The Influence of Countdown Timers on the Traffic Safety of Pedestrians and Vehicles at the Signalized Intersection

Aleksander Sobota, Marcin Jacek Klos and Grzegorz Karoń

Abstract Countdown Timers (timers) are auxiliary devices to the traffic signalization, which measure the time to change the displayed signal. Currently, the use of countdown timers in Poland is not regulated by law. Such devices, however, in some Polish cities are functioning and are installed on a growing number of intersections. In order to analyse the devices described the research was conducted on the impact of counter dispensing time on road safety. The study were subjected the countdown timers used for both pedestrian and vehicular traffic. At the time of measurements were compared behaviour of pedestrians and drivers in two periods of research: for a week with enabled and disabled countdown timers. The influence of the countdown timers into intersection capacity was calculated in the other part of the work [1], vehicle speed-issue wasn't tested. The results allow concluding that the countdown timers for both pedestrians and vehicles improve safety in the initial phase of the signal. Future work on other research proving grounds allow for more accurate determining the impact of the countdown timers on safety.

Keywords Countdown timer · Signalized intersection · Pedestrian safety · Traffic safety · Driver behaviour · Pedestrian behaviour

A. Sobota (✉) · M.J. Klos · G. Karoń
Faculty of Transport, Silesian University of Technology, Katowice, Poland
e-mail: aleksander.sobota@polsl.pl

M.J. Klos
e-mail: marcin.j.klos@polsl.pl

G. Karoń
e-mail: grzegorz.karon@polsl.pl

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1 Introduction

Road traffic safety is a set of rules regarding proper movement on roads [2]. Impact on the level of road safety has various factors such as the organization of road traffic, condition of road infrastructure, user behaviour, technical condition of vehicles. An extremely important aspect when introducing new elements to the road infrastructure is checking in the first step how a given element or device affects the safety of road users [3].

From the appearance of the first roads man tries to improve the transfer of information to the user of the road. The primary methods of information transmitted are road signs with pictograms placed on them. The development of technology and the need to provide faster and more accurate information gave rise to such devices as electric traffic lights; variable message signs (VMS). Analysed display device of time is a new road-information solution in the Polish conditions.

Countdown timers (timers) are auxiliary devices to the traffic lights, which measure the time (in seconds) to change the displayed signal. Currently, the use of countdown timers in Poland is not regulated [4] Such devices, however, in some Polish cities are functioning and are installed on a growing number of intersections. The introduction of new infrastructures without a prior examination of their impact on safety is experimental solution and not recommended. This device has been introduced due to the apparent (not extensively studied in Polish conditions) improvement of traffic and the positive public perception of the device. In locations with installed countdown timers drivers and pedestrians praise the new solution [5]. Time display causes seemingly less time waiting for a change of the light signal. Watching the passage of time for the signal changes is less burdensome than the stoppage without additional time information.

Displays of time are described in the literature and widely used in the world. The authors of the article [6] present an analysis of the impact of the countdown timer on the behaviour of the queue of vehicles at the inlet of junction. At the basis of made model authors states that the countdown timers improve traffic and allow the driver to take more precise decision about the stop before the traffic lights or about entering on the intersection. This behaviour of road users is desirable and results in increased traffic safety. Authors of the article [7] consider separately two types of countdown timers (for two different signalling shields) for vehicles: counting down the time to the end of a red signal and the green. The device analysed in this article has one shield, which displays time both to the green and the red signals. Studies have shown that the countdown timer of green signal limited situations of vehicle braking at the last moment; however, the countdown timer causes inaccurate decisions among the drivers of oncoming vehicles that potentially pose a risk of rear collisions. Analysing the countdown timer of the red signal was observed the reduction of early entries into the intersection of vehicles at the beginning of the queue. According to the authors, a countdown timer of the red signal is less controversial in terms of safety and more favourable due to an increase in effectiveness of the intersection. Authors of the article [8] state that the countdown timers for the

green signal are effective for intersections with low road traffic congestion; while for intersections with heavy traffic was observed frequent violation of traffic regulations. It was found that long-term use of countdown timers help to stop the driver before a red signal, however, does not prevent violations of the signal. Authors of the article [9] provide solutions of countdown timers for pedestrian applied in Korea. Based on the study they conclude that the best results for improving safety results in the use of numerical counter, along with a flashing pictogram of pedestrian are while ending the green signal. In the article [10] have been tested various solutions to improve safety at intersections. The results indicate that the time-keeping device with a light signalling device improves road safety. It indicated two positive aspects of this solution: quick exit at the beginning of the green signal and the ability to stop safely at the end of the signal. An additional parameter affecting the safety of the countdown timer at a pedestrian crossing is its perception by users of pedestrian crossings. Surveys of perceptions are presented in the article [11, 12]. Based on analysis, it was found that the countdown timer does not affect the perception of the signal lights for pedestrians. In the article was also examined the rate of passage through the crossing with enabled and disabled countdown timers. Based on the analysis, it was found that the rate of passage increased at the end of green signal. This behaviour, along with inattention can cause collisions, for example with vehicles turning right. Authors of the article [13] show the results regarding the impact of countdown timers to discharge queues of vehicles at the multi-groove crossroads. Based on the results was determined that the countdown timers have the greatest impact on the response time of the first and second vehicle waiting in the queue. Knowledge about positive impact of countdown timers on the efficiency of crossroads confirms the study validity of the safety device.

2 Analysis of Impact of the Countdown Timers Application on Pedestrian Safety

Some pedestrian crossings with traffic lights in Poland have been equipped with countdown timers (also known as second-timers or second hands) indicating to pedestrians remaining time to extinguish the green or red signal.

In order to perform the analysis of the time displays impact on the safety of pedestrian crossings have been selected research facility located at the intersection located in the city of Zabrze in Poland.

Measurements to verify impact of the use of countdown timers on pedestrian's behaviour were performed by ten working days (Monday to Friday), of which the first five days countdown timers were turned on, and another five days were turned off. Measurements were carried out from 7:00 a.m. to 7:00 p.m. This research methodology allowed comparing pedestrian's behaviour for two different states of the test equipment. The measurements were made using video cameras, located in invisible position for pedestrians. This approach was intended to exclude the impact of observing the behaviour of pedestrians. Our findings in this manner allowed

Table 1 Traffic congestion of vehicles and the number of pedestrians passing the crossing during flashing green and red signal in the period with enabled and disabled countdown timers

Variables	Countdown timers enabled	Countdown timers disabled
Volume of traffic flow [cars/60 h]	5735	5752
The number of passes during the red signal	167	173
The number of passes during the flashing green signal	301	380

Source Based on [1]

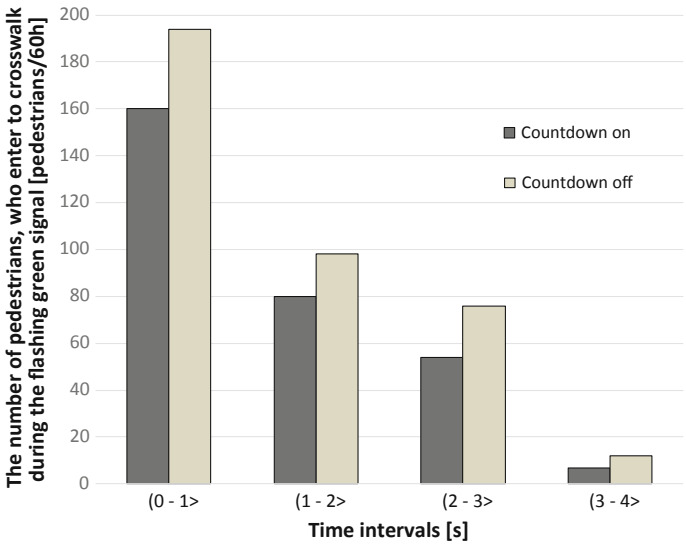


Fig. 1 Number of entrances of pedestrians on a pedestrian crossing at a given time when displaying the flashing green signal (*Source* Based on [1])

obtaining data on the size of the survey sample, and data concerning the number and the time point where the pedestrian passes through the pedestrian crossing.

The data summarized in Table 1 shows the sample size and the number of pedestrians passing in a given period during flashing green and red signal.

The difference between pedestrian traffic congestion on the tested crossing in a week with disabled countdown timers was higher by 0.29 %. During the week in which the countdown timers were disabled has been observed about 26.24 % more of pedestrians entering the flashing green signal, while for the red signal value increased by 3.59 %.

Additionally, in order to check the impact on the safety an analysis was made related to the exact time of the entrance to the pedestrian crossing. Figure 1 shows the analysis of the flashing green signal while Fig. 2 for a red signal.

Data in Fig. 1 shows that pedestrians prefer to enter the crossing during the flashing green signal at a time when countdown timers have been disabled.

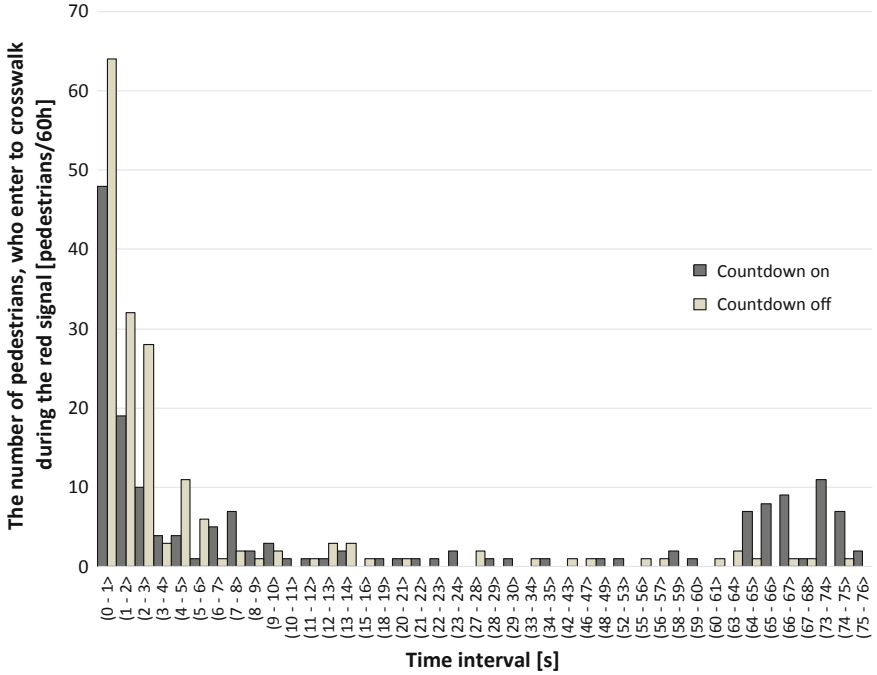


Fig. 2 Number of entrances of pedestrians on a pedestrian crossing at a given time when displaying the red signal (*Source* Based on [1])

Pedestrians knowing the additional information about the time are able to better judge whether they manage to go through the pedestrian crossing.

In Fig. 2, two phenomena have been observed in the analysis of the behaviour of pedestrians. For enabled countdown timers during the red signal has improved the safety at the beginning of the signal. Pedestrians seeing a long waiting time for a signal change did not enter the roadway in a prohibited time. The reverse situation was observed during the approaching end of the signal. Pedestrians seeing displayed final seconds of red signal willingly entered on the crossing. It can be concluded that the countdown timers enhancing safety for the initial red signal, but significantly worsen at the end of the signal.

3 Analysis of Impact of the Application the Countdown Timers on Vehicle Safety

To make the verification of impact of countdown timers on road traffic safety have been made measurements on traffic congestion and the number of trips on a yellow and a red light at enabled and disabled countdown timers. The research was conducted in two periods of research—such as countdown timers' research for

Table 2 Research sample size and number of vehicles passing the crossroads during yellow signal and red signal in the period with enabled and disabled countdown timers

Vehicles per 60 h	Countdown timers enabled	Countdown timers disabled
Sample size	32,560	32,361
The number of vehicles entering the crossroads during red signal	257	331
The number of vehicles entering the crossroads during yellow signal	1856	2488

Source Based on [1]

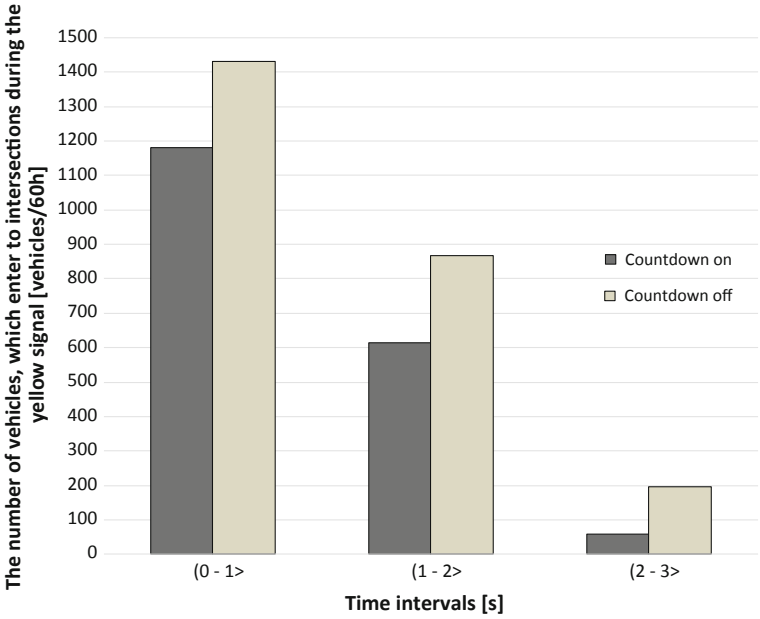


Fig. 3 Number of entries vehicles at crossroads during the yellow signal (*Source* Based on [1])

pedestrians. Analyses were therefore a total of 120 h of measurement for the tested crossroads.

Table 2 presents data on the sample size and the total number of vehicles entering the crossroads during the red and yellow signal.

The difference between the five-day periods of research was 199 [cars/60 h] (traffic congestion increased by 1 %, while countdown timers are enabled). It was found that comparable research sample size allows achieving representative results of countdown timers' impact on the traffic safety.

The graphs in Figs. 2 and 3 show a comparison of results for the two test periods. Have been analysed the number and the time of entry into the crossroads while displaying yellow and red signal. Have been also performed an analysis of the

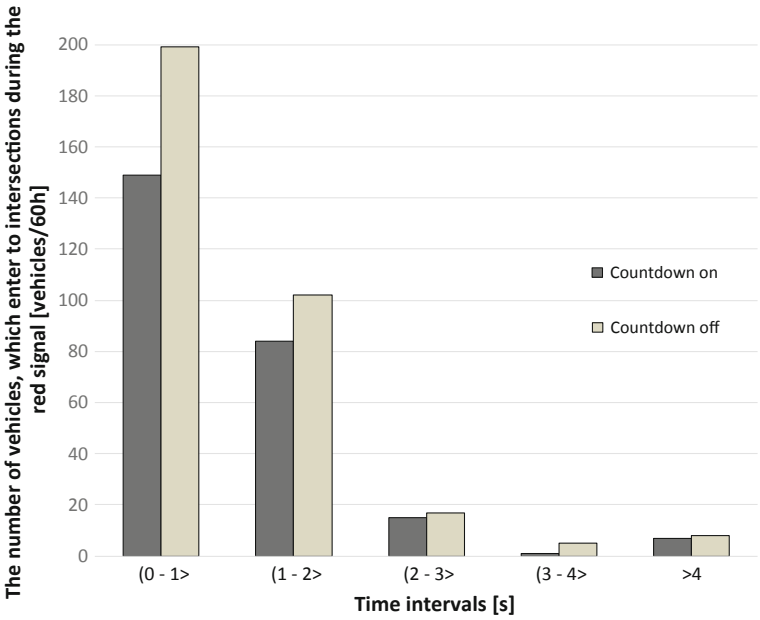


Fig. 4 Number of entries vehicles at crossroads during the red signal (*Source* Based on [1])

percentage of the number of entries into the yellow and red signal in each measurement interval.

Figure 3 shows the number of vehicles that entered the crossroads during the yellow signal duration. Based on the analysis of the graph can be seen an increased number of vehicles entering the crossroads when the countdown timers have been disabled. This difference is significant because it is 25.58 % of the vehicles. It can therefore be concluded that the countdown timers for the green signal help the driver to stop and not enter the crossroads during the yellow signal. This behaviour improves safety because it helps prevent collisions between roads.

Figure 4 shows the analysis of the distribution of vehicles entering the crossroads during red signal. There was the biggest difference in the number of vehicles in the first interval. During the research with enabled countdown timers 22.91 % fewer vehicles drove into the crossroads in a prohibited period.

4 Summary

When considering the impact of countdown timers on security should be separately analysed results for devices intended for pedestrians and vehicles. Additionally, should be examined the countdown timers divided into colour and the moment of displayed signal.

According to the results, countdown timers for pedestrians improve safety in the initial period of displaying red signal while significantly worsen at the end of the signal. Analysing the flashing green signal the countdown timers improve safety. Pedestrians in this situation are aware that this is the start of signal (first second of flashing green signal) and its end (second quarter). The entrance on the road at the last second of green light is allowed under Polish law but from a safety perspective this phenomenon is not desirable, that may result in a collision with road traffic.

In the future, this phenomenon should be verified on a larger number of crossings that will further having different geometry (different length of crossing the road, the island separating the road). Another aspect that should be checked is the impact on the perception of countdown timer on pedestrian safety due to its construction (numeric, graphic or combined).

According to the results, displays indicating the duration of individual signals at crossroads, equipped with traffic lights, reducing the number of entries at the red light at the beginning of the display of the signal. In the future, the study should cover a greater number of crossroads, which will vary in terms of geometry. Also, as in the case of signalling for pedestrians, should be checked different solutions of countdown timers. Additionally, should be paid attention to the size of the displayed pictogram, because the driver approaching from a distance only by properly reading information has a chance to use it.

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