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Effect of The Countdown Timer On Driver Conduct When A Yellow Flight Is Displayed At An Intersection

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Abstract: This research intends to provide input from various preliminary studies because there are inconsistencies. There are several countdown timer installations that have a positive influence, there are several previous studies that installing countdown timers have had a negative effect. One of the negative influences is that drivers, when the yellow and red lights flash, continue to drive at the intersection with a countdown timer. In connection with the effect of using a Countdown Timer on motorists who drive when the lights are yellow and red, this research was conducted. Recording was carried out on weekdays and holidays at the Pilangsari intersection, Sragen, Central Java, Indonesia, which included yellow lights after red and yellow lights after green, using the Time Slice Technique. Namely recording in the morning, afternoon and evening. Each for 2 hours. Then the number of vehicles traveling when the yellow light follows the red light (YFR) and when the yellow light follows the green light (YFG) is calculated. Pay attention to morning and evening rush hours. Then tabulation is carried out followed by interpretation of the tabulation results. Based on research, motorcycle riders ride more when yellow lights follow red lights, and light car drivers ride more when yellow lights follow green lights.

Keywords: Countdown Timer, Yellow Light, Driver, Intersection

1. Introduction

1.1. Background

Transportation as a catalyst for economic growth. An efficient and smooth transportation system plays an important role in driving economic progress and ensuring optimal comfort in traffic conditions. These include traffic infrastructure (cameras), adequate availability of public transportation, environmentally friendly fuel, guaranteed noise, and good driver behavior. To ensure efficient traffic flow, it is necessary to consider factors such as accessibility and permeability of safe spaces, as well as sustainability[1,2]). To maximize the use of public space, it is necessary to implement eye on the street[3]). Use of vehicle and driver monitoring cameras[4),5)]. Vehicles need to be installed with warning signal detectors (SWAD)[6]). On highways, it is necessary to propose the installation of cameras with real-time video processing to monitor driver activities while driving[4]). Mitigation of carbon emission costs due to fuel consumption and cooling systems in refrigerated trucks can be achieved through facilitating smooth conditions[7]). Vehicles need to use environmentally friendly braking systems[8]). Utilization of biofuel as an environmentally friendly alternative energy[9]). The research results show that the gasoline-ethanol mixture and oxygenated additives reduce variations in combustion pressure[10]). Exhaust gas analysis shows a significant reduction in engine emissions such as carbon dioxide, carbon mono oxide and hydrocarbons, resulting in lower smoke opacity[11]). Biomass-derived fuels are promising candidates for future bioenergy, which will reduce CO 2 emissions and dependence on fossil fuels[12]). To obtain forms of energy suitable for long-distance transportation, such as hydrogen gas and electricity, research and development of biomass gasification with hydrogen production or combined with Solid Oxide Fuel Cell (SOFC) should be promoted in the future[13]). Renewable energy ne eds to be increased to reduce fossil fuels[14]). For large trucks, increasing the load will reduce the frequency of deliveries thereby reducing carbon emission costs[5]). Biowaste-based mixed matrix membranes (MMM) have been proven to be able to reduce motorcycle exhaust gas from the testing room, meet the Indonesian National Standard (SNI) and contribute to the environment[15]). The results of the conversion of electric motorcycle are the best alternative to internal combustion engine (ICE) motorcycle based on sustainability considerations[16]. Apart from that, the lack of public transportation services causes people to prefer private vehicles over public transportation so that the capacity of road users increases beyond capacity. This phenomenon occurs because public transport coverage is inadequate in densely populated areas[17]. The need for a more comprehensive recognition of driving behavior, as highlighted[18)19)], is of paramount importance. Driver behavior has a significant influence on the occurrence of traffic jams.

Traffic congestion is a prevalent issue in numerous urban areas around Indonesia. According to the studies[20)21)], it has been found that the city of Malang is likewise confronted with the issue of traffic congestion. The traffic congestion seen exhibits a suboptimal level of service, which can be classified within the range of D, E, and F. In order to enhance the efficiency of traffic flow, a common approach is the implementation of signalization at various crossings, accompanied by the provision of Countdown Timers.

Junctions that are equipped with Traffic Signal Control Devices (TSCD), also known as traffic lights, serve the purpose of mitigating the likelihood of crashes at level junctions. Countdown timers are being implemented at signalized junctions nationwide with the aim of enhancing the quality of service and traffic safety provided at such intersections. When encountering the dilemma zone, the delay experienced at the termination of a signalized intersection with the Cooperative Signal Timing (CST) system is comparatively lower than that observed at the termination of a signalized intersection without CST. The provision of cycle times by the Cycle Signal Timing (CST) system offers drivers a sense of tranquility and assurance while crossing intersections or waiting at traffic signals. The utilization of signaled countdown timer (CST) devices enhances drivers' sense of ease and familiarity with signal indication cessation during the conclusion of the green period. The research revealed that the implementation of CST devices resulted in a notable 15 percent decrease in drivers' inclination to make decisions to pass through intersections. This reduction in decision-making was found to have an impact on the frequency of infractions and driver aggressiveness. Specifically, the study discovered that drivers tended to exhibit increased aggression when waiting for a green light when CST devices were present[22)23)18)24)25)26)27)]. Young drivers (under 30 years old) display significantly higher jerks than drivers 30 years and older[28)]. Meanwhile, the effect of the countdown timer on the yellow light and traffic safety, the results show, that a car in a leading position increases the probability not to stop after yellow-onset[19)]. The study finds that the signal countdown timer is an effective device that can enhance the traffic safety and operational performance of a signalized intersection[29)22)]. However, other researchers found that the application of Countdown Timers worsens safety at signalized intersections, and also worsens safety. Removal should be considered[27)]. Additionally, the presence of a countdown timer at signalized intersections was shown to introduce a delay in the initiation of the AFD[30)]. The presence of yellow lights at intersections has been found to exert an influence on a range of driver behaviors.

Multiple research studies examining driver behavior at yellow lights have consistently demonstrated a positive correlation between driving speed at the onset of the yellow phase and the likelihood of passing through the intersection during this period. The findings of this study suggest that individuals belonging to two specific age groups, namely young drivers aged 18 to 25 and middle-aged drivers aged 30 to 45, exhibit a reduced likelihood of encountering the amber light while driving at various speeds when their attention is diverted. This observation may indicate a potential compensatory risk that arises during critical driving instances for these particular age cohorts[31)]. Under mixed traffic conditions prevailing on Indian roads, drivers show complex response when faced with yellow signal because lane assignment gets dynamic in nature. The present study analyzes the effect of surrounding vehicles on response of the drivers while facing dilemma at intersections[24)]. Although dilemma zone definitions hold true in case of homogeneous traffic mix, a statistical analysis is performed to check the consistency across the definitions under mixed traffic condition. Present study shows a significant difference in percentage of red light running in comparison to homogeneous traffic as reported by various studies. For carrying out the research, study locations are chosen in such a way to reflect diversity in road geometry, traffic composition and signal characteristics. The results deduced in this study indicate a strong correlation between the driver's decision making choice and the effect of presence of surrounding vehicle at the onset of yellow signal. The effect of critical time analysis has been found out to be one of the parameters other than critical distance in categorizing driver's aggressiveness while facing the yellow signal. In the process of identifying the statistical significance of dilemma zone definitions, it has been found that under heterogeneous traffic condition, drivers behave differently as compared to homogenous traffic when it comes to dilemma zone. It is observed that the percentage of vehicles crossing the intersection when faced with dilemma by violating the red light is 11.6% according to dilemma zone definition I whereas the definition II has yielded about 10.8% violation covering different vehicle types. The above violation figures. The level of aggressiveness among drivers allows calculating the probability that a driver will cross an intersection even if stuck in a dilemma zone[32)]. Cognitive interference causes a longer perceptual response time (PRT) after the appearance of yellow, but only if there is no car in the lead position[19)]. We found that incongruent information, displayed on short spacing traffic signals, delayed drivers' responses without being detrimental to their decision-making processes[33)]. The results show that cars in the leading position increase the likelihood of not stopping after the appearance of yellow[34)]. The issue can be handled by increasing the size of the interval. The formula proposed by Gazis, Herman, and Maradudin (GHM) is employed to compute the duration of the yellow signal phase, during which the intersection configuration and approach velocity are assumed to be at their maximum permissible values[35)]. The driving behavior observations done by Atlas revealed notable disparities in driving behavior across different interval adjustments[36)]. A study demonstrated that modifying the duration of a yellow light led to a significant reduction of 36% in the occurrence of red light violations. A significant association has been observed between the implementation of red light cameras and a substantial decrease of 96 percent in the frequency of red light violations[37)]. It was found that the speed during the yellow light reduced significantly at all distances, i.e, 14-40% (6.5-22 km/hr.), resulting in 20-meter reduction of the maximum length of movement during the yellow signal period, compared to an unchanged distance at the control intersection[38)].

Based on the studies discussed previously, it turns out that there is inconsistency regarding the yellow flash signal at the intersection located on the CST (Signal countdown timers). By ascertaining the mileage of the car at the precise moment when the yellow traffic signal coincides with an intersection equipped with a countdown timer. The main objective of this research is to present a comprehensive analysis of the characteristics of motorcycle and light vehicle traffic at signalized intersections with Countdown Timers. Operating a motor vehicle during the duration of a yellow traffic signal is considered a breach of traffic regulations and poses a potential threat to the safety of the driver of the oncoming vehicle. Additionally, it is important to contribute insights about the divergent conclusions reached by researchers regarding the impact of the countdown timer.

Based on the above-mentioned problem, further difficulties have been formulated: What is the number of motorcyclists and drivers of light vehicles who remain on the road when the signal is yellow? What are the similarities and disparities in the conduct of motorcyclists and drivers of light vehicles?

1.2. Literature Review

1.2.1. All Red

All red indicates the green arm is starting to glow red while the other arm continues to glow red. However, the other arm continued to burn red. This disease is one that frequently affects drivers. Even though the entire signal is red, all cars still have the chance to get through the green light arm and reach safety up to the next arm, even though the rest of the lights are red.

All red consists of a yellow signal that lasts for three seconds, followed by a red signal that serves to pass passing vehicles on the arm ending the green flame. If the light is completely red, only vehicles on the arm that ends with the green signal may be driven, as in Fig 1.

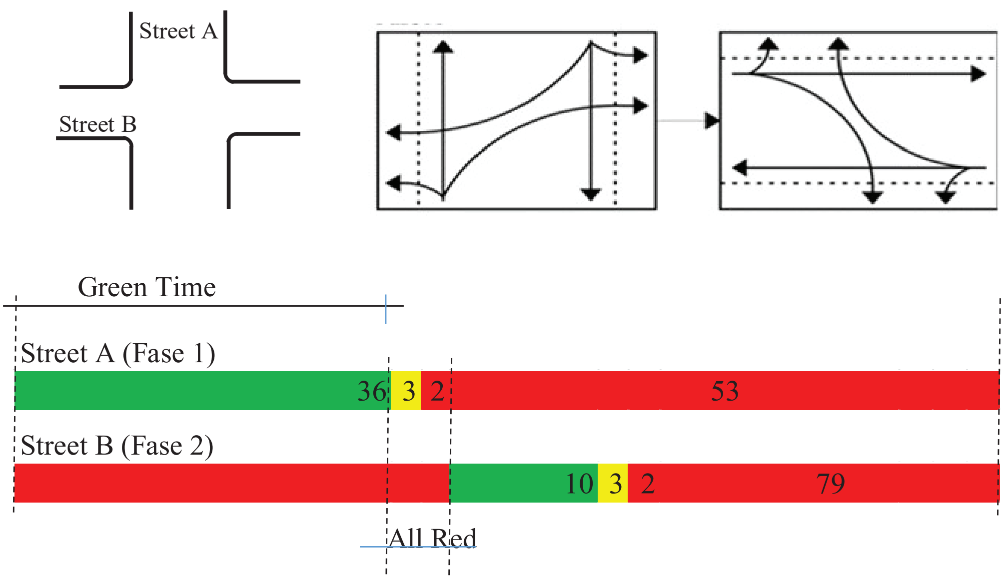

Fig. 1: The Yellow Light

Figure 1 shows the process of changing the green light to yellow and to red. As well as the process of changing the green light from arm A to arm B.

1.2.2. CST (Signal Countdown Timers)

In this traffic, signal countdown timers (CST) or countdown systems, both of which are APILL, are in use. Signal countdown timers will display the number with the greatest or most nominal value in units of time per second, which will thereafter decrease as time passes (for example, 5, 4, 3, 2, 1, 0). As soon as the time period expires, everything will return to normal. A board with red and green digital number-shaped LEDs is used to display the Signal countdown timing system. So that vehicles can see them, these boards and lights are frequently placed in close proximity to traffic signals or other crucial points. Before storing this data in memory, the device calculates how long the red and green lights will be illuminated in seconds. When the red light is illuminated, this device will display the data stored in its memory.

This is the period of time, in seconds, that the light is red, and it will decrease by 1 unit every second until the final zero is displayed (zero). This implies that the beginning software has been updated if the final digit, "0," is not reached or passed. At this time, the system will recalculate and store fresh data in memory, and the green light will be on. If the last digit 0 is reached or passed, the startup program has not been modified. This traffic light countdown timer signal system consists of simply two colors: red and green.

Fig. 2: Signal Countdown Timing Device.

Figure 2 is an example image of a countdown timer installed at a signaled intersection. The number 125 shows the length of time the red light is on at the intersection

2. Methods and Materials

2.1. Location

This research was conducted at the Pilangsari intersection Sragen Regency, Central Java Province, Indonesia

Sragen City is the border between Central Java and East Java Provinces. To the north is Purwodadi Regency, to the south is Karanganyar Regency, to the west is Surakarta City and to the east is Ngawi Regency.

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Fig. 3 Pilangsari Intersection with Countdown Timer

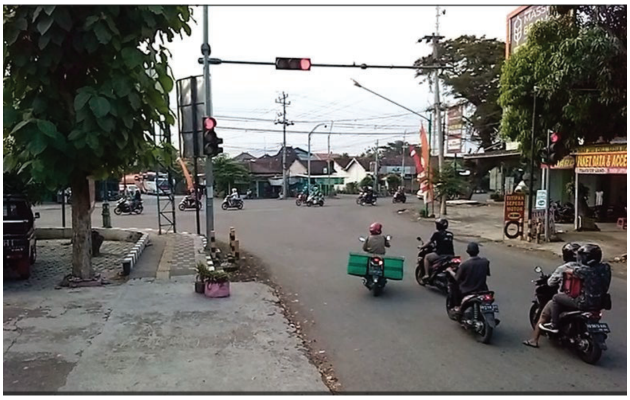

Fig. 4 Pilangsari Intersection without Countdown Timer

Table 1. Intersection conditions under study

Approach Code	Road Type	Median Yes / Not	approac h width (W_A)	Entry width W_{ENTRY}	Out Width W_{OUT}
U	Com	N	6	6	7,15
S	Com	N	6	6	7,65
T	Com	N	7	7	
B	Com	N	7	7	7,65

2.2. Research Stages

There are three phases to the research procedure. First, the Pilangsari-Sragen intersection was recorded using the Time Slice Technique on weekdays (Wednesday) during the morning and afternoon peak hours, as well as on weekends (Sunday) during the morning and afternoon peak hours. The recording must occur within a two-hour window on weekdays and holidays, both in the morning and afternoon. Following 15 minutes, the recording will end. There were ten phase changes within fifteen minutes

Based on the recording results, the second stage is to compile a list of recorded two- and four-wheeled vehicles, along with information on the type of vehicle and its lights (starting green, starting red, and finally red and yellow). The only footage of a moving car used in this study was captured when the yellow flash signal was on. The tabulation findings are displayed in the form of a graph depicting the number of drivers behind the wheel at each phase of the yellow flash signal over a two-hour period broken down into 15-minute increments..

The final stage involves developing conclusions based on the outcomes of studying the driver's behavior while the light is yellow. Figure 5 provides additional information. Below

Fig. 5: Diagram of Study Phases

2.3. Information

After doing the proper calculations, the following conclusions are obtained: Fig. 6., Fig. 8., Fig. 10., and Fig. 12. are fig for motorcycles that run when the flash is yellow. While Fig. 7., Fig. 9., Fig. 11 and Fig. 13., are fig for light vehicles that drive when the light is yellow.

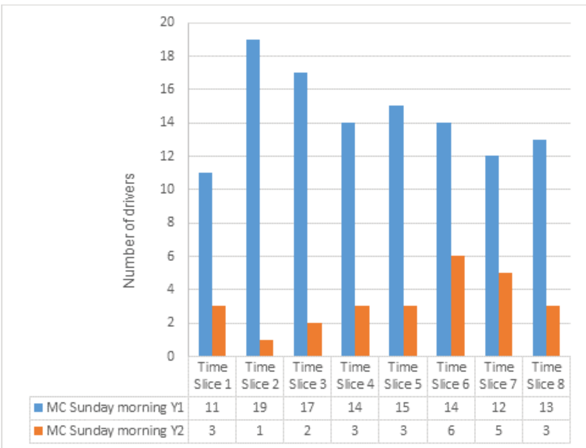

Fig. 6: Motorcycle at Yellow Light on Sunday Morning

Figure 6 shows the second Time Slice containing the concentration of motorcyclists when the yellow light is highest. At YFR, there were 19 cyclists. Drivers who continued their journey when the light turned yellow after the green light (YFG), only six vehicles continued their journey.

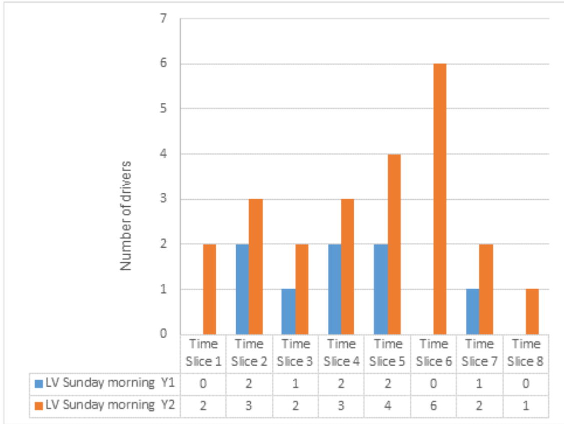

Fig. 7: A Vehicle drivers at Yellow on Sunday morning

Figure 7 shows that Time Slice 6 contains the highest concentration of vehicle drivers when the yellow light is on, as many as 6 cyclists in YFG. Light car drivers who drive at yellow lights after red lights (YFR) are only two vehicles.

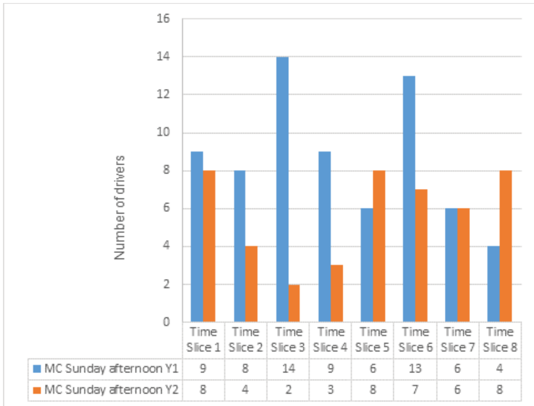

Fig. 8: A Motorcycle at Yellow Light on Sunday Afternoon

Figure 8 shows Time Slice 3 containing the highest concentration of motorcyclists when the light turns yellow. In YFR, there are 14 cyclists. For drivers who speed when the light turns yellow after the green light (YFG), eight vehicles are the ones driving the most.

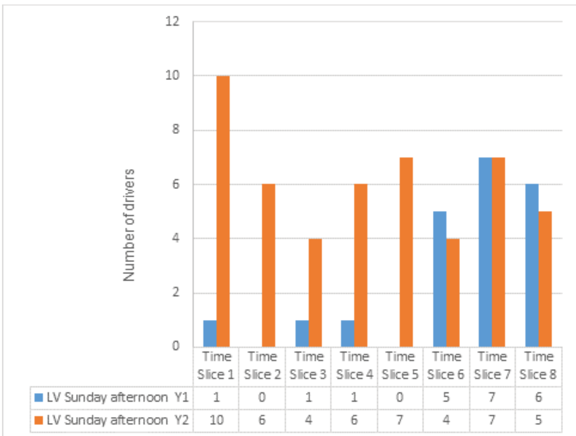

Fig. 9: A Vehicle drives on Yellow on Sunday Afternoon

Figure 9 shows that Time Slice 1 contains the highest concentration of light car drivers when the lights are yellow at YFG with 10 drivers. Light car drivers who drive when the yellow light follows the red flash light (YFR) are only seven vehicles.

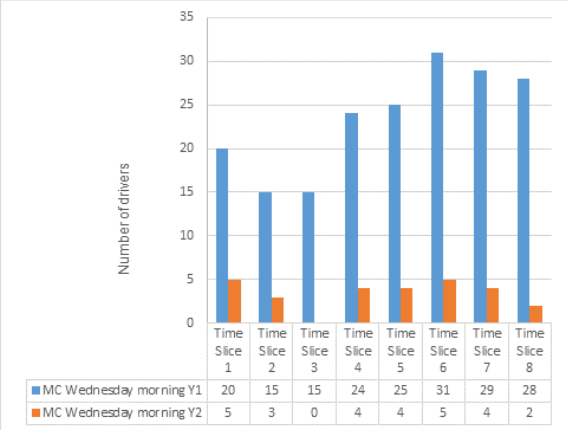

Fig 10: Motorcycle at Yellow Light on Wednesday Morning.

Figure 10 shows that Time Slice 6 contains the highest concentration of motorcycle riders when the yellow light on YFR is 31 cyclists. The most drivers who drove when the light turned yellow after the green light (YFG) were five vehicles.

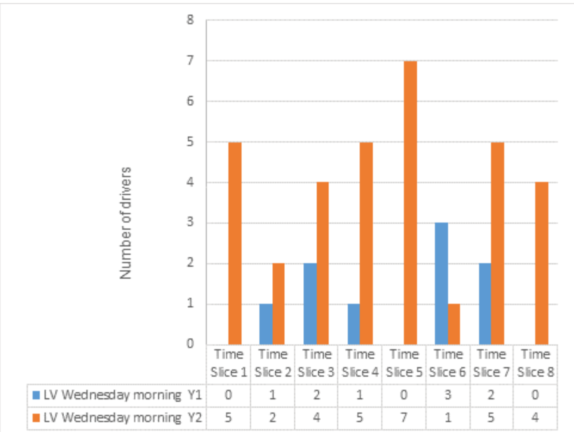

Fig. 11: A Vehicle drives on Yellow on Wednesday Morning

Figure 11 shows that Time Slice 5 has the highest concentration of light vehicle drivers when the yellow flash is seven cyclists in YFG. There were three light vehicle drivers operating at yellow lights after red lights (YFR).

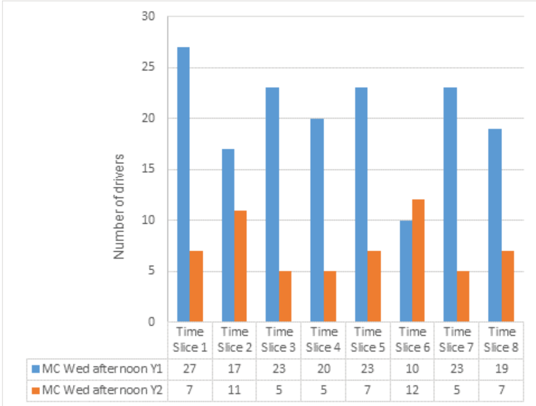

Fig. 12: A motorcycle in front of a yellow light on a Wednesday afternoon

Figure 12 shows that Time Slice 1 contains the highest concentration of motorcycle riders when the yellow light on YFR is 27 cyclists. The most drivers who drove when the light turned yellow after the green light (YFG) were 12 vehicles.

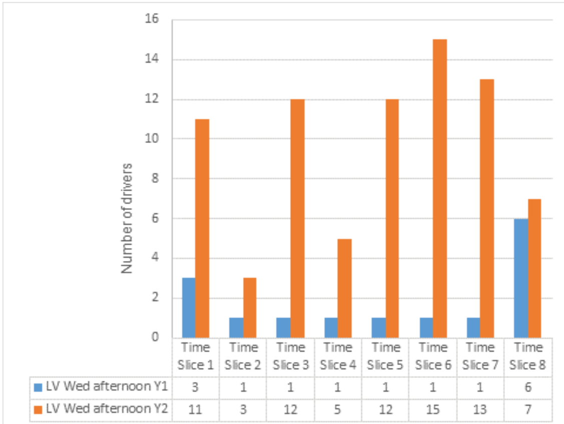

Fig. 13: A Vehicle drove during the Yellow Light on a Wednesday afternoon

Figure 13 shows that Time Slice 6 contains the highest concentration of light car drivers when the lights are yellow at YFG with 15 drivers. There are only six light car drivers who drive when the yellow light follows the red light (YFR).

3. Result

Motorcycle riders ride more when a yellow light follows a red light, and light car drivers ride more when a yellow light follows a green light. This situation is in accordance with research[24]), The percentage of vehicles crossing an intersection when facing a dilemma by violating a red light is 11.6% according to the definition of dilemma zone I while definition II results in approximately 10.8% of violations covering different types of vehicles.

This research shows that when the yellow light is on, many motorcycle continue to drive at the intersection with a countdown timer, as in Fig. 6, Fig. 8, Fig. 10, and Fig. 12.

This research in line with the results suggest that Countdown Timers worsen safety at signalized intersections, and thus their removal should be considered[27)].

It was found that CST devices can reduce drivers' decisions to pass through intersections by 15%, change driver violation rates, and increase driver aggression, causing drivers to be more aggressive when waiting for a green light [32)]. This is consistent with the findings of this investigation, namely that motorcyclists drive more aggressively when the light is still yellow.

4. Conclusion

After tabulating and calculating the data, the following conclusions are reached: 1. The number of bikers and light vehicle drivers present during the occurrence of the yellow lightning are 31 motorcycle and 15 Light Vehicle. 2. Motorcycle riders and light car drivers both speed when the yellow light flashes, but the number of motorcycle drivers is greater. From the results of the tabulation and interpretation above, it can be concluded that the installation of the Countdown Timer at the Pilangsari intersection triggers drivers to pass through the intersection when the signal turns yellow.

In this research there are still many shortcomings. Further research is needed with more data involved and involving more types of vehicles, not just light cars and motorcycle.

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Nomenclature

APILL	traffic signaling device
AFD	average fixation duration
CDT	countdown timer
CR	circular red
CST	signal countdown timers
HV	heavy vehicle (vehicle)
IHCM	Indonesia High Capasity Manual
LED	light-emitting diode
LV	light vehicle (vehicle)
MC	motorcycle (vehicle)
RSCT	red signal countdown timers
TSCD	traffic signal control devices
YFR	a yellow light follow red (sec)
YFG	a yellow light follow green (sec)

References

1) I. Surjandari, R. Rindrasari, and A. Dhini, "Evaluation of efficiency in logistics company : an analysis of last-mile delivery," 10 (*02*) 649–657 (2023).
2) A. Sihombing, A.K. Ramadhan, and C.S. Saskia, "Accessibility and permeability in transit area . case studies in jakarta-depok train stations accessibility and permeability in transit area . case studies in jakarta-depok train stations," 9 (*2*) 538–546 (2022).
3) S. Fadhila, and Y.N. Lukito, "Surveillance and architecture, analyzing the idea of eyes on the street," *Evergreen*, 7 (*1*) 132–137 (2020). doi:10.5109/2740980.
4) P. Panwar, P. Roshan, R. Singh, M. Rai, A.R. Mishra, and S.S. Chauhan, "DDNet- a deep learning approach to detect driver distraction and drowsiness," *Evergreen*, 9 (*3*) 881–892 (2022). doi:10.5109/4843120.
5) N.S. Zulkefly, H. Hishamuddin, F.A.A. Rashid, N. Razali, N. Saibani, and M.N.A. Rahman, "The effect of transportation disruptions on cold chain sustainability," *Evergreen*, 8 (*2*) 262–270 (2021). doi:10.5109/4480702.
6) S. Hassan, N.M. Yusof, M.S. Ikhsan, M.Z.I. Jumari, M.A.M. Nadir, M.H.H. Ibrahim, M.A.M. Nor Azman, M.A.F. Mohd Sarif, M.A.R. Abdul Rashid, M.S. Yusof, M. Ismon, H. Zakaria, M.A. Azmi, and O.M.F. Marwah, "Safety working environment at highway: safety warning detector (swad) system," *Evergreen*, 8 (*3*) 517–523 (2021). doi:10.5109/4491637.
7) B.A. Hardiyansyah, F.R. Sutikno, M. Zeibots, and K.D.S. Wijayaratna, "Evaluation of accessibility commuter-line station with jitney transportation modes by using gis application-a case study of depok station," *Civ. Environ. Sci.*, 006 (*01*) 43–55 (2023). doi:10.21776/ub.civense.2023.00601.6.
8) L.N. Patil, and H.P. Khairnar, "Investigation of human safety based on pedestrian perceptions associated to silent nature of electric vehicle," *Evergreen*, 8 (*2*) 280–289 (2021). doi:10.5109/4480704.
9) A.A.S. Gheidan, M.B.A. Wahid, O.A. Chukwunonso, and M.F. Yasin, "Impact of internal combustion engine on energy supplyand its emission reduction via sustainable fuel source," *Evergreen*, 9 (*3*) 830–844 (2022). https://doi.org/10.5109/4843114
10) I. Yamin, B. Sugiarto, Mokhtar, S. Abikusna, and B.R. Artala, "Analysis of utilization low grade bioethanol and oxygenated additives to cov and specific fuel consumption on si engine," *AIP Conf. Proc.*, 2255 (*1*) 43–50 (2020). doi:10.1063/5.0014566.
11) H.K. Chaudhary, K. Saraswat, H. Yadav, H. Puri, A.R. Mishra, and S.S. Chauhan, "A real time dynamic approach for management of vehicle generated traffic," 10 (*01*) 289–299 (2023).
12) R.K. Ahmad, S.A. Sulaiman, A.M.B.A. Majid, S. Yusuf, S.S. Dol, M. Inayat, and H.A. Umar, "Assessing the technical and environmental potential of coconut shell biomass: experimental study through

pyrolysis and gasification," *Evergreen*, 10 (*1*) 585–593 (2023). doi:10.5109/6782165.

13) Y. Furutani, K. Norinaga, S. Kudo, J.I. Hayashi, and T. Watanabe, "Current situation and future scope of biomass gasification in japan," *Evergreen*, 4 (*4*) 24–29 (2017). doi:10.5109/1929681.
14) T. Fujisaki, "Evaluation of green paradox: case study of japan," *Evergreen*, 5 (*4*) 26–31 (2018). doi:10.5109/2174855.
15) Y. Wibisono, A. Amanah, A. Sukoyo, F. Anugroho, and E. Kurniati, "Activated carbon loaded mixed matrix membranes extracted from oil palm empty fruit bunches for vehicle exhaust gas adsorbers," *Evergreen*, 8 (*3*) 593–600 (2021). doi:10.5109/4491651.
16) A. Habibie, M. Hisjam, W. Sutopo, and M. Nizam, "Sustainability evaluation of internal combustion engine motorcycle to electric motorcycle conversion," *Evergreen*, 8 (*2*) 469–476 (2021). doi:10.5109/4480731.
17) W. Kriswardhana, N. Hayati, and A. Kusdiyanto, "Public attitude to urban public transportation services in jember, indonesia," *Civ. Environ. Sci.*, 005 (*01*) 045–054 (2022). doi:10.21776/ub.civense.2022.00501.5.
18) R.C. Majhi, and V. Senathipathi, "Analyzing driver's response to yellow indication subjected to dilemma incursion: an econometric approach," *Transp. Res. Procedia*, 48 1111–1124 (2020). doi:10.1016/j.trpro.2020.08.137.
19) R. Kaul, and M. Jipp, "Influence of cognitive processes on driver decision-making in dilemma zone," *Transp. Res. Interdiscip. Perspect.*, 19 (*October 2022*) 100805 (2023). doi:10.1016/j.trip.2023.100805.
20) J. Fan, A. Li, A. Ilahi, and K. Gao, "Emission impacts of left-turn lane on light-heavy-duty mixed traffic in signalized intersections: optimization and empirical analysis," *Heliyon*, 9 (*5*) e16260 (2023). doi:10.1016/j.heliyon.2023.e16260.
21) I. Hidayati, C. Yamu, and W. Tan, "The emergence of mobility inequality in greater jakarta, indonesia: a socio-spatial analysis of path dependencies in transport-land use policies," *Sustain.*, 11 (*18*) (2019). doi:10.3390/su11185115.
22) C. Brand, T. Hagedorn, T. Kösters, M. Meier, G. Sieg, and J. Wessel, "Riding the green wave – how countdown timers at bicycle traffic lights impact on cycling behavior," *Travel Behav. Soc.*, 35 (*December 2023*) (2024). doi:10.1016/j.tbs.2023.100731.
23) R. Rossi, M. Gastaldi, F. Orsini, G. De Cet, and C. Meneguzzer, "A comparative simulator study of reaction times to yellow traffic light under manual and automated driving," *Transp. Res. Procedia*, 52 (*2020*) 276–283 (2021). doi:10.1016/j.trpro.2021.01.032.
24) R.C. Majhi, and V. Senathipathi, "Analyzing driver's response to yellow indication subjected to dilemma incursion under mixed traffic condition," *J. Traffic Transp. Eng. (English Ed.*, 8 (*1*) 107–116 (2021). doi:10.1016/j.jtte.2019.05.005.
25) H.A. Mohammed, M. Ghodrat Abadi, and D.S. Hurwitz, "Red-light running violation during car following at high-speed signalized intersections," *Transp. Eng.*, 8 (*March*) 100110 (2022). doi:10.1016/j.treng.2022.100110.
26) S.Y. Yong, and N. 'Ain M. Jamudin, "The role of advance amber warning signal in enhancing driver decision-making: a comparative study in brunei darussalam," *Transp. Eng.*, 15 (*December 2023*) 100225 (2023). doi:10.1016/j.treng.2023.100225.
27) W. Yan, S.C. Wong, B.P.Y. Loo, C.Y.H. Wu, H. Huang, X. Pei, and F. Meng, "An assessment of the effect of green signal countdown timers on drivers' behavior and on road safety at intersections, based on driving simulator experiments and naturalistic observation studies," *J. Safety Res.*, 82 1–12 (2022). doi:10.1016/j.jsr.2022.04.001.
28) M. Almallah, R. Alfahel, Q. Hussain, W.K.M. Alhajyaseen, and C. Dias, "Empirical evaluation of drivers' start-up behavior at signalized intersection using driving simulator," *Procedia Comput. Sci.*, 170 227–234 (2020). doi:10.1016/j.procs.2020.03.034.
29) J. Jatoth, N.K. Singh, and A. Mehar, "Evaluating the performance of signalized intersection with signal countdown timer," *Int. J. Intell. Transp. Syst. Res.*, 19 (*1*) 182–190 (2021). doi:10.1007/s13177-020-00233-2.
30) K. Małecki, and S. Iwan, "Modeling traffic flow on two-lane roads with traffic lights and countdown timer," *Transp. Res. Procedia*, 39 (*2018*) 300–308 (2019). doi:10.1016/j.trpro.2019.06.032.
31) W. Linda, and N. Boyle, "Title: decisions and actions of distracted drivers at the onset of yellow lights author: md. mazharul haque amanda d. ohlhauser simon washington linda ng boyle," (n.d.).
32) P. Papaioannou, E. Papadopoulos, A. Nikolaidou, I. Politis, S. Basbas, and E. Kountouri, "Dilemma zone: modeling drivers' decision at signalized intersections against aggressiveness and other factors using uav technology," *Safety*, 7 (*1*) (2021). doi:10.3390/safety7010011.
33) L.L. Di Stasi, F. Angioi, M. Bassani, C. Diaz-Piedra, and A. Megias-Robles, "The effect of traffic light spacing and signal congruency on drivers' responses at urban intersections," *Transp. Eng.*, 8 (*April*) 100113 (2022). doi:10.1016/j.treng.2022.100113.
34) T. Campisi, G. Tesoriere, A. Canale, S. Basbas, P. Vaitsis, A. Nikiforiadis, and M. Nikolaidis, "Comparison of red-light running (rlr) and yellow-light running (ylr) traffic violations in the cities of enna and thessaloniki," *Transp. Res. Procedia*, 45 (*2019*) 947–954 (2020). doi:10.1016/j.trpro.2020.02.072.
35) J. Cai, J. Zhao, J. Liu, J. Liu, K. Shen, X. Li, and Y. Ye, "Exploring factors affecting the yellow-light running behavior of electric bike riders at urban intersections

in china," *J. Adv. Transp.*, 2020 (2020). doi:10.1155/2020/8573232.

36) Q. Hussain, W. Alhajyaseen, K. Brijs, A. Pirdavani, and T. Brijs, "Interval at signalized intersections using a smart countdown system," 1–10 (2020).
37) H. Zheng, Y. Qin, and Z. Du, "Atlas analysis of the impact of the interval changes in yellow light signals on driving behavior," *IEEE Access*, 9 46339–46347 (2021). doi:10.1109/ACCESS.2021.3067167.
38) P. Tankasem, W. Chaipanha, P. Kaewwichian, J. Kumphong, T. Promraksa, and T. Sateinnam, "Effects of drivers' speed during the yellow-light signal and satisfaction of drivers at the intersections with the red-light cameras," *Eng. Appl. Sci. Res.*, 49 (*3*) 353–362 (2022). doi:10.14456/easr.2022.36.