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INCREASING PUBLIC SAFETY AT PEDESTRIAN CROSSINGS AS AN ELEMENT OF IMPROVEMENT IN QUALITY OF LIFE

POPRAWA BEZPIECZEŃSTWA NA PRZEJŚCIACH DLA PIESZYCH JAKO ELEMENT PODNOSZENIA JAKOŚCI ŻYCIA

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Abstract: The main aim of the article is to discuss the results of a survey among car drivers regarding safety at pedestrian crossings. An integral part of the paper was the assessment of that safety in the context of improvements in the public's quality of life, complete with presentation of the innovative approaches, particularly those involving the modernization of lighting solutions adopted for the purpose. The study put emphasis on pedestrian safety in municipal and suburban areas in Poland, based on data obtained for the period 2019-2020, for which the following methods were employed: descriptive method, simple statistical methods, questionnaire survey. Traffic incidents involving pedestrians are

decidedly more fatal in non-urbanized areas – higher mortality. The proper lighting of roads, particularly pedestrian crossings, significantly contributes to the increase of public safety in traffic,of special importance is the effective choice of light colour, intensity, and oscillation (pulse).

Keywords: road safety, quality of life, road accidents, lighting of pedestrian crossings.

Streszczenie: Nadrzędnym celem artykułu jest przedstawienie i omówienie wyników badania ankietowego na temat bezpieczeństwa na przejściach dla pieszych w opinii kierowców. Ponadto integralną część publikacji stanowi ocena tego bezpieczeństwa w kontekście poprawy jakości życia oraz omówienie możliwych innowacyjnych rozwiązań, w szczególności w zakresie modernizacji oświetlenia przejść dla pieszych. Obiektem badań jest bezpieczeństwo pieszych na przejściach w Polsce w miastach i na terenach podmiejskich. Okres badawczy to lata 2019-2020. Metody zastosowane do badania to: metoda opisowa, proste metody statystyczne oraz technika badania ankietowego. Wypadki z udziałem pieszych są znacznie bardziej niebezpieczne w obszarze niezabudowanym (wyższa śmiertelność). Odpowiednie oświetlenie dróg, w szczególności przejść dla pieszych, znacząco zwiększa bezpieczeństwo na drogach. Nie bez znaczenia jest kolor oświetlenia oraz jego intensywność i zmienność, które mogą ostrzegać o pieszych wchodzących na jezdnię.

Słowa kluczowe: bezpieczeństwo na drogach, jakość życia, wypadki drogowe, oświetlenie przejść dla pieszych.

1. Introduction

Quality of life is a notion embracing a number of elements, but emphasis is placed on public safety (and road traffic safety as part of the above). The main objective of this study was to examine the potential for improving the safety of pedestrians in road crossing zones, complete with analyses of the available innovative solutions in this segment, particularly those involving the modernization and redesign of lighting solutions for pedestrian crossings. This aspect is of great importance both from the social and the economic standpoint, and directly relates to the quality of life – both for pedestrians and other road users.

This paper presents findings obtained from literature studies, analyses of available study reports, legislative regulations and innovative commercial solutions, supported by the results of the authors' own questionnaire survey involving a representative sample of more than 600 drivers. The study was conducted in Poland, between April and May of 2020.

2. Quality of life in urban and suburban areas

Quality of life is an important determinant of the residential and investment attractiveness of a given area (see e.g. Wong, 2001). It directly affects the interest in a given location. The role of this element increases in proportion to the level of socio-economic development and social welfare.

The quality of life of an individual is influenced by: psychological traits and moral values (innate or acquired capabilities, life views, hierarchy of values, psychophysical efficiency, chance events, etc.), socio-cultural values (family background, education, skills, abilities, place of residence, social environment, interpersonal relations, etc.), and techno-economical values (affluence, access to goods and services, quality of locally available goods and services, fiscal burden, accessibility of innovative solutions, etc.) (Błaszczyk, Januszkiewicz, & Śmigielski 2006, p. 20; Majka, 1982, p. 140).

In the context of this study – the safety of pedestrian road users – it may also be useful to emphasise selected factors from the above list of properties typically associated with the quality of life, namely: chance events, place of residence, quality of locally available goods and services, and accessibility of innovative solutions.

Road traffic safety in general and the specific context of pedestrian safety are subject to numerous analyses and studies, globally (see e.g. Bener, Abu-Zidan, Bensiali, Al-Mulla, & Jadaan, 2003; Gumińska, Wachnicka, & Wierzbicka, 2014; Hughes, Newstead, Anund, Shu, & Falkmer, 2015; Olszewski, & Zielińska, 2012; Paradowska, 2016; Tomczuk, 2011; Wegman, Aarts, & Bax, 2008; Wytrykowska, & Tomczuk, 2018). As demonstrated below, the general level of pedestrian safety in Poland is decidedly lower in non-urbanized areas (including suburban zones) compared to that in cities. This trend has a direct negative effect on the quality of life in the analysed areas. The evaluations and recommendations of innovative solutions in this context, presented in a further section of this paper, were made with the intention to counteract this effect.

3. Safety at pedestrian crossings

Over the course of nearly two decades following Poland's accession to the European Union, the expressway infrastructure alone has been extended by more than 3000 km (Szruba, 2020, p. 63). The modernization of the existing road infrastructure has also been quite dynamic. Irrespective of these changes, road accidents remain a grave problem for the general public. In terms of the average number of deaths per 100 road accidents reported in the EU area, Poland takes a third place, with a tragic score of 9.0 (Statystyka, n.d.a, p. 83).

In 2020, the total number of road accidents reported in Poland amounted to 23 540, a decisive decline compared to 2019 data (Figure 1), but it must be remembered that the sudden change of the general trend corresponded with the outbreak of the COVID-19 pandemic. It can be reasonably argued that the pandemic contributed to the drastic reduction of public mobility in Poland. According to a study conducted on a statistically representative sample of Polish respondents between March 24 and April 6, 2020, the number of journeys reported for the period declined by around two-thirds (Borkowski, Jażdżewska-Gutta, & Szmelter-Jarosz, 2020). The period under

examination coincided with the first wave of the pandemic and the introduction of public travel restrictions. Since then, an increase of public mobility at later periods has been observed, but the majority of respondents remain reluctant to travel and limit their trips to the bare minimum. These changes are reflected in the number of road accidents reported, but it may reasonably be assumed that the values will return to the previous range (oscillating around 30 thousand) as soon as the threat of the present pandemic is relieved. For this reason, the study was based on data for 2019, while data from 2020 were only used to supplement the findings.

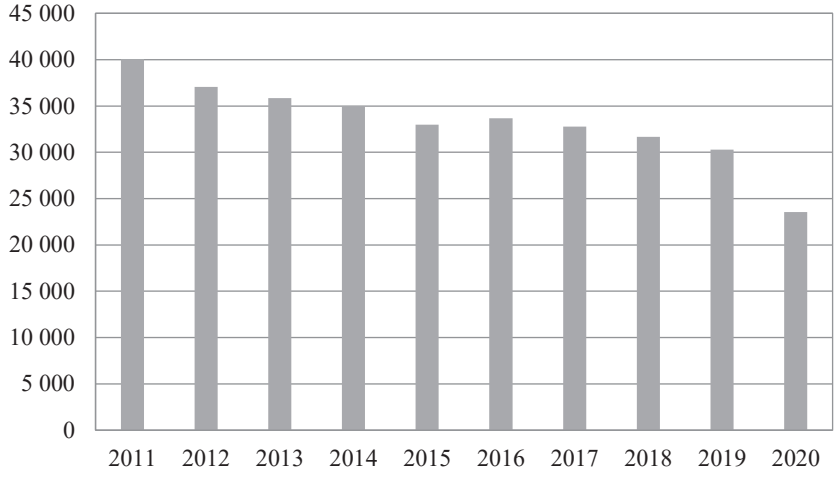

Fig. 1. Road accidents reported in Poland in 2011-2020

Source: own research based on data from the Annual Report – Road Accidents 2020.

In 2019, a total of 30 288 traffic accidents were registered by the Polish Police on public roads, residential areas, and pedestrian zones. More than 23% of these involved pedestrians (7005 casualties), compared to 5235 casualties in 2020 (Statystyka, n.d.b, p. 50), constituting around 22% of all accidents. In 2019, the number of deaths reported among pedestrian casualties was in the vicinity of 27% (793 deaths). It must be noted that nearly half of all accidents involving pedestrians – 49.5% traffic incidents (3466) took place at pedestrian crossings – i.e. zones formally designed to provide the safest way of passage and to create in pedestrians a sense of security and protection (Statystyka, n.d.a, p. 43). In the period 2011-2019, the number of accidents at pedestrian crossings remained at a steady level of 3300-4100 reported incidents (Figure 2), with a drastic reduction observed only in 2020.

Many reasons come into play regarding the incidence of hazardous situations in traffic. One of these is the inadequate choice of lighting intensity and luminance in the immediate vicinity of the crossing zones (Tomczuk, 2011, p. 122). The Polish

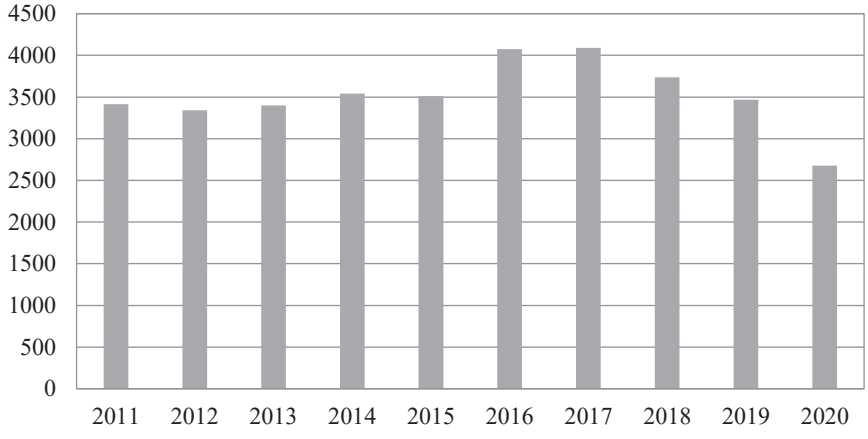

Fig. 2. The number of traffic accidents at pedestrian crossings reported in 2011-2020

Source: own research based on data from the Annual Report – Road Accidents 2020.

Police Report on road accidents emphasizes the observation that road accidents involving pedestrians are typically recorded in urbanized areas. This stems from the fact that these areas are naturally more frequented by pedestrians and the intensity of their movements is at its highest. However, road accidents in non-urbanized locations are decidedly more serious in their outcomes. Statistics for non-urbanized areas report one fatality for every two casualties, as opposed to one per 12 casualties for urbanized areas. The main reason behind this drastic difference is the lack of adequate lighting of roads, which brings catastrophic consequences, particularly under conditions of poor visibility (Statystyka, n.d.a, p. 17).

For many years, statistical findings have supported the observation that with the coming of the cold seasons (autumn and winter), the incidence of traffic accidents involving pedestrians grows by a significant factor. This trend is determined by the decrease in visibility, as the days grow shorter and the weather conditions are poor. In 2019, the largest number of pedestrian deaths was recorded for the months of December (16%) and January (12%) (Statystyka, n.d.a, p. 44).

It should also be noted that drivers of vehicles were held solely liable for more than 68% of all traffic accidents involving pedestrians (4591). Of these, 3791 incidents were caused by drivers of passenger cars. The most frequent charge was that of the failure to yield the right of way to a pedestrian at a crossing: 63.1% (Statystyka, n.d.a, p. 46).

In order to improve the safety of all road users at pedestrian crossings (particularly those of the zebra type, i.e. without traffic lights), special attention should be placed on initiatives and investments designed to improve the visibility of pedestrians on the

roads and in their vicinity. Effective zone lighting should provide drivers with better visibility conditions not only in the immediate crossing zone, but also in the areas ahead and behind each such zone, to offer more time for an adequate response; at the same time, it should also present adequate conditions for pedestrians to recognize any potential incoming traffic risk (Tomczuk & Wytrykowska, 2015, p. 1080).

Conclusions resulting from research in the context of searching for the relationship between the intensity and the number of dangerous situations and conflicts on the roads (Gumińska, Wachnicka, & Wierzbicka, 2014, pp. 2290-2292) determining the risk of a pedestrian's death (Olszewski & Zielińska, 2012, p. 25) may be helpful in selecting the most dangerous places, requiring modernization and introducing innovative solutions increasing safety within pedestrian crossings.

4. The findings of the questionnaire survey of drivers

In April and May 2020, the author conducted a questionnaire survey designed to identify drivers' opinions on safety at pedestrian crossings in Poland and to examine their preferences in relation to the available innovative solutions and lighting modernizations in terms of their perceived effect on limiting the incidence of traffic accidents involving pedestrians. A total of 665 responses were collected from various regions of Poland. Approximately 48% of the respondents had had their driving licence for 5 years or less, nearly 39% – for 5 to 10 years, less than 11% – from 11 to 20 years, and around 2.4% – for more than 20 years. Approximately a quarter of the respondents were residents of rural areas, more than 24% were residents of towns and cities of up to 100 thousand inhabitants, while around 21% of responses came from residents of cities of up to 500 thousand inhabitants, and 29% were from cities with a population of 500 thousand and above. The respondent group was characterised by a marked representation of university education (more than 55% of respondents) and secondary-level education (more than 42%). Nearly 53% of the respondents described their driving routines as daily (or almost daily), 23% drove once per week, more than 15% – several times per month, with responses of 'a couple of occasions per year' selected by slightly more than 9% of the respondent drivers. Hence, it may be assumed that the majority of the respondents can safely be described as frequent or fairly frequent drivers.

The respondents were asked to provide their opinion on road visibility at pedestrian crossing zones and to evaluate the lighting solutions adopted in Poland, and 87.5% of those surveyed had already experienced situations when, due to poor visibility conditions, they were forced to employ drastic responses to avoid collision with a pedestrian on a zebra crossing. Nearly 88% opposed the view that pedestrians are adequately visible at crossings after nightfall, with nearly half of them expressing a strong reservation to the above (response: 'absolutely not').

Almost all (98%) were adamant that zebra crossings are often poorly lit and require additional lighting. Nearly 97% of the respondents provided a positive

response (‘yes’, or ‘decidedly yes’) when asked if they would feel safer if zebra crossings were equipped with more adequate lighting, with ‘decidedly yes’ selected by more than 72% of respondents.

Another question was formulated as follows: what factors, in your opinion, present the most significant risk and danger in the vicinity of pedestrian crossings? The respondents could select any of the nine factors provided (see Table 1 for details). More than 78% of the surveyed drivers selected poor lighting as one of the factors responsible for traffic incidents at pedestrian crossings. This factor was only preceded by the ‘pedestrian carelessness’ response (included in more than 86% of responses). Other factors, in order of perceived importance, were associated with driver behaviour: failure to adapt the speed to road conditions (more than 74%), driving under the influence of alcohol or drugs (more than 61%), driver bravado (more than 51%); these were followed by factors related to technical and weather conditions: fog (nearly 44%), icy road (more than 42%), wet road (nearly 29%), and poor road surface (16.5%).

Table 1. Responses collected for the query: what factors, in your opinion, present the most significant risk and danger in the vicinity of pedestrian crossings? the respondents were free to select any number of factors from the list

Factor	‘Pedestrian carelessness’	Poor lighting	Failure to adapt the speed to road conditions	Driving under the influence of alcohol or drugs	Driver bravado	Fog	Icy road	Wet road	Poor road surface
Number of responses	574	521	495	408	340	292	283	192	110
Respondents who indicated a given factor (% of total)	86.3	78.3	74.4	61.4	51.1	43.9	42.6	28.9	16.5

Source: own research based on questionnaire survey responses from drivers.

Nearly 97% of the respondents were adamant that they would feel safer if zebra crossings were equipped with more adequate lighting, with 73% providing a ‘decidedly yes’ response. No significant preferences were found in relation to the colour of light at zebra crossings. The most frequent response was in favour of a red-tinted colour, but white and yellow were also fairly frequent choices. Tints of blue, green and orange were less frequently selected (in order of preference) (see Figure 3).

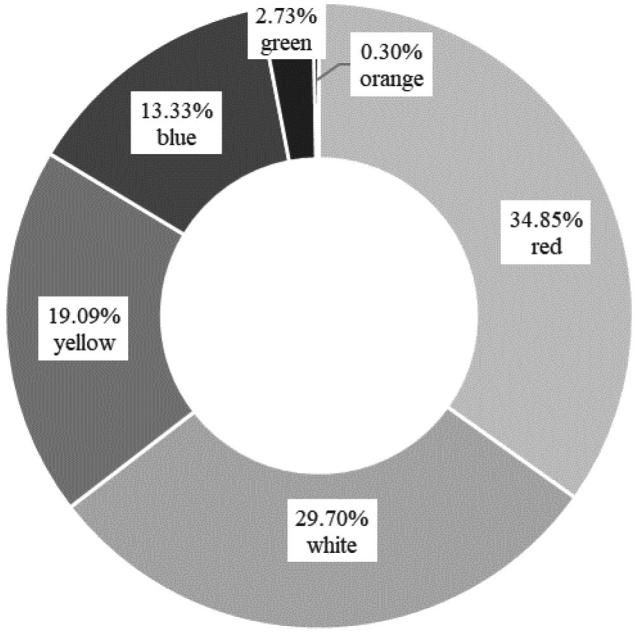

Fig. 3. Drivers' preferences for the most effective colour of street lights used at zebra crossings (attention-drawing) – the respondents were asked to select one answer.

Source: own research based on questionnaire survey responses from drivers.

In addition, the respondents emphasized the need for more intensive light, with selected responses in favour of a pulsating light.

5. Solutions improving public road safety at pedestrian crossings

For many years, pedestrian crossing safety has been identified as one of the problem areas requiring urgent attention and informed strategies at the level of central administration. This is confirmed, among others, by the publication of Guidelines for the Provision of Adequate Lighting Schemes at Pedestrian Crossings, formally issued by the Ministry of Infrastructure. The above document presents recommendations for the urgent evaluation of the quality and intensity of lighting, followed by immediate remedial measures in those zones that fail to meet the standards required by the technical road classification (Internet 1). Another suggested response to the problem in question was the development of road modernization programmes, infrastructural development strategies and public campaigns by public administration bodies. It should also be noted that Polish entrepreneurs have already presented a number of innovative commercial solutions and creative projects designed to improve safety at

pedestrian crossing zones. Some of these solutions have already been implemented on a local scale, others are still in their conceptual phase with plans to introduce to the market.

The majority of the already implemented solutions are based on the PUFFIN approach (Pedestrian User Friendly Intelligent crossing) (Table 2). Those systems are fitted with smart sensors to inform drivers of the presence of pedestrians (Gryziak & Kozłowski, 2019, p. 35). In striving to maintain competitive advantage, companies offer modular solutions with multi-functional capabilities which can easily be tailored to specific needs and the budgetary constraints of the ordering party (Internet 2).

Since these solutions are designed to improve public safety, they are typically addressed to public administration bodies. For this reason it may be important to ensure their fit with the requirements and standards of public services as well as the strategies of development postulated by the EU and national policies. Another important property of the analysed products is their conformity with the ideas postulated by the Smart City approach (Sikora-Fernandez, 2013, p. 84; Zakrzewska-Półtorak, 2016, pp. 284-285).

The main intention behind the solutions designed to improve public road safety at pedestrian crossings is to supplement the existing lighting systems (as opposed to a complete redesign or modernization) (Internet 2, 3, 4, 5, 6, 7). This approach allows for the considerable simplification of formal procedures, as the intervention in the existing infrastructure is fairly marginal. In addition, it allows for a sizeable reduction of the cost of assembly.

Comparative analyses of products already available on the market show a number of functional and other similarities between them. The first common aspect is the use of pro-environmental solutions. Many modern products are powered by renewable sources, such as solar energy and wind power (Internet 4, 6), or even equipped with energy storage capabilities (Internet 6).

Producers also seem to prioritize the autonomous operation of their systems and modular design (requiring no intervention in the existing road infrastructure). Before making an informed choice, it may also be useful to examine the declared life span of replaceable parts (lamps) and additional functions offered (such as the remote reporting of failure/incoming failure).

The most innovative concepts represent a radical step forward by postulating active light tinting at pedestrian crossings. This approach is based on the notion that changes in tint will better serve to clearly inform drivers of pedestrians approaching the crossing and those already on the lane, so that they have sufficient time to react accordingly. This solution offers the important benefit of drawing drivers' attention well ahead of the time and over longer distances (Internet 7).

Table 2. A comparison between various commercial solutions designed to improve the lighting conditions at pedestrian crossings

Company	Product	Motion sensor	Change of light tint	Intervention in existing road infrastructure	Failure/ impending failure reporting	Sourced by renewable energy source	Smart City
Alumast	Lamp	+	–	–	–	–	+
Philips	Lamp	+	–	–	–	–	+
Smart Pass	Sign with pulsating light	+	–	–	+	–	+
Solar futura	Lamp	+	–	–	+	+	+
Stoye	Sign with pulsating light	+	–	–	no data	–	+
Zebra	Lamp	+	+	–	+	+	+

Source: own research based on Internet sources (Internet 2, 3, 4, 5, 6, 7).

6. Conclusion

With the coming of every cold season, voices are raised for the need to provide adequate levels of safety at pedestrian crossings. Poor weather conditions and early nightfall, drastically limit road visibility and are directly reflected in the number of traffic accidents involving pedestrians.

Naturally, the human factor is the main cause of traffic incidents, but in view of the available innovative solutions designed to stimulate more adequate responses from drivers approaching pedestrian zones, it seems reasonable to postulate a rapid dissemination of such measures to ensure adequate visibility (including the elimination of distracting or blinding light). This author's findings, supported by the evidence from the survey, serve to reinforce the weight of the problem at hand such as an important element affecting the quality of life of all involved parties, both those in drivers and pedestrians. The adequate lighting of zebra-type crossings, situated in urbanized areas and in suburban or rural zones (particularly within the administrative limits of towns and cities), would bring tangible benefits both in terms of public safety and quality of life, and would effectively boost the area's attractiveness as a place of investment and residence.

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