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The costs of losses at electricity distributors and municipal electric power consumers caused by the failure of the low voltage electrical power distribution lines

Streszczenie. *W artykule analizie poddano koszty awarii u dystrybutorów oraz odbiorców energii elektrycznej spowodowane zawodnością elektroenergetycznych linii dystrybucyjnych niskiego napięcia. Analizy wykonano w podziale na linie napowietrzne i kablowe. Określono wartości średnie kosztów strat, ich wartości minimalne, maksymalne, odchylenie standardowe oraz przedział ufności. Określono funkcje gęstości dla każdego rodzaju kosztów. Kosztami poddanymi analizie były m.in.: koszt zakupu nowych materiałów i urządzeń, koszt pracy sprzętu, koszt pracy monterów.*

Abstract. *The article analyzes the costs of breakdown at electricity distributors and at electricity consumers caused by the failure of the LV distribution power lines. The analyzes were performed in the division into overhead and cable lines. Average values of loss costs, their minimum and maximum values, standard deviation and confidence interval were determined. Density functions for each type of cost were determined. The costs subject to the analysis were for example: the cost of purchasing new materials and devices, the cost of equipment work, the cost of fitters work.* ***(Koszty strat u dystrybutorów oraz odbiorców komunalnych energii elektrycznej spowodowane zawodnością elektroenergetycznych linii dystrybucyjnych niskiego napięcia.)***

Słowa kluczowe: elektroenergetyczne linie dystrybucyjne niskiego napięcia, , koszty strat u dystrybutorów i odbiorców energii elektrycznej,
Keywords: electrical power LV distribution lines, effects of electrical power failures in distribution lines, costs of losses at distributors

Introduction

The distribution network is a set of devices cooperating with each other, the purpose of which is to accomplish a specific task - supplying electricity to consumers. The main elements of the network are overhead lines, cable lines and transformer and distribution stations. Distribution networks are divided by their rated voltages into: high (HV), medium (MV) and low voltage (LV). The most extensive networks are medium and low voltage networks ensuring the supply of electricity to a large number of medium and small consumers [10].

In 70% of cases, electric power lines of low voltage are built as overhead lines. They are usually located outside strongly urbanized areas. In city centers, the majority of low and medium voltage lines are cable lines, and existing overhead lines are gradually replaced by cable lines [10].

The MV and LV lines as well as MV / LV transformer stations are important elements of the distribution network of each Distribution System Operator and have a fundamental impact on the quality of power supply to consumers [10].

The quality of electricity supply consists of two basic factors: energy quality and reliability of its supply [8].

The reliability of electricity supply to consumers is the ability of the power supply system to provide the necessary power and electricity without interruption. The general measure of reliability of power supply to electricity customers at a given time is the probability of uninterrupted power supply at this time. The reliability of electricity supply to consumers supplied from the MV and LV grids is decisively influenced by the reliability of the electricity distribution subsystem, which is much lower than the reliability of the electricity transmission subsystem [6].

Reliability in the supply of electricity is very important. Breaks in the supply of electricity cause disorganization of everyday life and nervousness, economic losses, social losses, and in particular cases threaten the health or life of a person [6, 7].

Characterization of costs of losses at distributors and consumers of electricity

The costs resulting from the failure of electrical power systems are divided as follows [5, 6, 9]:

- costs incurred by the electricity distributor:
  - costs of locating and removing failures,
  - costs of discounts for recipients,
  - loss of profit resulting from failure to supply electricity to consumers.
- loss costs for industrial consumers of electricity:
  - losses due to failure to produce or not producing the product on time,
  - losses related to the time needed to restart the technological line,
  - losses resulting from the destruction of raw materials and materials that are used for the production,
  - losses resulting from the need to provide employees with remuneration for stop time.
- costs of losses for municipal consumers of electricity:
  - losses resulting from forced inactivity of residents,
  - losses connected with the destruction of perishable foodstuffs,
  - losses caused by deterioration of sanitary and health conditions,
  - losses resulting from the loss of the possibility to use national income while staying at home.

The costs of losses at distributors of electricity are primarily related to the removal of breakdowns and the loss of profit due to the failure to supply electricity to consumers. These costs, together with operating costs, reduce the company's profit.

In the publication [2], the authors characterize the costs of losses at distributors of electricity. The costs were divided into: the cost of purchasing new materials and devices, the cost of equipment work, the cost of fitters work, the cost of accessing the repair brigade and construction equipment to the place of failure, the cost of lost profit.

The cost of purchasing new devices and materials is very diverse, and its value depends on the extent of the failure and the device that has been damaged. The costs of equipment work result from the necessity of using specialized construction or power equipment in order to locate a failure or directly in the phase of its removal. The removal of failures in electrical power systems is also associated with significant human work. This work results both from the need to operate specialist equipment and many works performed manually or only using simple assembly tools. The cost of profit loss is a result of the lack of supply to electricity consumers during a failure.

The analysis show that the costs of lost profits can be determined based on the dependence:

$$K_{uz} = k_{juz} \cdot \Delta A \tag{1}$$

where: k_{juz} – unit profit loss rate (in the distribution company under consideration $k_{juz} = 0{,}19\ PLN/kWh$, ΔA – value of electric power not delivered to consumers as a result of failure, determined on the basis of the chart of loads with active power *P = f(t)* in a given network.

The total cost of failure can be determined by the formula:

$$K_{aw} = K_{miu} + K_{sprz} + K_{pm} + K_{d} + K_{uz} \tag{2}$$

where: K_{miu} – the cost of purchasing new materials and devices, K_{sprz} – the cost of equipment work, K_{pm} – the cost of fitters work, K_{d} – the cost of accessing the repair brigade and construction equipment to the place of failure, K_{uz} – the cost of lost profit.

In the analysis, the authors used data concerning the local distribution company, in which the following rates apply:

o the cost of the cable laboratory work:
- access to the place of failure 4,73 PLN/km;
- working hours of the cable laboratory 97,16 PLN/h;

o labour cost of a heavy goods vehicle:
- access to the place of failure 3,35 PLN/km;

o the cost of labour of a special car (various types of renovation brigade vehicles):
- access to the place of failure: 1,92 PLN/km;

o labour costs of special equipment (cranes, excavators, drilling rigs):
- working hour of equipment: 99,43 PLN/h;

o employee labour cost:
- worker's man-hour 49,84 PLN/h.

In the further part of the article, the results of a detailed statistical analysis of costs occurring in dependence (2) will be presented.

The contemporary electricity consumer has very high requirements regarding the quality and continuity of electricity supply. Possible interruptions in energy supply lead to significant material losses, and in extreme cases may lead to a threat to human health or life [4].

Using the method of calculating the cost of losses at the consumers presented in the publication [6], based on comprehensive statistical information, in the publication [1], the Authors made a detailed analysis and determined the value of the economic equivalent of the cost of forced inactivity of consumers in the event of a power failure. The current value of this equivalent is $k_{Ab_{village}} = 18{,}10 \left[\frac{PLN}{kWh}\right]$ for the residents of the village and $k_{Ab_{city}} = 20{,}70 \left[\frac{PLN}{kWh}\right]$ for city dwellers. Based on these indicators and knowing the value of undelivered energy attributable to a given failure, loss costs were determined for electricity consumers.

The analysis was made on the basis of empirical data from 10 years of observation in a large distribution company in the country. The statistics include 10374 cases of failures of overhead electrical power distribution lines LV and 1248 cases of failures of the electrical power distribution cable lines LV. On its basis, the average values of the analyzed costs, standard deviations, confidence intervals for the mean, minimum and maximum values were determined. Non-parametric verification was also carried out. The theoretical distributions of the probability density of the cost of lo-ses at electricity distributors and municipal electricity consumers as a result of the failure were determined. All analyzes were carried out at the significance level of $\alpha = 0{,}05$.

Statistical analysis of the cost of losses at distributors of electricity

a) The cost of purchasing new materials and devices

Based on empirical data, statistical parameters were determined characterizing the costs of purchasing new materials and devices K_{miu}, which in the case of failure of the LV overhead line are:

- average cost value: $\overline{K}_{miu} = 180{,}05\ PLN$,
- standard deviation: $s = 220{,}22\ PLN$,
- confidence interval for the average: $175{,}81\ PLN < \overline{K}_{miu} < 184{,}28\ PLN$,
- minimum value: $K_{miu_{min}} = 0{,}17\ PLN$,
- maximum value: $K_{miu_{max}} = 1392{,}30\ PLN$.

An attempt was made to identify the theoretical model of the probability density function of the purchase costs of new devices and materials. Probability distributions have been considered, such as: normal, exponential, logarithmic-normal, or Weibull.

Based on the analysis of statistical data, it was found that the best fit is characterized by a log-normal distribution. The log-normal distribution parameter values determined using the Statistica package are $m = 4{,}6322$, $\sigma = 1{,}0349$.

The empirical and theoretical function of the probability density of the purchase costs of new devices and materials in the case of overhead line failure is shown in Figure 1.

Based on empirical data, statistical parameters were determined characterizing the costs of purchasing new materials and devices K_{miu}, which in the case of failure of the LV cable line are:

- average cost value: $\overline{K}_{miu} = 281{,}18\ PLN$,
- standard deviation: $s = 220{,}10\ PLN$,
- confidence interval for the average: $268{,}96\ PLN < \overline{K}_{miu} < 293{,}41\ PLN$,
- minimum value: $K_{miu_{min}} = 0{,}01\ PLN$,
- maximum value: $K_{miu_{max}} = 1018{,}73\ PLN$.

Based on the analysis of statistical data, it was found that the best fit is characterized by a log-normal distribution. The log-normal distribution parameter values determined using the Statistica package are $m = 5{,}2268$, $\sigma = 1{,}0990$.

The empirical and theoretical function of the probability density of the purchase costs of new devices and materials in the case of cable line failure is shown in Figure 2.

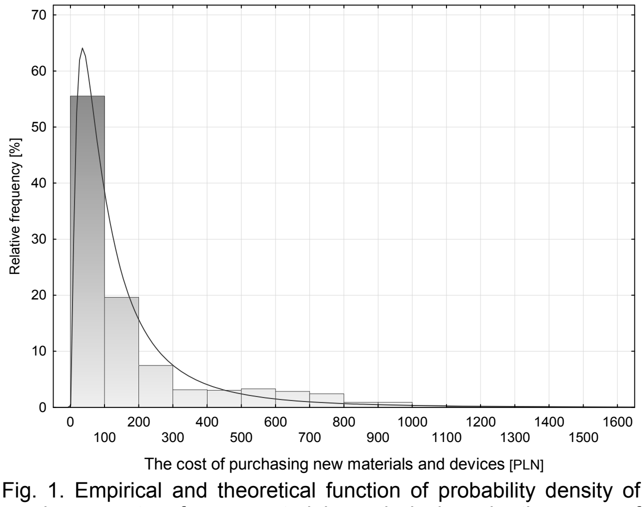

Fig. 1. Empirical and theoretical function of probability density of purchase costs of new materials and devices in the case of overhead distribution lines failure

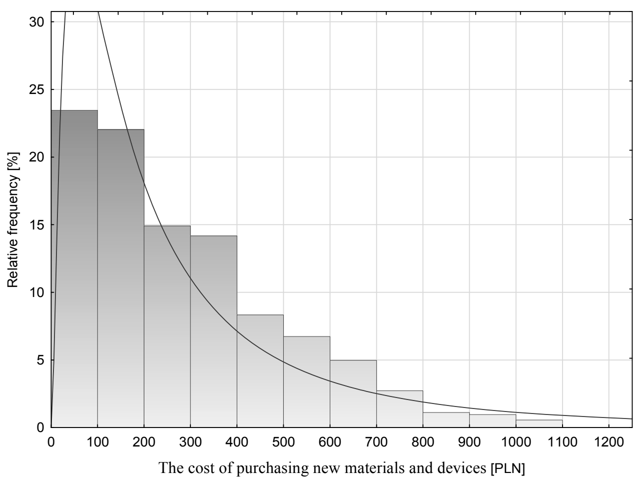

Fig. 2. Empirical and theoretical function of probability density of purchase costs of new materials and devices in the case of distribution cable lines failure

b) The cost of equipment work

Based on empirical data, statistical parameters were determined characterizing the cost of equipment work K_{sprz}, which in the case of failure of the LV overhead line are:

- average cost value: $\bar{K}_{sprz} = 1123{,}29\ PLN$,
- standard deviation: $s = 1158{,}89\ PLN$,
- confidence interval for the average: $1100{,}99\ PLN < \bar{K}_{sprz} < 1145{,}59\ PLN$,
- minimum value: $K_{sprz_{min}} = 25{,}43\ PLN$,
- maximum value: $K_{sprz_{max}} = 12393{,}00\ PLN$.

Based on the analysis of statistical data, it was found that the best fit is characterized by a log-normal distribution. The log-normal distribution parameter values determined using the Statistica package are $m = 6{,}6028$, $\sigma = 0{,}9169$.

The empirical and theoretical function of the probability density of the cost of equipment work in the case of overhead line failure is shown in Figure 3.

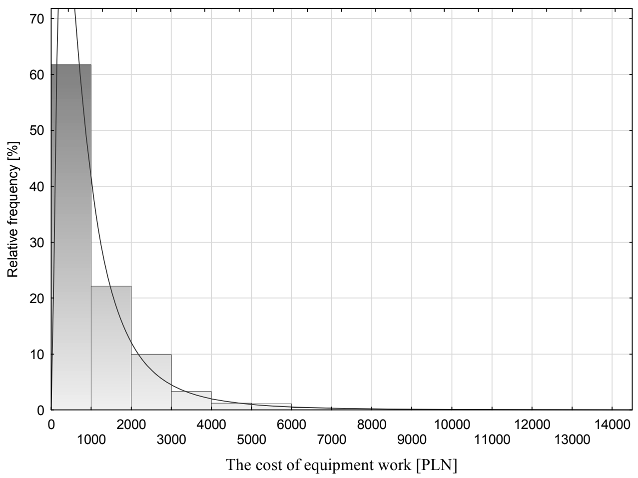

Fig. 3. Empirical and theoretical function of probability density of the cost of equipment work in the case of overhead distribution lines failure

Based on empirical data, statistical parameters were determined characterizing the cost of equipment work K_{sprz}, which in the case of failure of the LV cable line are:

- average cost value: $\bar{K}_{sprz} = 988{,}00\ PLN$,
- standard deviation: : $s = 820{,}70\ PLN$,
- confidence interval for the average: $942{,}42\ PLN < \bar{K}_{sprz} < 1033{,}57\ PLN$,
- minimum value: $K_{sprz_{min}} = 154{,}66\ PLN$,
- maximum value: $K_{sprz_{max}} = 5486{,}97\ PLN$.

Based on the analysis of statistical data, it was found that the best fit is characterized by a log-normal distribution. The log-normal distribution parameter values determined using the Statistica package are $m = 6{,}6147$, $\sigma = 0{,}7388$.

The empirical and theoretical function of the probability density of the cost of equipment work in the case of cable line failure is shown in Figure 4.

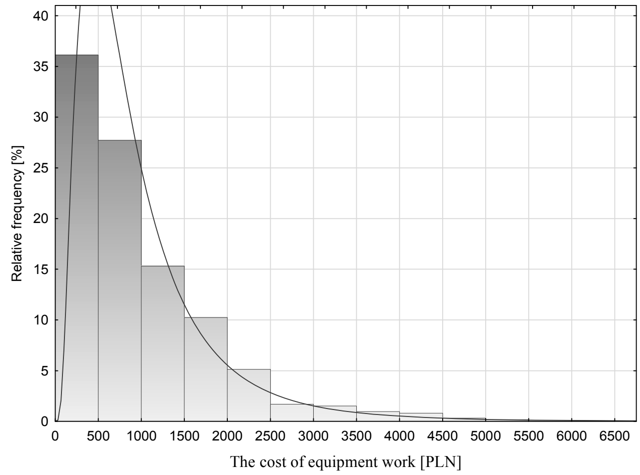

Fig. 4. Empirical and theoretical function of probability density of the cost of equipment work in the case of distribution cable lines failure

c) The cost of fitters work

Based on empirical data, statistical parameters were determined the cost of fitters work K_{pm}, which in the case of failure of the LV overhead line are:

- average cost value: $\bar{K}_{pm} = 1296{,}26\ PLN$,
- standard deviation: $s = 1513{,}44\ PLN$,
- confidence interval for the average: $1267{,}14\ PLN < \bar{K}_{pm} < 1325{,}39\ PLN$,
- minimum value: $K_{pm_{min}} = 20{,}05\ PLN$,
- maximum value: $K_{pm_{max}} = 15614{,}90\ PLN$.

Based on the analysis of statistical data, it was found that the best fit is characterized by a log-normal distribution. The log-normal distribution parameter values determined using the Statistica package are $m = 6{,}6066$, $\sigma = 1{,}0847$.

The empirical and theoretical function of the probability density of the cost of fitters work in the case of overhead line failure is shown in Figure 5.

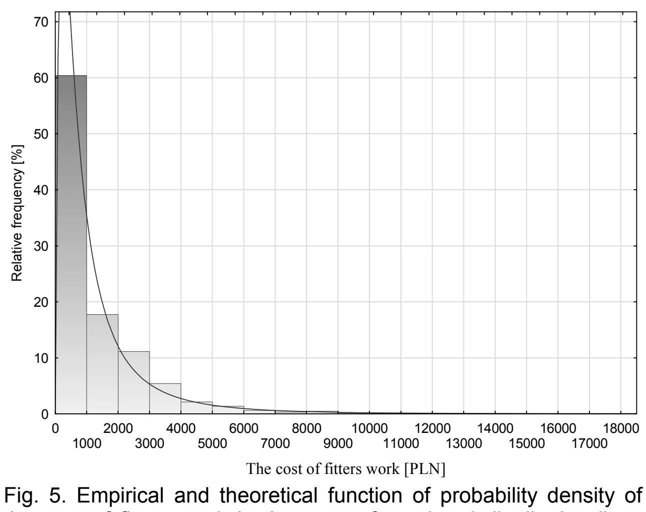

Fig. 5. Empirical and theoretical function of probability density of the cost of fitters work in the case of overhead distribution lines failure

Based on empirical data, statistical parameters were determined characterizing the cost of fitters work K_{pm}, which in the case of failure of the LV cable line are:
- average cost value: $\bar{K}_{pm} = 1071,86\ PLN$,
- standard deviation: : $s = 1067,38\ PLN$,
- confidence interval for the average: $1012,59\ PLN < \bar{K}_{pm} < 1131,14\ PLN$,
- minimum value: $K_{pm_{min}} = 78,68\ PLN$,
- maximum value: $K_{pm_{max}} = 8075,86\ PLN$.

Based on the analysis of statistical data, it was found that the best fit is characterized by a log-normal distribution. The log-normal distribution parameter values determined using the Statistica package are $m = 6,5384$, $\sigma = 0,9621$.

The empirical and theoretical function of the probability density of the cost of fitters work in the case of cable line failure is shown in Figure 6.

d) The cost of accessing the repair brigade and construction equipment to the place of failure

Based on empirical data, statistical parameters were determined the cost of accessing the repair brigade and construction equipment to the place of failure K_d, which in the case of failure of the LV overhead line are:
- average cost value: $\bar{K}_d = 78,47\ PLN$,
- standard deviation: $s = 44,93\ PLN$,
- confidence interval for the average: $77,60\ PLN < \bar{K}_d < 79,33\ PLN$,
- minimum value: $K_{d_{min}} = 0,00\ PLN$,
- maximum value: $K_{d_{max}} = 156,00\ PLN$.

Based on the analysis of statistical data, it was found that the best fit is characterized by a rectangular distribution. The values of the rectangular distribution parameters determined using the Statistica package are $m = 6,25$, $D_d = 0,00, D_g = 156,00$.

The empirical and theoretical function of the probability density of the cost of accessing the repair brigade and construction equipment to the place of failure in the case of overhead line failure is shown in Figure 7.

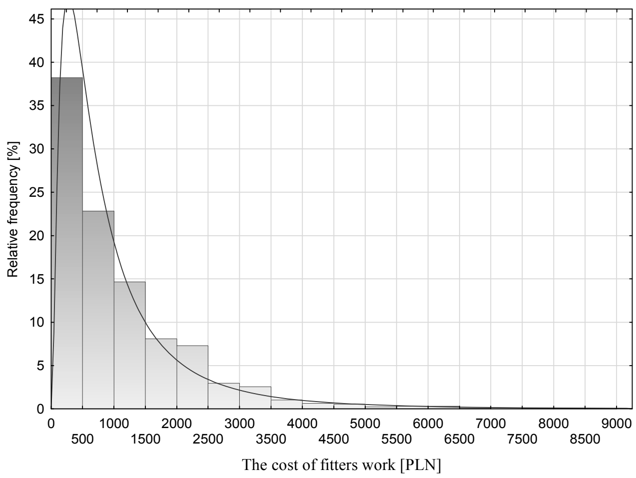

Fig. 6. Empirical and theoretical function of probability density of the cost of fitters work in the case of distribution cable lines failure

Based on empirical data, statistical parameters were determined the cost of accessing the repair brigade and construction equipment to the place of failure K_d, which in the case of failure of the LV cable line are:
- average cost value: $\bar{K}_d = 79,08\ PLN$,
- standard deviation: $s = 44,98\ PLN$,
- confidence interval for the average: $76,59\ PLN < \bar{K}_d < 81,58\ PLN$,
- minimum value: $K_{d_{min}} = 0,04\ PLN$,
- maximum value: $K_{d_{max}} = 155,94\ PLN$.

Based on the analysis of statistical data, it was found that the best fit is characterized by a rectangular distribution. The values of the rectangular distribution parameters determined using the Statistica package are $m = 6,25$, $D_d = 0,04, D_g = 155,94$.

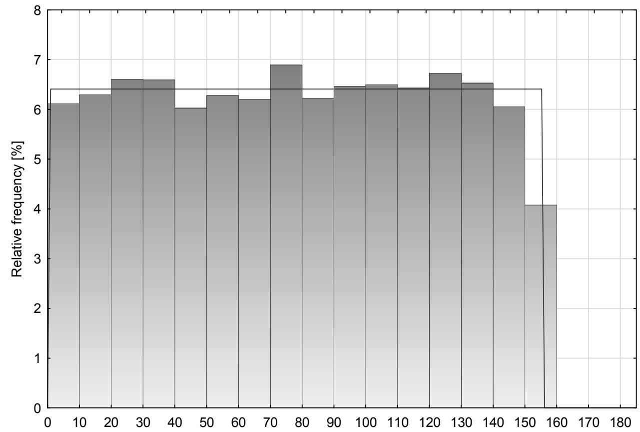

Fig. 7. Empirical and theoretical function of probability density of the cost of accessing the repair brigade and construction equipment to the place of failure in the case of overhead distribution lines failure

The empirical and theoretical function of the probability density of the cost of accessing the repair brigade and construction equipment to the place of failure in the case of cable line failure is shown in Figure 8.

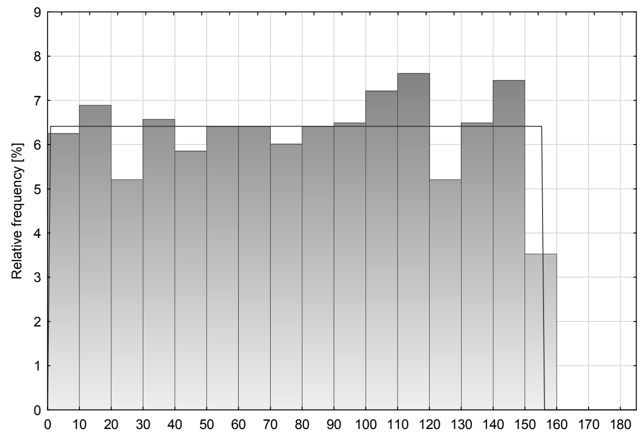

Fig. 8. Empirical and theoretical function of probability density of the cost of accessing the repair brigade and construction equipment to the place of failure in the case of cable distribution lines failure

e) the cost of lost profit

Based on empirical data, statistical parameters were determined the cost of lost profit K_{uz}, which in the case of failure of the LV overhead line are:
- average cost value: $\bar{K}_{uz} = 110,65\ PLN$,
- standard deviation: $s = 125,41\ PLN$,
- confidence interval for the average: $108,24\ PLN < \bar{K}_{uz} < 113,07\ PLN$,
- minimum value: $K_{uz_{min}} = 0,01\ PLN$,
- maximum value: $K_{uz_{max}} = 894,70\ PLN$.

Based on the analysis of statistical data, it was found that the best fit is characterized by a log-normal distribution.

The log-normal distribution parameter values determined using the Statistica package are $m = 3{,}7331$, $\sigma = 2{,}1402$.

The empirical and theoretical function of the probability density of the cost of lost profit in the case of overhead line failure is shown in Figure 9.

Based on empirical data, statistical parameters were determined characterizing the cost of lost profit K_{uz}, which in the case of failure of the LV cable line are:

- average cost value: $\overline{K}_{uz} = 51{,}53\ PLN$,
- standard deviation: : $s = 57{,}43\ PLN$,
- confidence interval for the average: $48{,}35\ PLN < \overline{K}_{uz} < 54{,}72\ PLN$,
- minimum value: $K_{uz_{min}} = 0{,}01\ PLN$,
- maximum value: $K_{uz_{max}} = 272{,}52\ PLN$.

Based on the analysis of statistical data, it was found that the best fit is characterized by a log-normal distribution. The log-normal distribution parameter values determined using the Statistica package are $m = 2{,}5350$, $\sigma = 2{,}8906$.

The empirical and theoretical function of the probability density of the cost of fitters work in the case of cable line failure is shown in Figure 10.

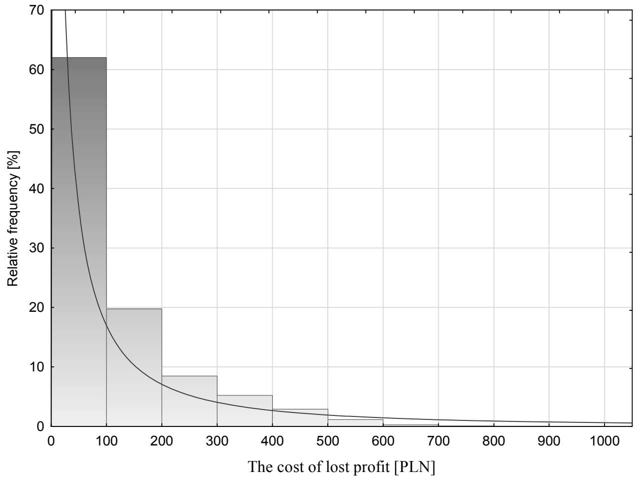

Fig. 9. Empirical and theoretical function of probability density of the cost of lost profit in the case of overhead distribution lines failure

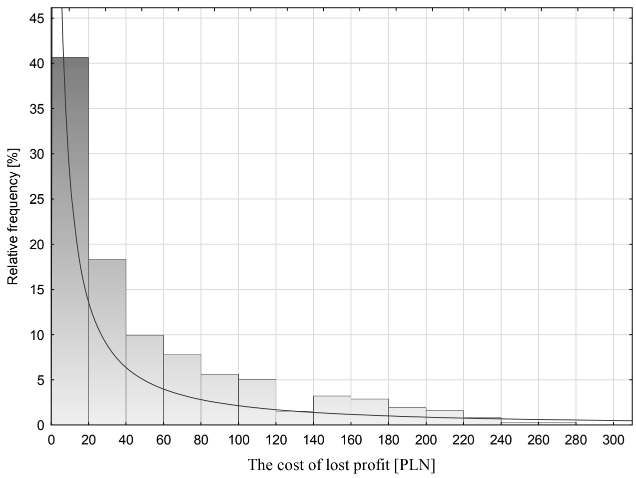

Fig. 10. Empirical and theoretical function of probability density of the cost of lost profit in the case of distribution cable lines failure

f) the total cost of failure

On the basis of empirical data, statistical parameters were determined that characterize the total cost of losses at electricity distributors K_{aw} in the case of failure of the LV overhead line, which are:

- average cost value: $\overline{K}_{aw} = 2788{,}72\ PLN$,
- standard deviation: : $s = 2726{,}59\ PLN$,
- confidence interval for the average: $2736{,}25\ PLN < \overline{K}_{aw} < 2841{,}19\ PLN$,
- minimum value: $K_{aw_{min}} = 166{,}06\ PLN$,
- maximum value: $K_{aw_{max}} = 27022{,}30\ PLN$.

Based on the analysis of statistical data, it was found that the best fit is characterized by a log-normal distribution. The log-normal distribution parameter values determined using the Statistica package are $m = 7{,}5721$, $\sigma = 0{,}8321$.

The empirical and theoretical function of the probability density of the total cost of losses at electricity distributors in the case of overhead line failure is shown in Figure 11.

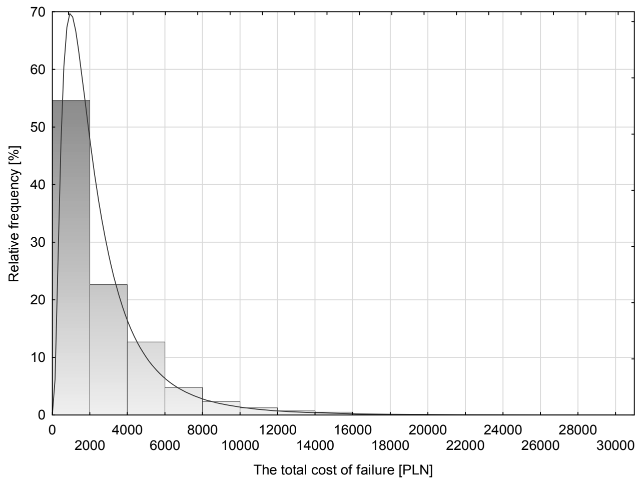

Fig. 11. Empirical and theoretical function of probability density of the total cost of losses at electricity distributors in the case of overhead distribution lines failure

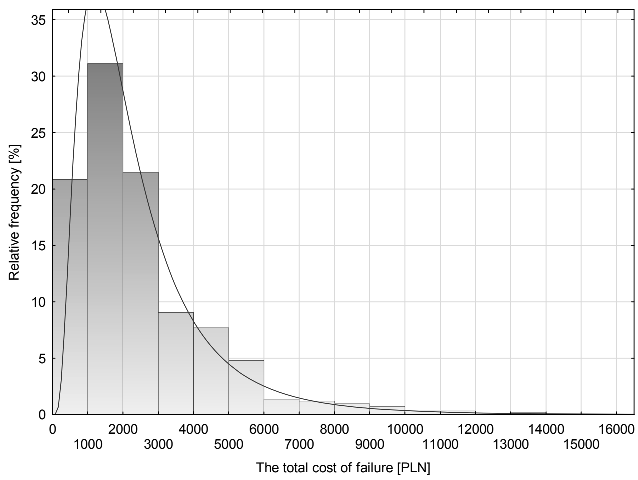

Fig. 12. Empirical and theoretical function of probability density of the total cost of losses at electricity distributors in the case of cable distribution lines failure

On the basis of empirical data, statistical parameters were determined that characterize the total cost of losses at electricity distributors K_{aw} in the case of failure of the LV cable line, which are:

- average cost value: $\overline{K}_{aw} = 2471{,}66\ PLN$,
- standard deviation: : $s = 1919{,}61\ PLN$,
- confidence interval for the average: $2365{,}06\ PLN < \overline{K}_{aw} < 2578{,}27\ PLN$,
- minimum value: $K_{aw_{min}} = 426{,}74\ PLN$,
- maximum value: $K_{aw_{max}} = 13872{,}60\ PLN$.

Based on the analysis of statistical data, it was found that the best fit is characterized by a log-normal distribution.

The log-normal distribution parameter values determined using the Statistica package are $m = 7{,}5647$, $\sigma = 0{,}6949$.

The empirical and theoretical function of the probability density of the total cost of losses at electricity distributors in the case of cable line failure is shown in Figure 12.

Statistical analysis of the costs of losses at electricity consumers

On the basis of empirical data, statistical parameters were determined that characterize the costs of losses at electricity consumers K_{odb} in the case of failure of the LV overhead line, which are:

- average cost value: $\overline{K}_{odb} = 21139{,}98\ PLN$,
- standard deviation: : $s = 23637{,}48\ PLN$,
- confidence interval for the average: $20685{,}12\ PLN < \overline{K}_{odb} < 21594{,}84\ PLN$,
- minimum value: $K_{odb_{min}} = 0{,}00\ PLN$,
- maximum value: $K_{odb_{max}} = 175659{,}40\ PLN$.

Based on the analysis of statistical data, it was found that the best fit is characterized by a log-normal distribution. The log-normal distribution parameter values determined using the Statistica package are $m = 8{,}7727$, $\sigma = 3{,}1369$.

The empirical and theoretical function of the probability density of the costs of losses at electricity consumers in the case of overhead line failure is shown in Figure 13.

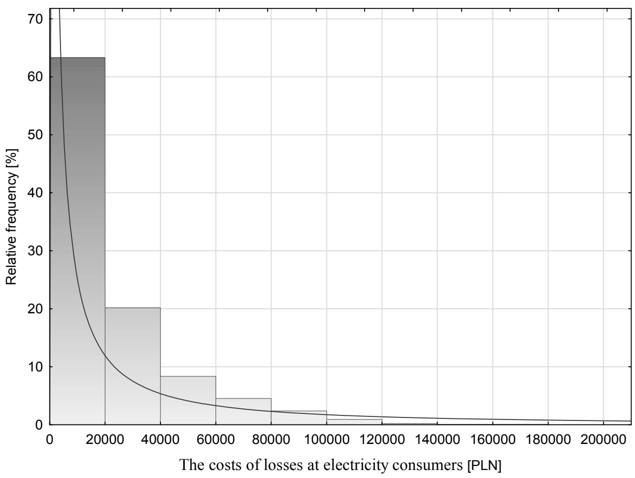

Fig. 13. Empirical and theoretical function of probability density of the costs of losses at electricity consumers in the case of overhead distribution lines failure

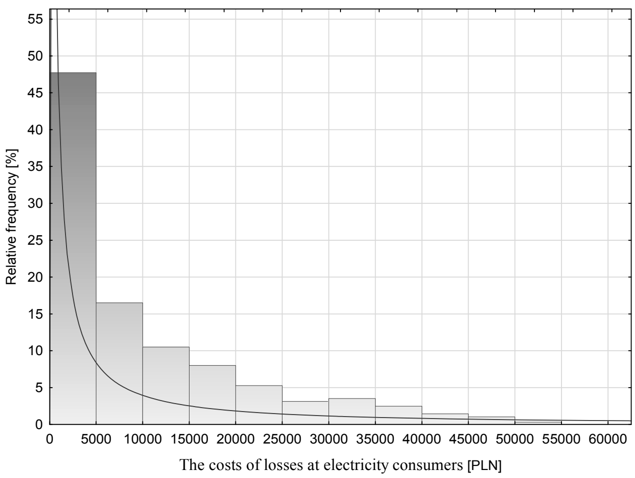

Fig. 14. Empirical and theoretical function of probability density of the costs of losses at electricity consumers in the case of cable distribution lines failure

On the basis of empirical data, statistical parameters were determined that characterize the costs of losses at electricity consumers K_{odb} in the case of failure of the LV cable line, which are:

- average cost value: $\overline{K}_{odb} = 10117{,}74\ PLN$,
- standard deviation: : $s = 11274{,}97 PLN$,
- confidence interval for the average: $9491{,}59\ PLN < \overline{K}_{odb} < 10743{,}89\ PLN$,
- minimum value: $K_{odb_{min}} = 0{,}00\ PLN$,
- maximum value: $K_{odb_{max}} = 53504{,}02\ PLN$.

Based on the analysis of statistical data, it was found that the best fit is characterized by a log-normal distribution. The log-normal distribution parameter values determined using the Statistica package are $m = 7{,}1549$, $\sigma = 4{,}5650$.

The empirical and theoretical function of the probability density of the costs of losses at electricity consumers in the case of cable line failure is shown in Figure 14.

Summary

Table 1 summarizes the results of the statistical analysis of the cost of the electrical power distribution LV lines failures.

Table 1. Average values of losses costs at distributors and consumers of electricity. The costs were generated as a result of the failure of electrical power distribution LV lines

Type of costs	Overhead lines	Cable lines
	PLN	
K_{miu}	180,05	281,18
K_{sprz}	1123,29	988,00
K_{pm}	1296,26	1071,86
K_d	78,47	79,08
K_{uz}	110,65	51,53
K_{aw}	2788,72	2471,66
K_{odb}	21139,98	10117,74

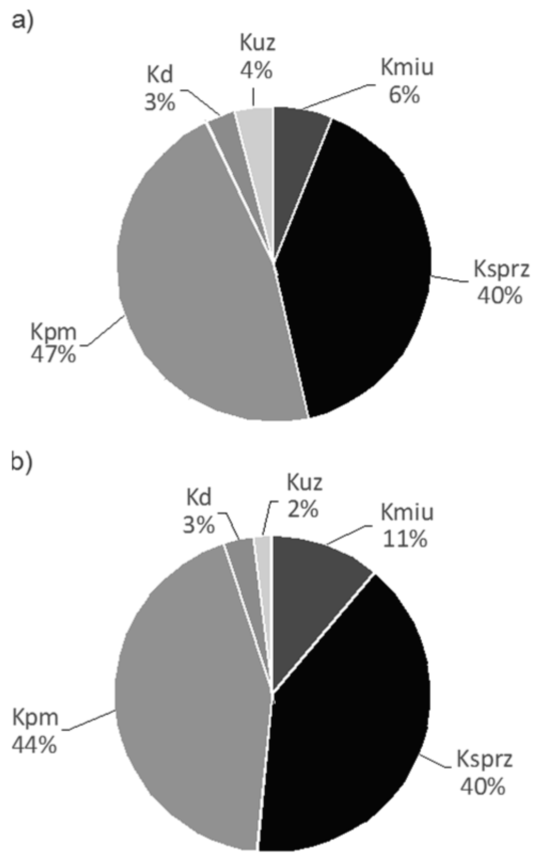

Fig. 15. Shares of individual components in the total costs of the failure of the electrical power distribution LV lines: a) overhead, b) cable

Figure 15 shows the percentage share of individual components of losses at electricity distributors in total costs of failure.

Analyzing the received costs of losses at distributors in connection with failures in the electrical power LV distribution lines, it should be noted that both average values of the total costs of removing failures and other costs are similar for overhead and cable lines. In the case of overhead lines, the costs of lost profits are almost twice as high.

The cost of fitters' work has the largest share in the total costs for both overhead lines and cable lines. This share is 47% and 44% respectively.

The smallest share in the total costs, in both considered cases, are the cost of accessing the repair brigade and construction equipment to the place of failure, as well as the costs of lost profits.

The costs of purchasing new materials and devices in the case of overhead lines failure are lower than in the case of cable lines failure. It results from the fact that overhead lines are repaired using cheap materials (e.g. pieces of aluminum or steel-aluminum conduit or connectors), while for repairs in cable lines, expensive materials and components, e.g. cable sleeves, are used. Their use is caused by the need to meet the requirements for line parameters. After the repair, the cable line must have the same technical parameters as before the repair.

The costs of equipment work are comparable for both types of lines considered. In the case of repairs in lines, construction equipment is used, e.g., cranes in the case of overhead lines and excavators in the case of cable lines. It should be noted that the cost of equipment is slightly lower in cable lines. This may be due to the fact that some repair works can be performed without the use of specialized equipment, e.g. by manually digging out a fragment of the damaged cable.

The cost of accessing the repair brigade and construction equipment to the place of failure are comparable for overhead and cable lines. Overhead lines are usually located in suburban and rural areas, which affects the cost of fitter's travel to the place of failure, while the location of the damage does not require the use of specialized equipment. In the case of cable lines, the distance to the place of failure is small, but in addition to the fitters brigade, there is a need to travel a specialized car, whose presence is necessary to accurately locate the damage.

The cost of lost profit is greater in the case of overhead lines, which results from the specificity of the network's operation. Although cable lines are more heavily loaded, they are better reserved. Thanks to this, during their failure, power outages to consumers are short. In the case of consumers supplied from overhead lines, the duration of the failure is longer, overhead lines are not reserved and their damage is tantamount to the lack of power supply for the entire period of repair. This fact also results in the difference in costs for consumers supplied from overhead and cable lines. The losses they incur are strongly correlated with the amount of undelivered electricity.

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