before real-world implementation, and to explore various 'what-if' scenarios, simulation tools like SUMO provide a valuable platform for modeling traffic flow and predicting the effects of different interventions. Traffic simulation is vital for assessing the impact of mobility behaviors on traffic flow, considering safety, efficiency, and environmental aspects (Belleza et al., 2023; Izadi et al., 2021). Realistic traffic networks, crucial for meaningful simulations, necessitate appropriate tools that accurately represent road user interactions (Bergin, 2020).

A comparative study evaluating traffic simulation software such as SUMO, MATSim, Aimsum Next, PTV Vissim, and GAMA, based on criteria like software nature, network and demand creation, visualization, documentation, and modeler specifications, ranked SUMO highest, indicating flexible network/demand creation, visualization, documentation, and modeler adaptability (Diallo et al., 2021).

However, to effectively use SUMO, accurate traffic count data are needed in order to simulate realistic traffic conditions and assess the effectiveness of traffic strategies. Video-based traffic flow monitoring and counting offer advantages like convenience, high accuracy, and cost-effectiveness compared to manual surveys; furthermore, it enhances security, especially during nighttime. While repeated counts improve accuracy for ground truth data, the absence of a data validation process can lead to reliability issues due to human error. This will also ensure reliable and unbiased data. Furthermore, maintaining complete video footage ensures data reliability and impartiality by allowing for verification and independent review (Belleza et al., 2023; Jayasinghe et al., 2021; Majumder & Wilmot, 2023).

These reasons led the researcher to utilize the traffic simulation tool SUMO to model and evaluate the effectiveness of lane configuration changes and traffic signal timing for alleviating traffic congestion in a high-density area, such as the vicinity of NwSSU in Calbayog City, employing video-based traffic counting for efficient and accurate data acquisition.

Research Literature

Traffic congestion in the vicinity of universities is a common problem in urban cities. Studies have shown that universities often act as “traffic generators,” contributing to increased vehicle volume, particularly during peak school hours. These increased volumes can strain local road networks, leading to longer commute times and reduced accessibility. For instance, the study of Sun et al. (2021) in China found that school runs increase the probability of road congestion by 4.5 percentage points. Moreover, traffic congestion is more severe around schools that are larger, better-resourced, public rather than private, located in more expensive neighborhoods, or lacking student accommodation. This is consistent with the findings of Rebuta et al. (2024) in Davao City, which indicate that congestion increased the travel time to work or school. The case of Northwest Samar State University (NwSSU) in Calbayog City, as highlighted in this research, aligns with these broader trends, demonstrating the need for a solution.

Several studies have explored various strategies for alleviating traffic congestion. While some are costly, others prove unsuccessful due to high demand. The study of Alkaissi (2023) suggests using one-way traffic movement with a circulation network that significantly improves traffic operation and reduces congestion to a great extent. Similarly, the study of Ginting and Widyaningsih (2022) shows that the application of a one-way system can improve traffic performance with an increase in the level of road service in one lane.

Simulation software has emerged as an increasingly valuable tool for analyzing and refining such strategies. For example, Zhang et al. (2020) employed in their study and showed that using a one-way street planning model to modify part of a two-way street into a one-way street can indeed improve the traffic operation of the area. However, traffic organization is often based on experience, and new traffic problems have emerged during the implementation process (Zhu et al., 2019). The study of Kim et al. (2023) also employed in their study and showed that traffic improved by changing the display time of the traffic lights in the road network. However, the study of Malhotra (2019) shows that male drivers are more likely to run red lights than female drivers indicating that a traffic light system may not be effective in all cases.

Tools like SUMO (Simulation of Urban Mobility) enable researchers to model traffic flow and evaluate the potential impact of interventions. For example, the study of Singh et al. (2019) employed SUMO to reduce traffic congestion, and the results showed improvement through traffic diversions. Similarly, Izadi et al. (2021) employed SUMO in their study to evaluate the impact of motorcycles mobility on vehicular traffic. The modeling and evaluation results show that vehicular traffic flow can be enhanced or deteriorated based on motorcycle mobility model.

SUMO offers a useful tool, like routesampler, to match the actual traffic count to the simulation. The routesampler tool requires routes and traffic counts, which are separated in XML files. A study of Behrisch and Hartwig (2022) evaluated the routesampler and found it to be the most suitable tool for obtaining counting data and a plausible route distribution. Furthermore, the study of Kim et al. (2023) is similar to this study as it employed SUMO and routesampler to evaluate the impact of traffic signals on traffic flow.

This shows the capability of SUMO as an effective tool for traffic analysis and the evaluation of potential strategies. The current study utilized SUMO to model traffic flow around NwSSU and evaluate the potential of one-way street and traffic light systems.

II. Methodology

This study employed an experimental research design. Experimental research is a scientific method where researchers manipulate independent variables to observe their effect on dependent variables while controlling other factors to predict outcomes (Zubair et al., 2022).

Specifically, the traffic simulation tool SUMO was utilized to examine the effects of traffic interventions. These interventions included a one-way lane configuration along Cajurao Street, a static traffic light system (TLS) at the Cajurao-Gomez intersection, and a combination of both, as proven effective in improving traffic flow in previous studies (Alkaissi, 2023; Ginting & Widyaningsih, 2022; Kim et al., 2023; Zhang et al., 2020). The dependent variables analyzed were time loss and waiting time. The goal of this analysis was to identify an optimized traffic flow.

According to Azlan and Rohani (2018), traffic simulation is a widely used method applied in the research on traffic modeling, planning and development of traffic networks and systems. SUMO, in particular, has been shown to be effective in evaluating the impact of various traffic interventions (Belleza et al., 2023; Izadi et al., 2021).

Procedures

The researcher initially sought approval from the panel members before gathering data. Upon approval, the researcher procured two cameras through a trusted online shop and then contacted the university president via a communication letter to request permission for camera installation.

Upon the cameras' arrival via courier, they were checked for damages and tested for recording over several days. The traffic counting procedure in this study, utilizing recorded video, adhered to the established guidelines of Majumder and Wilmot (2023). The cameras were strategically installed to capture traffic flow while ensuring no private spaces were included in the footage.

With the cameras secured and strategically positioned after overcoming initial placement challenges, the data collection phase commenced. The cameras recorded traffic flow for 24 hours daily from March 24 to 28, 2025. Following this period, the cameras were removed, and the footage was extracted from the SD cards. Traffic counting was then conducted using the recorded video, with manual counts recorded on standard DPWH forms.

Adhering to the established guidelines of Majumder and Wilmot (2023), the researcher took a 5-minute break for every hour of manual video counts to ensure accuracy. A vehicle was counted only when its front passed the designated counting point within the specified time interval. To avoid counting errors, the study implemented repeated counts. If the repeated count matched the initial count, the initial count was assumed accurate. If the counts differed, a second repeated count was conducted to investigate the discrepancy and increase confidence in the final count.

The gathered traffic count was then input into a traffic simulation tool called Simulation of Urban Mobility (SUMO) to simulate baseline and intervention traffic scenarios. For the traffic simulation, the traffic network of NwSSU and its vicinity was first extracted using the netconvert tool, which retrieved the map from Open Street Map, selecting only the "highway" category representing roads for vehicles. A network file, necessary for the simulation, was then generated. The extracted network was subsequently refined and corrected using the netedit tool to address discrepancies with the actual scenario.

The traffic counts for each vehicle type obtained through manual counting were input into separate XML files, the required format for the routesampler tool. Routes were also necessary to run the routesampler tool. These routes were generated using the findallroutes tool, which creates all possible routes vehicles could take. Only routes originating and terminating at the network boundaries were used to ensure a realistic traffic simulation. After using the routesampler tool, individual routes for each vehicle type were generated and stored in separate XML files. Additional files were also manually created to enable SUMO to generate traffic metrics such as "timeLoss," "waitingTime," and emissions. Finally, the network file, route files, and additional files were linked in the SUMO configuration.

After completing the required files and data preparation, the simulation was run. Following the simulation, two additional XML files were generated, representing the outputs for traffic metrics and emissions. These steps were then repeated 60 times to simulate the 60 traffic scenarios covering the morning, noon, afternoon, and evening periods across five days. These outputs were then extracted to MS Excel for organization, analysis, and visualization of both the manually collected traffic data and the simulation results.

III. Results and Discussion

The traffic count data revealed peak volumes coinciding with the arrival and departure times of students and employees. Similarly, a study conducted by Zamora and Fillone (2017) also documented peak traffic occurring at these times.

Based on the SUMO traffic simulations and analysis of waiting time and time loss, the findings indicate that a one-way lane configuration along Cajurao Street resulted the least waiting time and time loss. Conversely, the implementation of a static traffic light system at the Cajurao-

Gomez intersection led to the highest waiting time and time loss, representing the least optimized scenario among those tested.

These simulation results align with findings from several prior studies (Alkaissi, 2023; Ginting & Widyaningsih, 2022; Zhang et al., 2020; Zhu et al., 2019), suggesting a consistent trend.

However, the results of this study did not align with the findings of a recent study by Kim et al. (2023) that employed traffic lights in a traffic simulation on a road network. This discrepancy may be because a static traffic light system operates on fixed time intervals, regardless of the actual traffic flow. This means that if traffic volumes vary significantly throughout a period, the signal timings will often be inefficient. Static TLS systems allocate a fixed amount of green time to each traffic movement, even if there are no vehicles waiting, which leads to wasted green time and increased delays for other movements.

The analysis suggests that the baseline scenario generally performs well in terms of emissions and fuel consumption. Implementing a static traffic light at the Cajurao-Gomez intersection consistently leads to the highest emissions across most pollutants and fuel consumption. The one-way street configuration on Cajurao Street often results in the lowest emissions for several pollutants during the early weekdays. The combined intervention of a one-way street and a static traffic light tends to worsen emissions compared to the one-way street alone, particularly towards the end of the week.

IV. Conclusion

Based on the SUMO traffic simulations and analysis of waiting time and time loss, the findings indicate that a one-way lane configuration along Cajurao Street resulted in the most optimized traffic scenario, demonstrating the least waiting time and time loss. Conversely, the implementation of a static traffic light system at the Cajurao-Gomez intersection led to the highest waiting time and time loss, representing the least optimized scenario among those tested.

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