



## OPINION OF RESIDENTS ON LIGHTING IN THE CITY OF PILA

*Piotr Gorzelańczyk*

Department of Transport

Stanisław Staszic State University of Applied Sciences in Pila

ORCID: <https://orcid.org/0000-0001-9662-400X>

e-mail: [piotr.gorzelanczyk@ans.pila.pl](mailto:piotr.gorzelanczyk@ans.pila.pl)

*Miłosz Miśkowski*

Department of Transport

Stanisław Staszic State University of Applied Sciences in Pila

ORCID: <https://orcid.org/0009-0003-4962-1457>

e-mail: [miskowski.milosz@gmail.com](mailto:miskowski.milosz@gmail.com)

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### Abstract

The article analyzes the efficiency of street lighting in the city of Pila. For this purpose, a survey was conducted to find out the opinions of residents about lighting in the city of Pila. For this purpose, 167 residents of Pila were asked what they thought about lighting in the analyzed city. Based on the survey, some of the respondents believe that road lighting is good and effective, while the other part says that lighting does not fulfill its functions, tasks and something should be changed in this regard. There are several streets that are well and poorly lit at the same time, so the effectiveness of street lighting in these places cannot be clearly determined. There is also a group of respondents who indicate that the lighting does not work properly, i.e. it is out of order for a long time. The last part of the article contains suggestions for upgrading city lighting in Pila. The article ends with a summary.

**OPINIA MIESZKAŃCÓW NA TEMAT OŚWIETLENIA MIASTA PIŁY*****Piotr Gorzelańczyk***Katedra Transportu  
Akademia Nauk Stosowanych im. Stanisława Staszica w Piłi***Miłosz Miśkowski***Katedra Transportu  
Akademia Nauk Stosowanych im. Stanisława Staszica w Piłi

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**Abstrakt**

W artykule przeanalizowano efektywność oświetlenia ulicznego w Piłi. W tym celu przeprowadzono badanie ankietowe, aby poznać opinie mieszkańców na temat oświetlenia w mieście. Zapytano 167 mieszkańców Piły, co sądzą na temat oświetlenia w analizowanym mieście. Część respondentów uważa, że oświetlenie drogowe jest dobre i skuteczne, natomiast druga część twierdzi, że oświetlenie nie spełnia swoich funkcji, zadań i należałoby coś w tej kwestii zmienić. Jest kilka ulic, które są jednocześnie dobrze i słabo oświetlone, dlatego nie można jednoznacznie określić skuteczności oświetlenia ulicznego w tych miejscach. Jest też grupa respondentów, którzy zwracają uwagę na to, że oświetlenie nie działa prawidłowo, tzn. jest nieczynne przez dłuższy czas. W końcowej części artykułu zaproponowano propozycje modernizacji oświetlenia w Piłi. Artykuł kończy się stosownymi wnioskami.

**Introduction**

Every citizen of the Republic of Poland should be provided with convenient conditions when navigating in the evening and at night on public roads or pavements. Road lighting reduces the number of accidents and increases the comfort of all road users. Test results conducted to analyze the effectiveness of road lighting have shown that the number of accidents at night is reduced by 30-45% with proper road lighting (*Standards concerning...*, 2018).

**Road Lighting**

In the literature, the issue of lighting has existed for a long time and has been widely discussed. Lighting accompanies people in all their daily activities. Lighting is used, among others, in apartments, schools, offices, social spaces, sports facilities, as well as on roads and through the middle of transport. Light

is a very important factor in traffic safety. It is important to provide the best possible comfort for all road users: pedestrians, cyclists and those using motor vehicles.

Lighting is the use of light, which aims to make places, objects and the environment visible. The most important task of road lighting is to develop such an environment so that the person who is there can feel safe (*Charakterystyka oświetlenia elektrycznego...*, 2018).

The main task of road lighting is primarily to ensure safety and comfortable movement of road users especially in zones with increased risk of accidents. Focus should be on the places where motor traffic streams intersect with pedestrian traffic (Górczewska, 2016).

One of the basic slogans that refers to road lighting is the slogan 'see and be seen. This applies to both drivers and other road users. Night time, along with unlit pavements and roads, is associated with many people by great danger. This affects the belief of many people that a bandit may be lurking around the corner. The provision of artificial lighting is becoming a very important factor that will allow the use of street space at night. It guarantees well-being, health and makes the space useful (Martyniuk-Pęczek, 2014).

There are many places in the world where many people stay there even after dark. A lot of things are influenced by the fact that they are intensively used. Among them we can mention lighting. Artificial light is a very important element in forming the image of space. It mainly complements the basic function of the place. The city's lighting urban planning has a very important function, as lighting projects are one common, main element of the city's functioning when it gets dark. We can say that lighting is presented as a creator of space, because it creates the night life of the city.

There are many groups of light source parameters, but photometric features are the most important for road lighting. The group of photometric parameters of the light source can include: luminous flux, luminous efficiency, durability, luminance, luminance. Information on this subject can be found in the following literature (Kolakowski, 2003; Tabaka, 2012; Owczarek, 2014; *Luminancja*, 2018; *Parametry źródeł światła*, 2018; Oziemblewski, 2023a, 2023b).

Lighting fittings are the most important element of any road infrastructure. Due to the nature and place of installation, they are exposed to a large number of harmful factors. These include, but are not limited to: atmospheric, temperature differences, water and dust penetration. That is why it is so important for the luminaire to be correctly designed.

The definition of a lighting fixture states that it is a device designed to distribute, filter and transform the luminous flux of one or more light sources (Wandachowicz, 2007). The luminaire is an electrical device that is used by a larger number of recipients. It is important to keep the lighting fixture safe and construct optimal performance parameters.

## Analysis of the City of Piła

The city of Piła is a picturesque agglomeration located on the River Gwda, on the edge of West Pomerania and Greater Poland. Half of the city's surface are parks and forests, filling the areas between new residential districts. Nearby lakes add beauty to this city. The city area is a space of unspoiled nature and wonderful landscapes that encourage active recreation. The city, thanks to its good location, is a significant intersection of transport paths in the country. Piła is also an uninterrupted and intensively developing economic center. The leading branches of the economy include the electronics, electrical and printing industries. Piła is a town with about 74,000 inhabitants (*Nasze miasto*, 2023).

### Road infrastructure of the city of Piła

There are four categories of public roads in Piła: national roads, provincial roads, pociat roads and communal roads:

- national roads No. 11 and 10, provide trans-regional transit connections Koszalin-Poznań-Bytom and Szczecin-Warsaw;

- provincial roads No. 180, No. 179 and No. 188 in the city of Piła along streets: ul. Siemiradzkiego, al. Wojska Polskiego, al. John Paul II, al. Powstańców Włkp.;

- powiat roads in the city of Piła: Browarna, Staromiejska, Ceglana, Kamienna, Kossaka, Kotuńska Droga, Kwiatowa, Lelewela, Lotnicza, Ludowa, 11th November, Łączna, Okrzei, Okólna, 1st Maja, Medyczna, Mickiewicza, Podchorążych, Roosevelt, Rydygier, Śniadeckich, Towarowa, Tucholska, Młodych, Walecka, Wawelska, Spring of Nations, Wyspiański, Zygmunt Stary, Road to Zelgniewo;

- 321 communal public roads and internal roads.

Below are the categories of roads in the city of Piła. According to the data, the lengths of these sections are as follows (*Stan i rozwój infrastruktury drogowej w Pile*, 2023):

- national roads: 13.5 km;

- voivodship roads: 11.6 km;

- powiat roads: 42.1 km;

- commune roads: 139.59 km.

One of the most important aspects in the road infrastructure of the city of Piła is the beltway, i.e. the national road number 10 and 11. The modern beltway makes it possible to bypass the city center, thanks to which the traffic in the city has become smooth.

## Structure of road lighting in the city of Piła

In the city of Piła over the years, investments related to the reconstruction and construction of lighting were carried out. The last such investment was in 2017, as part of which 253 new lighting poles appeared in the city. These are innovative poles with energy-saving LED lighting. The investment was implemented as part of a project called “Supporting a low-carbon economy by improving urban mobility in Piła”. The lighting used in the above streets is modern and energy-saving based on LED light sources. Ultimately, the installation of central control of its intensity is planned, especially at night when there is little traffic on the roads.

The city of Piła also cares about the current lighting, which is in constant use. The part, which is owned by the city of Piła, is maintained by a company selected on the basis of a tender. This is a tender for the provision of maintenance services for street lighting devices, roads, squares and bridges in the commune of Piła. ENEA S.A. is responsible for the maintenance of the second part of lighting in the Piła commune. and ENEA Operator private limited company.

Lighting that is located in Piła is 94% owned by ENEA joint-stock company and ENEA Operator private Limited company (ENEA) only 6% of the lighting belongs to the Piła Commune. The following is the ownership list of street lighting (*Informacja o wyniku kontroli doraźnej...*, 2015):

- number of lighting points – 6,623 pieces, including:
  - ownership of ENEA – 5,387 pieces,
  - ownership of the commune – 1,236 pieces (18.66%);
- the number of poles used for luminaire assembly – 6,426 pieces, including:
  - ownership of ENEA – 4,680 pieces,
  - ownership of the commune – 873 units (13.59%);
- length of cable lighting lines – 181.79 kilometers, including:
  - ownership of ENEA – 144.85 kilometers,
  - ownership of the commune – 36.94 kilometers (20.32%);
- the length of overhead lighting lines – 19.15 kilometers, including:
  - ownership of ENEA – 18.79 kilometers,
  - ownership of the commune – 0.36 kilometers (1.88%);
- number of lighting circuits – 412 pieces, including:
  - ownership of ENEA – 327 pieces,
  - ownership of the commune – 85 pieces;
- number of working earths – 754 pieces, including:
  - ownership of ENEA – 275 pieces,
  - ownership of the commune – 479 pieces;
- number of lighting cabinets (power distribution boards) – 162 pieces, including:
  - ownership of ENEA – 116 pieces,
  - ownership of the commune – 46 items (28.40%);

- number of energy measuring points – 162 pieces, including:
  - ownership of ENEA – 116 pieces,
  - ownership of the commune – 46 items.

## Methodology

The purpose of the survey was to find out whether, in the opinion of city residents, road lighting in the city of Piła is effective, or whether something should be changed. The survey was based on a questionnaire. Due to the prevailing COVID-19 pandemic, the survey was conducted online.

The subject of the survey was to find out the opinions of Piła residents on lighting: traffic roads, pedestrian crossings, bus stops, bicycle paths, public buildings, pedestrian crossings and residential areas. People from all districts of Piła participated in the survey, namely: Gladyszewo, Górne, Jadwizyn, Motylewo, Podlas, Staszyce, Srodmiescie, Zamosc and Zielona Dolina.

## Results and Analysis of Test Results

The research method used in the article gave the opportunity to formulate conclusions in which the findings were adopted. An important part of the research procedure is certainly the analysis of research results and confrontation with specific research problems. The study was conducted using a questionnaire. The research analyzed the questionnaires that were filled in electronically by the inhabitants of the city of Piła, then the conclusions were constructed. We used our own questionnaire, which consisted of 16 questions, including 3 questions constituted a metric. The study was completely anonymous. Performing the above study, an analysis of the results is presented in Figure 1.

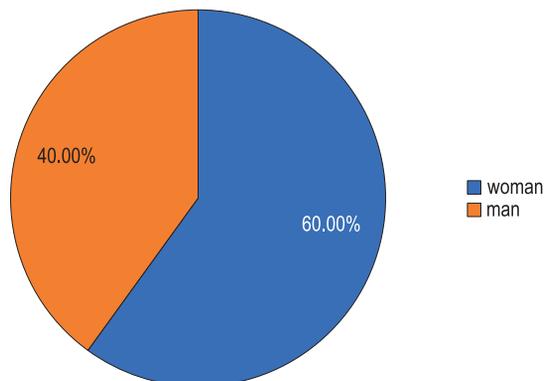


Fig. 1. Sex structure

Source: own elaboration.

167 residents of the city of Piła participated in the study. Incorrectly completed surveys were not considered. Based on the conducted research, it was found that women dominated in the group of respondents, constituting 60%, while men constituted 40%. The results are presented in the Figure 1.

Figure 2 presents the age of the respondents. Considering the data in the chart above, it can be seen that the overwhelming number of respondents are in the 18-25 age range. According to research, it is 51.5%. In second place are people in the age group 26-35 years – 22.4%. Third place was occupied by people from 36-45 years old – 14.5%. The next item is respondents from the age group 46-55 years – 8.5%. In the age group 56-65 years, 2.4% responded. However, the last position is occupied by people over 66 years old – 0.7%.

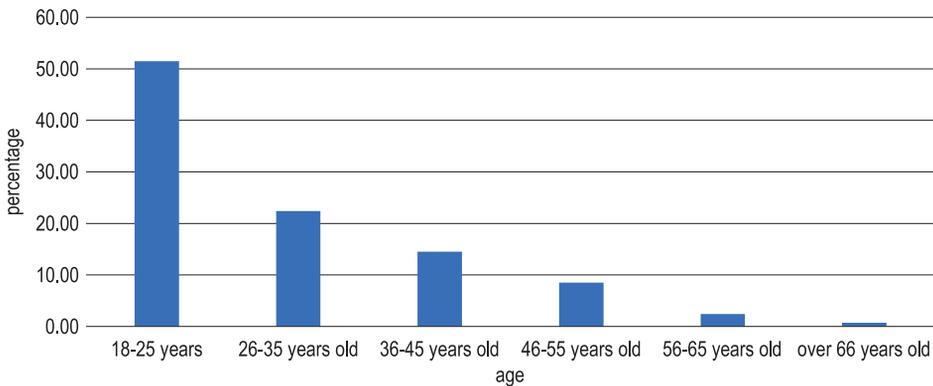


Fig. 2. Age of the respondents

Source: own elaboration.

Another issue in the questionnaire was the question about the residential district in the city of Piła (Fig. 3). The order and percentage number of districts inhabited by respondents are presented below: Zamoście – 26.1%, Śródmieście – 20.1%, Górne – 13.9%, Podlasie – 10.9%, Zielona Dolina – 10.9%, Staszyce – 7, 9%, Motylewo – 4.2%, Jadwiżyn – 3.6% and Gładyszew – 2.4%. The largest number of respondents live in Zamoście. This may be due to the fact that this is an area where there is a problem with road lighting efficiency, and many residents wanted to have their say.

Analysis of the collected material shows that the inhabitants of Piła assess the condition of road lighting in 46.4% as good (Fig. 4). In contrast, 42.8% of respondents said that the lighting was in poor condition. The distribution of results is similar. Only a small number of people said that road lighting is in very good condition and 10.8% of respondents belonged to this group.

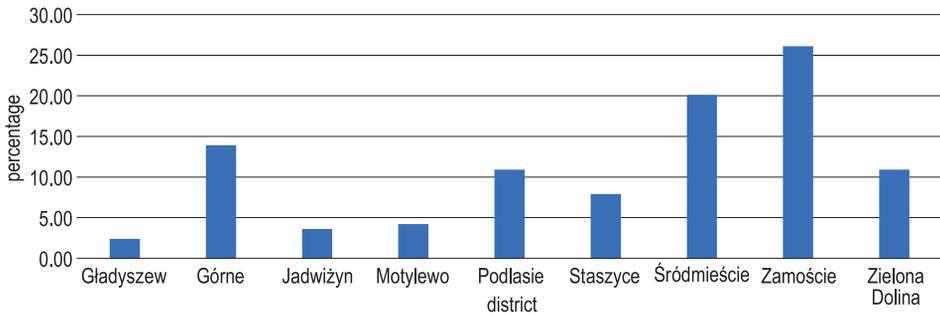


Fig. 3. Place of residence

Source: own elaboration.

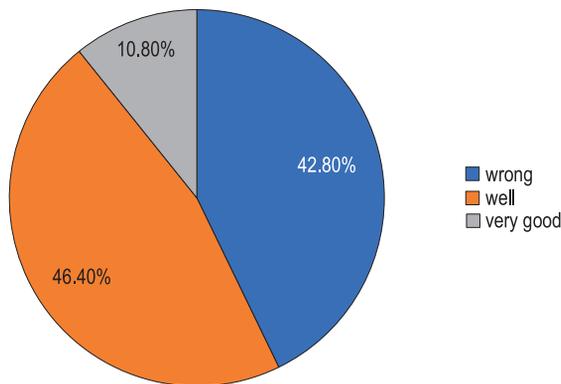


Fig. 4. Assessment of road lighting in the city of Piła

Source: own elaboration.

Research results on lighting bicycle paths in the city of Piła turned out to be very surprising (Fig. 5). The vast majority of respondents noted that the conditions regarding path lighting are good. 54.2% of respondents belonged to them. The remaining group of residents, as many as 34.9% declared that lighting along bicycle paths should be improved. A group of 10.9% of people confirmed that the lighting condition is unqualified. In the “Other answer” heading, respondents replied that the lighting of bicycle paths is very average and the level of lighting depends on the place.

Research clearly shows that there is a need for investment in lighting for pedestrian crossings in the city of Piła (Fig. 6). The result is so serious that renovation and increased work on lighting these places in the city are required. 68.1% of respondents found it difficult to navigate in these places. The group of 27.1% of respondents included people who think that the lighting of pedestrian crossings in the city of Piła fulfills its tasks. Only a few (4.8%) of respondents said that lighting was assessed in very good condition. Many people said in writing

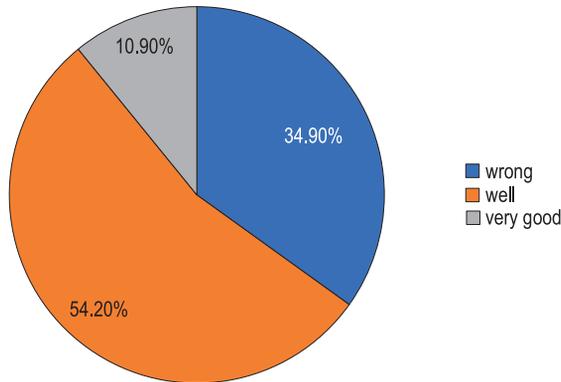


Fig. 5. Assessment of cycling path lighting in the city of Pila

Source: own elaboration.

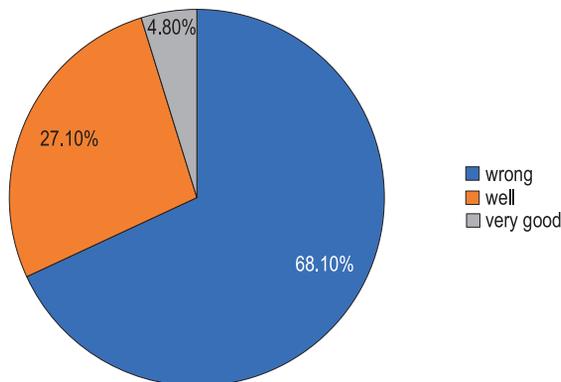


Fig. 6. Rating of lighting for pedestrian crossings in the city of Pila

Source: own elaboration.

that there is a need for illuminated pedestrian crossings in a dozen or so places throughout the city where there is heavy traffic.

Another important issue is the assessment of bus stop lighting (Fig. 7). The analysis of the collected research material shows that more than half of the respondents concluded that bus stops are poorly lit. This is how 52.4% of people rated it. The second group includes people who have a different opinion and think that the lighting of bus stops in Pila is in good condition. Another group (6%) thinks that the lighting of the stops is in very good condition.

In the light of the conducted research, respondents in a greater percentage assess the lighting of pavements as bad (Fig. 8). 53.6% of people declared such an answer. Research shows that this is a significant result. In contrast, 41% of respondents believe that the lighting of sidewalks is in good condition, and only a small number (5.4%) believe that they are in very good condition.

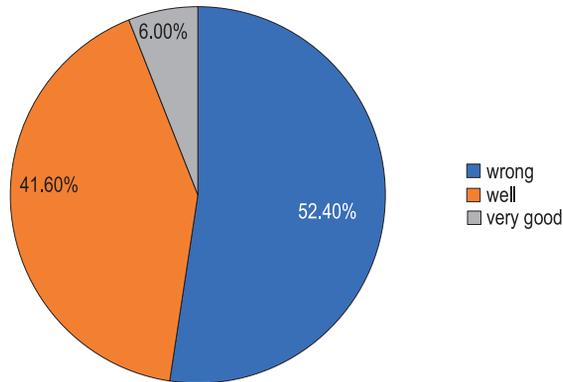


Fig. 7. Lighting assessment of bus stops in the city of Piła

Source: own elaboration.

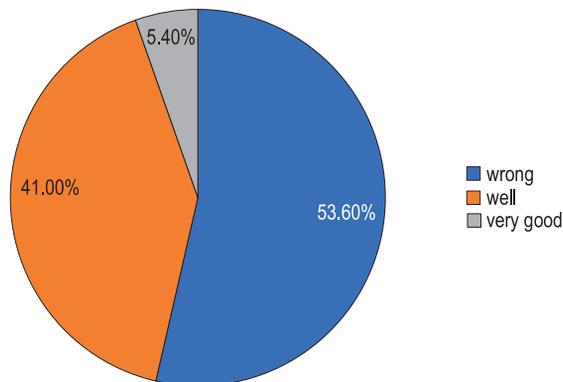


Fig. 8. Rating of pavement lighting in the city of Piła

Source: own elaboration.

The next, ninth question concerned places in the city of Piła, where road lighting does its job well. The answers were different depending on the resident's place of residence, but there were several statements that were largely repeated, i.e.

- street February 14, especially the promenade on this street – a large number, as much as 39% indicated this location;
- city center – 20% of votes;
- Mickiewicza street – 6% of votes;
- Constitution Square – 6% of votes;
- park on the island – 4% of votes;
- Kossaka street – 4% of votes;
- Bydgoska street – 4% of votes;
- al. Powstańców Wielkopolskich – just like ul. Bydgoska won 4% of the vote;
- PKP station – 3% of votes.

The remaining places, which were indicated by the residents, won a maximum of 2% of votes. This is not strange, because the promenade on 14 Lutego Street has been recently renovated and is a showcase of the city.

The next question was quite the opposite of the previous one, because it concerned pointing to places in the city of Piła that are poorly lit. The largest number of responses concerned pedestrian crossings, streets outside the center, but also internal roads and housing estates. Below are those places which, according to residents, are the worst illuminated:

- pedestrian crossings – 27% of votes;
- places away from the center – 17% of votes;
- Bydgoska street – 7% of votes;
- Młodych street – 4% of votes;
- bus stops – 4% of votes;
- roads and pavements in housing estates – 4% of votes;
- al. Independence – 4% of votes;
- Street. Okólna – 4% of votes;
- Street. Wielkopolska Insurgents – 4% of votes.

The remaining number of places selected by respondents was a minority, below 3%.

Analysis of the collected material shows that the use of reflective elements is as follows (Fig. 9): 26.5% of respondents think that they are in favor of using reflective elements, while 27.1% of respondents are of the opinion that these elements are not needed. The above chart shows the percentage of how respondents responded, but by adding up the votes for and against, we can say that:

- 52.4% of respondents are in favor of using reflective elements;
- 40.4% of residents are not in favor of using reflective elements,

In the group, which consisted of 7.2%, there were undecided people.

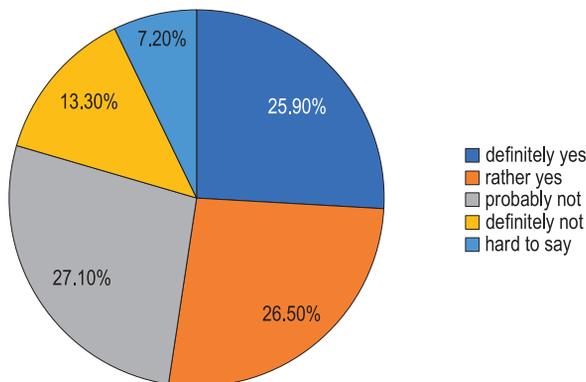


Fig. 9. Answers of the inhabitants of the city of Piła about the use of reflective elements on the sidewalk, road, bicycle path

Source: own elaboration.

The research results regarding the opinion of the inhabitants of the city of Piła about the introduction of solar lamps on the streets of Piła turned out to be very surprising (Fig. 10). The vast majority of respondents are in favor of introducing solar lamps, thanks to which the costs of lighting incurred by the City Hall would be reduced. 86.1% of respondents gave such an answer. There was also a group of people who were not favorable to this idea in the number of 4.2%. Few people declared that they have no opinion on this topic.

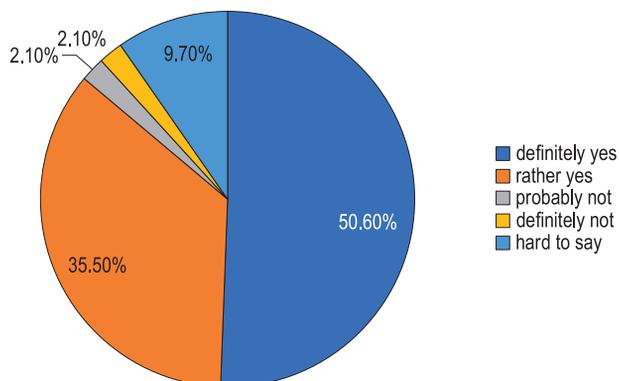


Fig. 10. Opinion of the inhabitants of the city of Piła about the introduction of solar lamps  
Source: own elaboration.

In the next question, the survey results show that sentences are divided about lighting in the place of residence (Fig. 11). A positive opinion was expressed by 48.2% of respondents, while 45.2% said that lighting in front of their place of residence would not fulfill their function. There was also a group of people who could not answer this question – 6.6%.

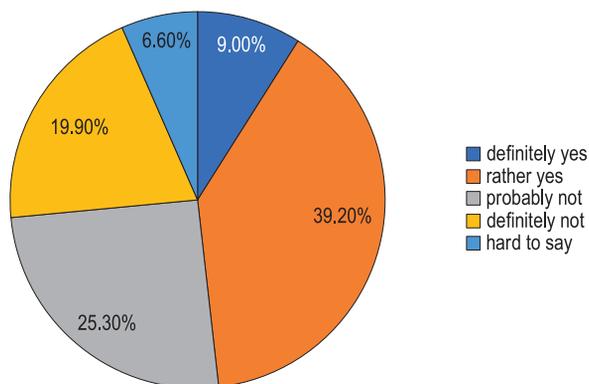


Fig. 11. Opinion of the inhabitants of the city of Piła about lighting in the place of residence  
Source: own elaboration.

An important aspect in the research was the opinion of the city inhabitants regarding street lighting caused by a breakdown (Fig. 12). Failures occur once every six months in 39.2% of residents, followed by 33.1% of those surveyed failures occur once a year. Based on these values, it can be concluded that failures do not occur very often in Pila. Once a month, 18.1% of residents suffer a breakdown, while the smallest number of lighting damage occurs once a week.

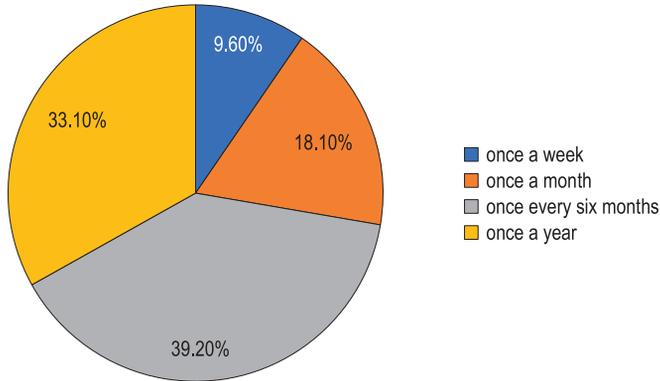


Fig. 12. Answers of the inhabitants of the city of Pila about the lack of street lighting caused by a breakdown

Source: own elaboration.

The next, fifteenth question concerned the introduction of intelligent lighting in the city (Fig. 13). The vast majority are for innovation in lighting. 77.1% of respondents gave such an answer. The group of 15.6% of respondents opposed this idea. The minority belongs to a group of people constituting 7.3% who think that it is difficult for them to comment on this topic, perhaps they have not heard about the news related to lighting.

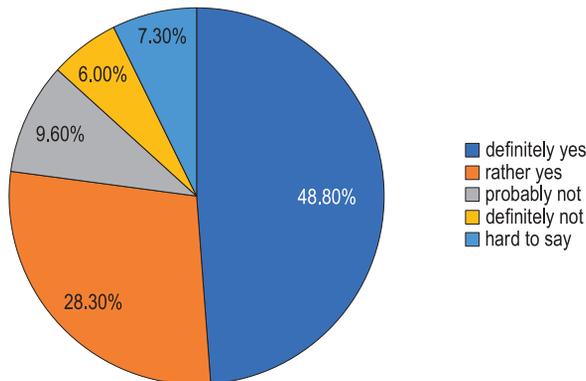


Fig. 13. Opinions of Pila residents regarding the introduction of intelligent lighting

Source: own elaboration.

To conclude on lighting, let's analyze the last question in the questionnaire. In this question, the respondents had to provide comments on the functioning of lighting in the city of Piła. From among 167 answers, the most frequently repeated were chosen. Respondents indicated comments such as:

- undoubtedly the largest number of people indicated the lack or poorly lit pedestrian crossings;

- a group of people said that old lighting should be replaced with a new, better technology, e.g. LED fixtures;

- many respondents indicated the poor functioning of the current lighting, i.e. high failure rate, lighting operation during the day, in the autumn time too late switching on of the lamps, wrong setting of the lamps (they do not illuminate these places what they should), many lighting fittings dirty requiring refreshing;

- there was also a group of people who indicated the lack of lighting in some places, in particular: on housing estate roads leading to blocks of flats, at playgrounds, by trashcans.

The inhabitants of the city of Piła expressed their opinions on the subject of road lighting divided into two almost equal groups. It is not possible to say 100% whether lighting in the city of Piła is effective because the survey results are divided. Some respondents believe that road lighting is good and effective. The second part of the respondents claims that lighting does not fulfill its functions, tasks and something should be changed in this matter. There are several streets that are simultaneously served as well and poorly lit, which is why it is impossible to clearly determine the efficiency of street lighting in these places. There is also a group of respondents who pay attention to the fact that lighting is not working properly, i.e. it is out of order for a long time. This may result from the ignorance of these people that all failures and damages should be reported to the Piła City Hall.

## **The Concept of Modification of Road Lighting in the City of Piła**

### **Lighting of pedestrian crossings**

One of several solutions to improve the efficiency of road lighting in the city of Piła is to use better lighting at pedestrian crossings. According to more than half of respondents (62% of those surveyed), pedestrian crossings in Piła are poorly lit. The introduction of illuminated pedestrian crossings will definitely improve safety in this city.

Pedestrian crossing lighting should consist of: a complete lighting system that includes: a lighting fixture and a pole and/or boom configuration, thanks to which it is possible to obtain the assumed lighting parameters (a fixed lighting

class). There are several types of lighting for pedestrian crossings: standard and dedicated. Standard lighting – this is a technical type of lighting for road sections, intersections and other elements of road infrastructure. It is implemented with the help of various lighting solutions, i.e. distribution of light streams from luminaires along the road, e.g. linearly in one-sided structure (on sections of roads and streets), but also locally at road intersections and complex road systems (the use of a mast system ensuring lighting area). Dedicated lighting – it is a type of technical solution for pedestrian crossing lighting using lighting consisting in the use of lighting fittings with asymmetrical light distribution, located in the appropriate configuration (*Wytyczne organizacji bezpiecznego ruchu pieszych...*, 2017).

According to data on improving road lighting performance and urban traffic safety, the light color of an illuminated pedestrian crossing should be different from that of street lighting. With a different color, drivers perceive them as different, which encourages them to pay more attention. In addition, they believe that the level of lighting at pedestrian crossings should be significantly increased, which will have a positive impact on pedestrian safety (*Wytyczne organizacji bezpiecznego ruchu pieszych...*, 2017).

### **The use of led technology**

Another solution to improve the efficiency of road lighting in the city of Pila is the use of LED luminaires. LED (Light Emitting Diode) technology is the latest lighting technology, thanks to which the city of Pila can significantly reduce energy costs incurred for road lighting. The use of LED luminaires is more energy efficient than other solutions, and has many additional features that result in a significant reduction in the said costs.

The quality of lighting is not only dependent on the light source, but largely depends on the quality of the lighting fixture used. An effective luminaire should have high technical parameters that guarantee high tightness of the optical and electrical system. It should also limit the occurrence of glare. The most important factor in the replacement or use of new LED luminaires is the financial aspect. By replacing lighting with LED technology, the city gains huge benefits, as the lighting costs in each city's budget are one of the biggest burdens. The use of LED street lighting is currently one of the rational solutions (*Audyt...*, 2016).

### **Road lighting control system**

The next proposal to modify road lighting in the city of Pila is to use a road lighting control system. This is another solution reducing the costs incurred by the city for road lighting.

The principle of this system is to reduce the illuminance when there is no pedestrian or vehicle traffic on the road. In the situation when users appear on a given section of the road, the system increases the illuminance. The increase in lighting level is only raised on the designated road length, i.e. in front of and behind the road user. After some time, when there is no movement within the range of a given lamp (the user has left the road), the system reduces lighting intensity to several percent of its power. Only as many luminaires as needed are needed to properly perform the visual task by the motion user. A given luminaire that works in a concurrent lighting system is smoothly switched on at an optimal distance in front of the oncoming vehicle. It lights up to the designated moment, which results from previously adopted guidelines, after which (unless the next road user is approaching) it proceeds smoothly dim. The distance of the section illuminated in front of the road user depends mainly on the speed of vehicle movement. This measure is adapted to the maximum permissible speed in a given place. The lamp's illumination and dimming are very gentle to give a smooth impression (Goc *et al.*, 2010)

## Conclusions

Road lighting is an inseparable element accompanying society in the evening and at night. It is an element of road infrastructure that should be effective and fulfill its function well, as health and human life may depend on its functioning.

The main purpose of the article was to assess the efficiency of street lighting in the city of Piła. The analysis was conducted on the basis of a questionnaire survey. Respondents had to express opinions on the functioning of road lighting in the city. They consisted of 13 multiple-choice and 3 open-ended questions. In total, 167 people responded. Thanks to the results obtained, conclusions were drawn about the functioning of lighting and in the fifth chapter several solutions were proposed that could improve the efficiency of this lighting.

First and foremost, the city of Piła should replace more and more luminaires, ultimately seeking to use LED luminaires throughout the city, which significantly reduce electricity costs. In the street lighting modification section, three innovative, energy-saving, modern proposals for Piła have been described, thanks to which the city can gain many benefits. The above-mentioned solutions were the most repetitive answers indicated by the respondents.

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