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ANALIZA ZDARZEŃ NA PRZEJAZDACH KOLEJOWO-DROGOWYCH W WYBRANYCH WOJEWÓDZTWACH W POLSCE W LATACH 2009-2019

Streszczenie: Przejazdy kolejowo-drogowe są newralgicznym punktem sieci transportu kolejowego oraz drogowego. W artykule przedstawiono analizę zdarzeń na strzeżonych i niestrzeżonych przejazdach kolejowo-drogowych w trzech województwach w Polsce: Świętokrzyskie, Podlaskie, Opolskie i Lubuskie w latach 2009-2019 na podstawie danych z Systemu Ewidencji Wypadków i Kolizji. Dodatkowo przedstawiono mapy koncentracji zdarzeń kolejowo-drogowych.

Słowa kluczowe: bezpieczeństwo ruchu drogowego, przejazd strzeżony, przejazd niestrzeżony, zdarzenia kolejowo-drogowe

ANALYSIS OF RAIL-ROAD CROSSINGS INCIDENTS IN SELECTED VOIVODSHIPS IN POLAND IN 2009-2019

Summary: Rail-road crossings are a critical point in the rail and road transport network. The article presents an analysis of incidents on guarded and unguarded rail-road crossings in four voivodships in Poland: Świętokrzyskie, Podlaskie, Opolskie, and Lubuskie in 2009-2019 based on data from the Accident and Collision Record System (in polish: SEWiK). Additionally, the maps of the concentration of rail-road incidents are presented.

Keywords: road traffic safety, guarded crossing, unguarded crossing, rail-road incidents

1. Introduction

Growing car traffic contributes to a reduction in the level of road safety. Conducting analyzes of the occurrence of incidents on the transport network allows searching for solutions that increase road safety [1,2]. Rail-road crossings are a critical point in the rail and road transport network. It is important to ensure safety in these places as both modes of transport are used to transport people and goods [3,4]. Rail transport is

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considered to be a safer form of movement compared to road transport. However, the effects of incidents on rail-road crossings are dangerous, especially for road users. The consequences may include material losses, i.e. significant damage to the vehicle, as well as the loss of health and even life.

In Poland are 6 categories of rail-road crossings [5,6]:

- Category A – road traffic is managed by e.g.: authorized employees of the railway manager, railway undertaking, using hand signals, crossing systems or devices equipped with barriers closing the entire width of the road,
- Category B - road traffic is managed by automatic crossing systems, equipped with traffic lights and barriers closing the traffic,
- Category C - road traffic is managed using automatic level crossing systems equipped only with traffic lights;
- Category D - they are not equipped with traffic protection systems and devices;
- Category E - crossings equipped with, e.g.: a semi-automatic or automatic crossing system or turnstiles, barriers or labyrinths,
- Category F - rail-road crossings or crossings located on internal roads.

Depending on the traffic conditions at the rail-road crossing and in relation to the basic principles of work of security devices, crossings secured with technical devices, the so-called guarded crossings, or rail-road crossings without technical devices - unguarded crossings. Unguarded crossings secured only with road signs within the crossings. Tables 1 and 2 show the number of incidents, fatalities, seriously and slightly injured people on rail-road crossings in Poland in 2009-2019. The data in the table shows that there were more rail-road incidents on guarded crossings in the analyzed period. There is an upward trend in the number of rail-road incidents on guarded crossings, and a downward trend on unguarded crossings. The number of unguarded rail-road crossings is greater than the guarded ones, but in 2008-2018 there are less and less of them [5]. On the other hand, the number of fatalities and lightly and seriously injured people is higher in the case of incidents on unguarded rail-road crossings than on guarded ones. Despite the fact that guarded rail-road crossings are characterized by a greater number of incidents, their effects are less dangerous than in the case of unguarded crossings.

Table 1. Number of incidents on guarded and unguarded rail-road crossings in Poland in 2009-2019, source: own research based on [7]

Rail-road crossing	guarded	unguarded
2009	657	447
2010	663	445
2011	665	407
2012	628	409
2013	676	396
2014	543	347
2015	641	304
2016	1042	348
2017	1061	367
2018	992	330
2019	1022	313

Table 2. Number of fatalities, seriously injured and slightly injured in incidents on guarded and unguarded rail-road crossings in Poland in 2009-2019, source: own research based on [7]

Rail-road crossing	fatalities		seriously injured person		slightly injured person	
	guarded	unguarded	guarded	unguarded	guarded	unguarded
2009	9	36	4	26	14	65
2010	15	18	9	23	18	61
2011	14	20	10	16	10	70
2012	6	33	4	17	13	38
2013	4	29	7	21	13	42
2014	8	18	6	21	14	30
2015	13	26	7	24	14	30
2016	5	26	10	24	10	26
2017	6	19	18	23	8	26
2018	7	27	6	21	3	50
2019	5	30	5	19	9	17

The article aims to analyze incidents on guarded and unguarded rail-road crossings in four voivodships in Poland: Świętokrzyskie, Podlaskie, Opolskie, and Lubuskie in 2009-2019. An analysis of the number of rail-road incidents on guarded and unguarded crossings was carried out based on data from the Accident and Collision Record System (in polish: SEWiK). Then, the maps of the concentration of incidents on guarded and unguarded rail-road crossings in the analyzed voivodships were analyzed.

The article consists of four parts. After the introduction, the second chapter presents the characteristics of the research area. The third chapter presents an analysis of incidents on guarded and unguarded rail-road crossings in four voivodships in Poland in 2009 and 2019. Additionally, this chapter presents maps of incident concentration on guarded and unguarded rail-road crossings in 2009-2019. The article ends with a summary.

2. Characteristics of the research area

The figure shows the length of railway lines in particular voivodships in Poland in 2019. The Śląskie, Wielkopolskie, Mazowieckie, and Dolnośląskie voivodships are characterized by the longest network of railway lines. On the other hand, the voivodships: Świętokrzyskie, Podlaskie, Opolskie, and Lubuskie are characterized by the shortest network of railway lines in Poland. Therefore, in the further part of the article, the incidents on guarded and unguarded rail-road crossings in the following voivodships: Świętokrzyskie, Podlaskie, Opolskie, and Lubuskie in 2009-2019 were analyzed.

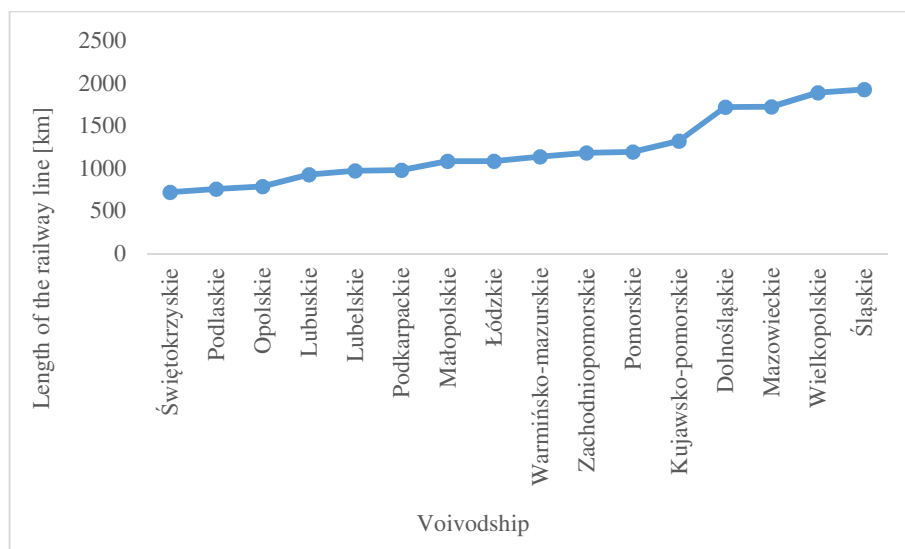


Figure 1. The length of railway lines in particular voivodships in Poland in 2019, source: own research based on [8]

Table 3 presents the density of railway lines per km² for the analyzed voivodships in 2018. The data show that the lowest density of railway lines is characteristic of Podlaskie Voivodship, and the highest density of the analyzed voivodships. This indicator for the Świętokrzyskie and Lubuskie voivodships is between the lowest and the highest of the analyzed voivodships.

Table 3. The density of railway lines per km² for the analyzed voivodships in 2018, źródło: [9]

Voivodship	The density of railway lines per km ²
Świętokrzyskie	5.1
Opolskie	8.3
Podlaskie	3.6
Lubuskie	6.5

3. Analysis of rail-road incidents in selected voivodships in Poland

3.1. Świętokrzyskie Voivodship

Figure 2 shows the number of incidents on guarded and unguarded rail-road crossings in the Świętokrzyskie Voivodship in the years 2000-2019. On guarded rail-road crossings, it can be seen that the fewest incidents took place in 2010, 2012, 2013, 2015 (below 25), and the most in 2016, 2017, and 2019 (35 and more). In the case of unguarded rail-road crossings, the largest number of incidents took place in 2010, 2011, and 2019 (over 20), while the lowest in 2013 and 2015 (below 10).

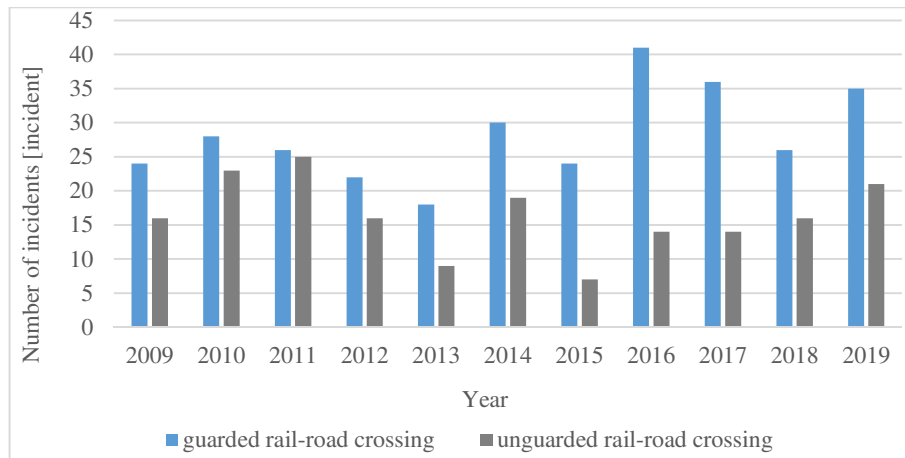


Figure 2. Incidents on guarded and unguarded rail-road crossings in the Świętokrzyskie Voivodship in 2009-2019

On the other hand, Figure 3 shows the maps of incident concentration on rail-road crossings in the Świętokrzyskie Voivodship in 2009-2019. In the case of guarded rail-road crossings in the Świętokrzyskie Voivodship, it can be noticed that a greater number of crossings is characterized by the occurrence of 3 or more incidents than in the case of unguarded ones. 1-2 incidents occurred in most cases at unguarded rail-road crossings.

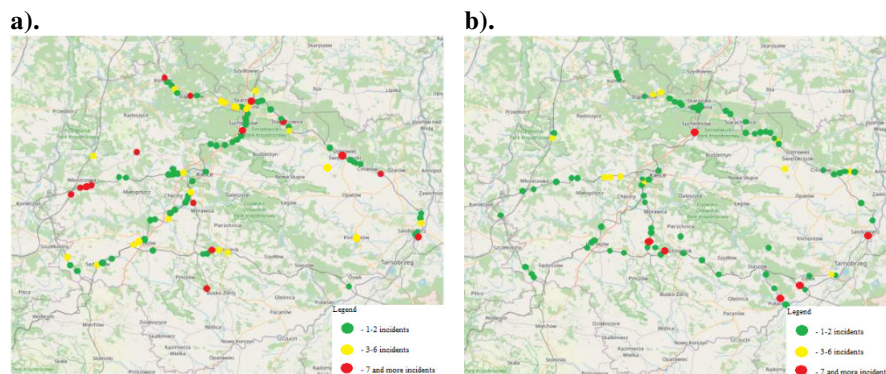


Figure 3. Map of concentration on a). guarded; b). unguarded rail-road crossings in the Świętokrzyskie Voivodship in 2009-2019

3.2. Podlaskie Voivodship

Figure 4 shows the number of incidents on guarded and unguarded rail-road crossings in Podlaskie Voivodship in 2009-2019. At unguarded rail-road crossings in 2009, 2010, and 2012, a greater number of incidents was observed than on guarded crossings. On guarded rail-road crossings, the fewest incidents can be observed in 2009, 2012, 2013, and 2014 (less than 10), and the highest number in 2016, 2017, 2018, and 2019 (more than 15). In 2013, 2014, and 2019, the lowest number of

incidents (10 or less) took place on unguarded rail-road crossings, while the highest number occurred in 2012 and 2017 (over 15).

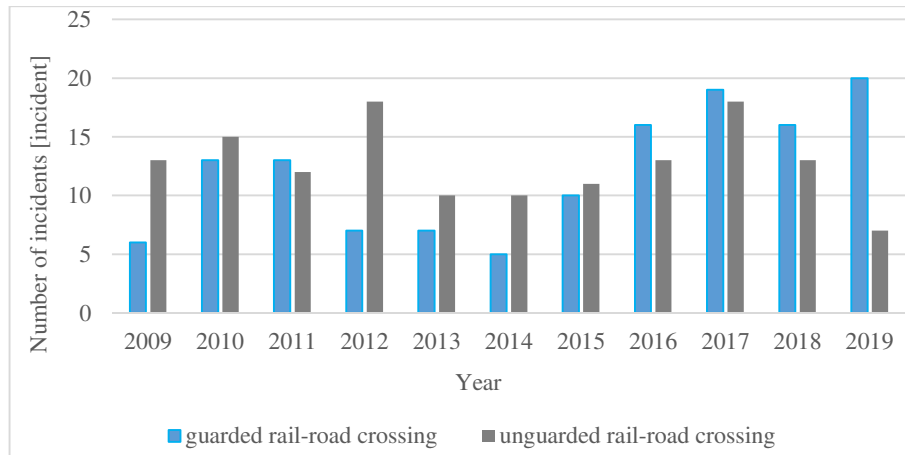


Figure 4. Incidents on guarded and unguarded rail-road crossings in Podlaskie Voivodship in 2009-2019

In turn, Figure 5 shows the maps of incident concentration on rail-road crossings in Podlaskie Voivodship in 2009-2019. In the analyzed period, incidents were recorded on more unguarded rail-road crossings in Podlaskie Voivodship than in the case of guarded crossings. However, on guarded rail-road crossings, it can be observed that more of them were characterized by more than 6 incidents.

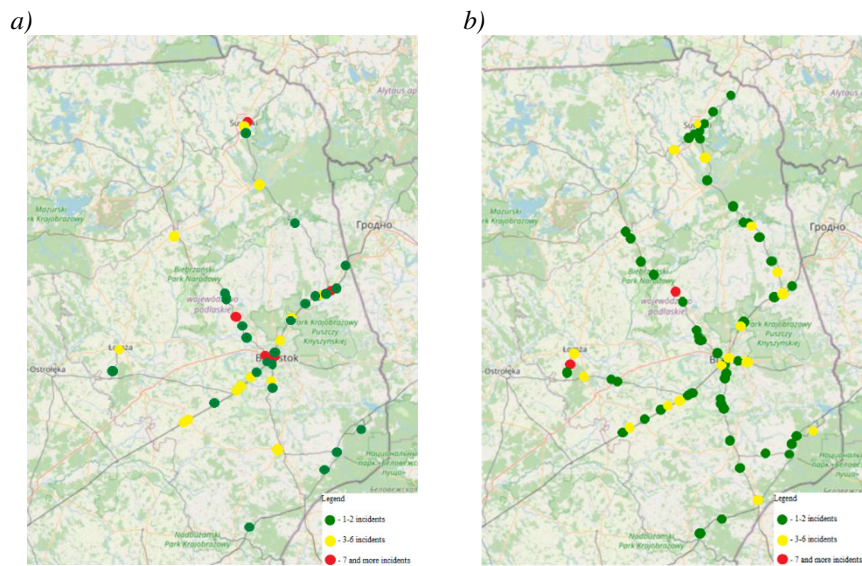


Figure 5. Map of concentration on a). guarded; b). unguarded rail-road crossings in the Podlaskie Voivodship in 2009-2019

3.3. Opolskie Voivodship

Figure 6 shows the number of incidents on guarded and unguarded rail-road crossings in the Opolskie Voivodship in 2009-2019. In the case of guarded rail-road crossings, a large increase in the number of incidents can be observed in 2018 and 2019 (63 and 77 incidents, respectively). The lowest number of incidents on guarded rail-road crossings occurred in 2013, 2015, and 2016 (less than 20). In the case of unguarded rail-road crossings, the largest number of incidents occurred in 2010 and 2011 (15 and more), while the lowest in 2015, 2016, and 2018 (less than 10).

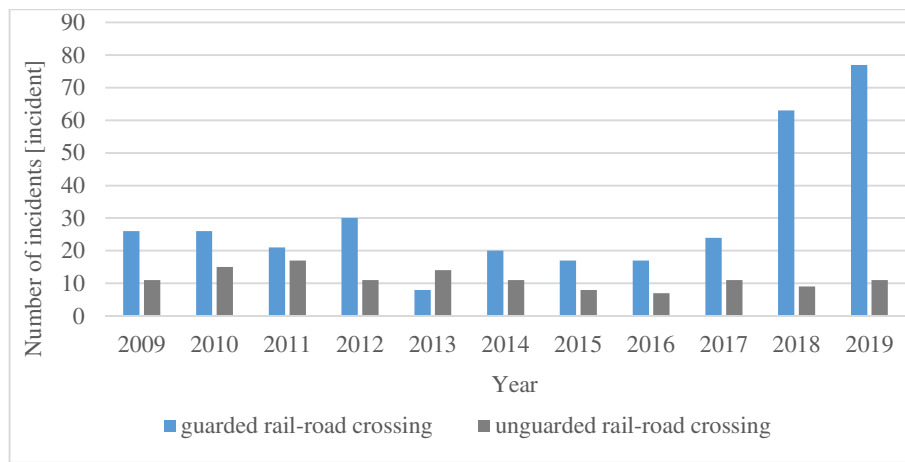


Figure 6. Incidents on guarded and unguarded rail-road crossings in the Opolskie Voivodship in 2009-2019

On the other hand, Figure 7 shows the maps of incident concentration on rail-road crossings in the Opolskie Voivodship in 2009-2019. In the Opolskie Voivodship, only one unguarded rail-road crossing is characterized by more than 6 incidents.

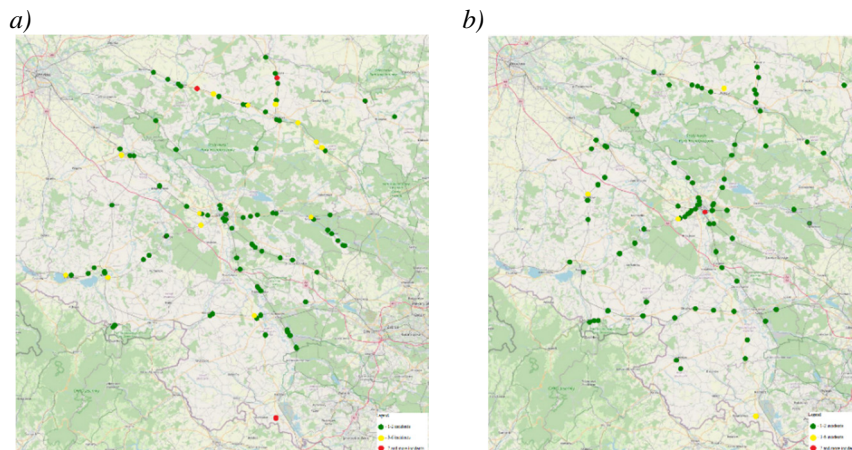


Figure 7. Map of concentration on a). guarded; b). unguarded rail-road crossings in the Opolskie Voivodship in 2009-2019

3.4. Lubuskie Voivodship

Figure 8 shows the number of incidents on guarded and unguarded rail-road crossings in the Lubuskie Voivodship in 2009-2019. In 2009, 2011, 2012, and 2014, more incidents took place on unguarded rail-road crossings than on guarded crossings, and in 2010 the number of incidents was the same in both cases. The largest number of incidents on guarded rail-road crossings took place in 2010, 2016, 2017, and 2019 (over 20), while the lowest in 2014 and 2015. In the case of unguarded rail-road crossings, the largest number of incidents occurred in 2009 and 2010 (over 20), and the least in 2013, 2014, 2015, 2017, and 2018 (below 10).

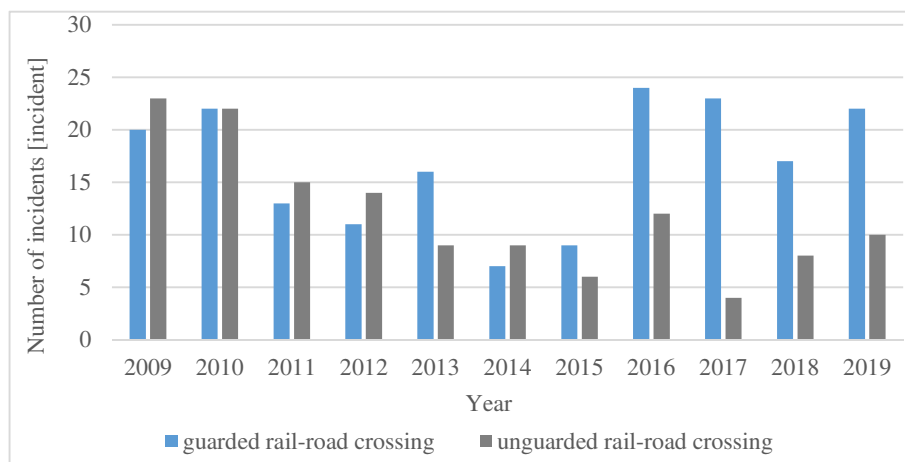


Figure 8. Incidents on guarded and unguarded rail-road crossings in the Lubuskie Voivodship in 2009-2019

In turn, Figure 9 shows the maps of incident concentration on rail-road crossings in Lubuskie Voivodship in 2009-2019. In the analyzed period, in the Lubuskie Voivodship, there were no more than 6 incidents on the guarded rail-road crossing. A significant number of unguarded rail-road crossings were characterized by the occurrence of 1-2 incidents.

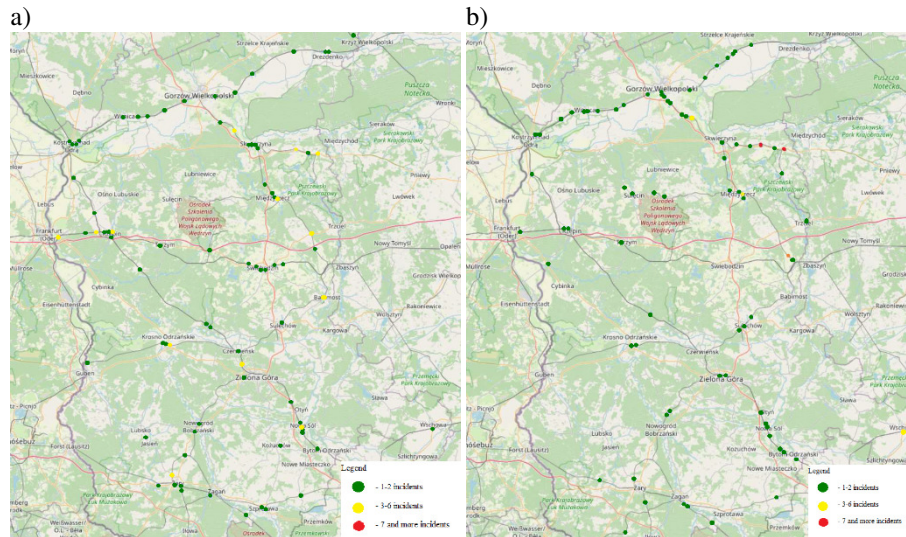


Figure 9. Map of concentration on a). guarded; b). unguarded rail-road crossings in the Lubuskie Voivodship in 2009-2019

4. Summary

The article aimed to analyze the incidents on guarded and unguarded rail-road crossings in four voivodships in Poland: Świętokrzyskie, Podlaskie, Opolskie, and Lubuskie in the years 2009-2019. The analyzes of incidents on guarded and unguarded rail-road crossings and their concentration maps allowed for the formulation of the following conclusions:

- There were more road incidents on guarded rail-road crossings than on unguarded crossings in Poland in 2009-2019. However, despite this, there were more lightly and seriously injured and fatalities in incidents at unguarded rail-road crossings,
- There is a greater probability of an incident on a guarded rail-road crossing than on an unguarded crossing, because the number of incidents at these level crossings is greater, and there are fewer of them than the unguarded one,
- Despite the fact that the Opolskie Voivodship is characterized by the highest line density per km², the number of incidents on rail-road crossings was not the highest in the analyzed period, except for 2018 and 2019. The Świętokrzyskie Voivodship has the highest number of incidents on rail-road crossings among the analyzed voivodships,
- There is no downward or upward trend in the number of incidents on guarded and unguarded rail-road crossings in the voivodships analyzed in 2009-2019,
- On rail-road crossings in the analyzed voivodships, the majority of rail-road incidents occurred 1-2 times.

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