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PROFESSIONAL PAPER

Analysis of Traffic Safety on the Laktasi – Klasnice 1 Road Section

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Abstract: Road traffic safety represents one of the major challenges of modern society due to the significant negative consequences that traffic accidents have on human life, health and material property. The analysis of safety on specific road sections enables an objective assessment of safety conditions, identification of dominant accident causes, and recognition of hazardous locations, which provides a basis for improving road traffic safety. This paper analyses traffic safety on the main road M-1-101, specifically the Laktasi-Klasnice 1 road section, which is located on the territory of the City of Laktasi. The analysis covers the period from 2020 to 2022 and is based on statistical processing of traffic accident data, including their structure, consequences, and causes. The research analyzes the total number and structure of traffic accidents, the consequences per person (road users), the time distribution of accidents, as well as accident causes. In addition, traffic accidents were mapped and dangerous spots were identified, along with an assessment of public and traffic risk on the observed road section. The results indicate the presence of critical sections with an increased level of risk. The results obtained can serve as a basis for planning and implementing measures to improve traffic safety and reduce the number of traffic accidents and their consequences.

Keywords: traffic safety, traffic accidents, risk analysis, dangerous spots

INTRODUCTION

Road transport plays a dominant role in the overall transportation system, but it is also associated with significant safety challenges, among which traffic accidents represent the most serious issue. Traffic accidents constitute a major social problem due to their severe human and economic consequences. According to reports by the World Health Organization, approximately 1.3 million people die annually in road traffic accidents worldwide, while between 20 and 50 million people sustain non-fatal injuries. Road safety is influenced by multiple factors, including road infrastructure characteristics, road user behavior, vehicle condition, and traffic flow organization. The analysis of road safety on specific road sections is particularly important, as it enables the identification of hazardous locations, the recognition of dominant accident causes, and the assessment of accident structure and consequences. Based on such analyses, targeted and effective measures for improving road safety can be defined. This paper analyzes road safety on the section of the main road M-1-101 (Banja Luka – Gradiska), specifically the Laktasi – Klasnice 1 section, located within the territory of the City of Laktasi. The section has strategic importance due to its role in connecting major urban centers and is characterized by high traffic volumes and increased safety risk. The aim of this study is to assess the state of road safety on the observed section for the period 2020–2022, identify key risk factors, and determine hazardous locations. The analysis is based on statistical processing of traffic accident data, including their structure, consequences, temporal distribution, and causes, as well as the assessment of public and traffic risk. The obtained results provide a basis for proposing measures aimed at improving road safety on the analyzed section.

LITERATURE REVIEW

Traffic safety analysis and the identification of hazardous locations represent an important area of research aimed at improving road safety and reducing the number of traffic accidents. In this context, hazardous locations, commonly referred to as "black spots", are defined as road sections with a significantly higher concentration of traffic accidents compared to other parts of the road network. Modern approaches to traffic safety analysis emphasize that accident occurrence is not the result of a single factor, but rather a combination of infrastructural characteristics, traffic flow conditions, and road user behavior. Therefore, the identification of hazardous locations requires a comprehensive analysis that includes both spatial distribution of accidents and the characteristics of the road environment ,[18]. Particular attention in the literature is given to the impact of road infrastructure on accident occurrence. Road sections with a high density of direct access points, intensive linear development, and mixed traffic conditions are often identified as high-risk areas due to the increased number of conflict points. Frequent vehicle entry and exit maneuvers, combined with insufficient traffic organization, significantly increase the probability of accidents . In addition to infrastructure, the presence of vulnerable road users, such as pedestrians, further increases the complexity of traffic conditions. Locations with pedestrian crossings, public transport stops, and direct access to residential and commercial facilities are especially sensitive, as they involve frequent interactions between vehicles and pedestrians. Research conducted in the Western Balkan region highlights that road design and infrastructure management play a key role in traffic safety. Inadequate infrastructure and insufficient control of access points are recognized as significant contributors to accident occurrence . Furthermore, studies focusing on traffic safety in the Republic of Srpska indicate that there has been no significant decrease in the number of traffic accidents, injured, and fatalities in recent years, emphasizing the need for detailed analysis of specific locations and the identification of key risk factors. Based on these findings, this study focuses on the spatial analysis of traffic accidents and the identification of hazardous locations, with particular emphasis on the influence of infrastructural characteristics and traffic conditions on accident occurrence.

Previous research indicates that hazardous locations should not be identified solely based on accident frequency, but rather in relation to the expected safety level of similar road sections . Advanced spatial analysis methods, such as kernel density estimation, are increasingly used for identifying accident clusters, as they provide more accurate spatial representation of risk . In addition, recent studies have emphasized the importance of incorporating traffic exposure indicators, such as traffic volume (AADT), in order to achieve a more accurate assessment of accident risk and to avoid bias related to raw accident frequency. Modern approaches to traffic safety analysis also emphasize the importance of combining infrastructural, behavioral, and traffic flow factors in order to achieve a comprehensive assessment of road safety conditions.

REGULATORY AND INSTITUTIONAL FRAMEWORK

Road safety in Republic of Srpska and Bosnia and Herzegovina is regulated by national legislation and international documents that define risk management, the identification of hazardous locations, and the implementation of preventive measures. At the level of Republic of Srpska, the field of road safety is governed by the Law on Road Traffic Safety of Republic of Srpska , which prescribes traffic rules, institutional responsibilities, and safety management. Procedures for the identification and remediation of hazardous locations on the road network are further elaborated through by-laws, primarily the Rulebook on the Identification of Hazardous Locations, Methods and Criteria for Determining Priorities for Their Elimination, and Methods of Hazardous Location Treatment , adopted pursuant to the aforementioned law. At the state level, the Law on the Basics of Road Traffic Safety in Bosnia and Herzegovina defines the fundamental rules of conduct for road users, the requirements that drivers and vehicles must meet, as well as a unified system for recording traffic accident data, thereby ensuring comparability and systematization of data across the entire territory of the country.

The international framework is defined by Directive 2008/96/EC on road infrastructure safety management, which emphasizes the importance of a systematic and preventive approach to road safety management through the identification of accident concentration locations (black spot analysis), risk assessment, and continuous improvement of infrastructure throughout the entire road lifecycle. In accordance with this Directive, European Union Member States are required to introduce procedures that include road safety impact assessments in the early planning stages, safety audits during the design phase, management of hazardous locations on the existing network, as well as regular road safety inspections. Particular emphasis is placed on problem definition and analysis of the existing situation, consideration of the "do-nothing" scenario, the establishment of measurable road safety objectives, and the comparative analysis of proposed alternatives, including the assessment of their effectiveness and justification. The Directive also provides for the systematic consideration of key elements affecting safety, such as severe consequences (fatalities and serious injuries), the presence of vulnerable road users (pedestrians, cyclists, motorcyclists), traffic volume and structure, impacts on the existing road network (intersections, access points), seasonal and climatic conditions, as well as road geome-

try and roadside equipment characteristics. Furthermore, criteria are defined for application during the conceptual and detailed design phases, as well as prior to commissioning and during the initial period of operation, with the possibility of subsequent review based on actual user behavior. The fundamental principles of this Directive are also recognized in national legislation, particularly in the segments related to hazardous location management and road safety audits. The presented regulatory framework provides the methodological basis for the analysis conducted in this paper, particularly in the segment related to the identification of hazardous locations and the assessment of public and traffic risk on the observed section of the main road M-1-101.

METHODOLOGY

The road safety analysis was conducted on the section of the main road M-1-101 Laktasi – Klasnice 1 for the period from 01 January 2020 to 31 December 2022. During the observed period, the official database of traffic accidents of the Ministry of Interior of the Republic of Srpska was used, and the collected data were analyzed using descriptive statistical methods. Data on the population of the City of Laktasi were obtained from the results of the 2013 Population , while data on the number of registered vehicles were taken from official statistical publications . The methodological framework and part of the analyzed data are based on the author's previously completed undergraduate thesis . The analysis included the structure of accidents according to consequences, causes, age and gender structure of participants, temporal distribution (by year, day of the week, and hour), as well as the spatial concentration of accidents. The identification of hazardous locations was carried out in accordance with the applicable regulatory framework . Based on the obtained results, an assessment of public and traffic risk was performed. The spatial analysis of traffic accidents was conducted using GIS-based tools, specifically Google Earth, which enabled precise geolocation and visualization of accident locations along the observed road section. In addition to accident mapping, an assessment of access density was conducted. The number of intersections with local roads and direct access points from residential and commercial properties was determined through visual inspection and counting using GIS tools along the observed road section. Based on these data, access density was calculated as the number of access points per kilometer. Each accident was positioned according to available coordinate data, allowing for the identification of spatial clusters and the analysis of accident distribution patterns.

ROAD SAFETY ANALYSIS ON THE LAKTASI – KLASNICE 1 ROAD SECTION

The analysis of traffic accidents represents a key part of this paper, as it enables an assessment of the actual state of road safety on the observed road section. This chapter presents the results of the analysis of traffic accidents that occurred on the Laktasi – Klasnice 1 road section in the period from 2020 to 2022. The analysis was conducted according to multiple criteria in order to obtain a comprehensive overview of the scope, structure, and causes of traffic accidents.

Statistical Overview of Traffic Accidents (2020–2022)

During the observed period, a total of 169 traffic accidents were recorded on the road section. By year, 42 accidents were recorded in 2020, 54 in 2021, and 73 in 2022. The total increase in the number of accidents in 2022 compared to 2020 amounts to 73.8%, indicating a continuous growth of safety risk on the observed section. This is presented in **Figure 1**.

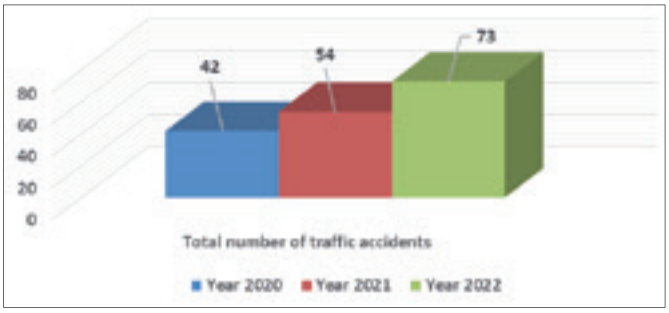

Figure 1. Graphical presentation of the total number of traffic accidents in the period 2020–2022

Consequences of Traffic Accidents for Persons

During the observed period, out of a total of 169 traffic accidents, 141 accidents (83.4%) resulted in material damage, while 28 accidents (16.6%) involved injured persons. No fatal traffic accidents were recorded. Within the structure of accidents involving injured persons, 7 accidents with seriously injured persons and 21 accidents with slightly injured persons were recorded. The increase in the number of accidents involving injured persons was particularly pronounced in 2022, indicating a rise in the severity of consequences during the observed period, as shown in **Figure 2**.

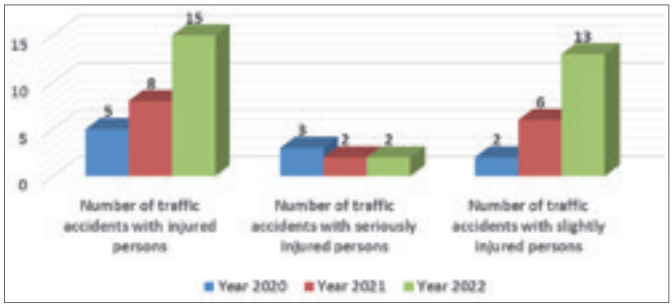

Figure 2. Graphical presentation of the number of t/a with consequences for persons in the period 2020–2022

Table 1. Categories of seriously injured persons in the period 2020-2022

Category of seriously injured persons	2020.	GENDER	2021.	GENDER	2022.	GENDER
Number of seriously injured persons	3	M: 3	3	M: 2 F: 1	2	M: 1 F: 1
Driver of a passenger vehicle	2	M: 2	1	M: 1	0	-
Front-seat passenger in a passenger vehicle	0	-	1	M: 1	0	-
Pedestrian	0	-	1	F: 1	2	M: 1 F: 1
Pedestrian – child	1	M: 1	0	-	0	-

Table 2. Categories of slightly injured persons in the period 2020-2022

Category of slightly injured persons	2020.	GENDER	2021.	GENDER	2022.	GENDER
Number of slightly injured persons	3	M: 1 F:2	9	M: 1 F: 8	19	M: 6 F: 13
Driver of a passenger vehicle	2	M: 1 F: 1	2	M: 1 F: 1	9	M: 3 F: 6
Front-seat passenger in a passenger vehicle	1	F: 1	1	M: 1	5	M: 1 F: 4
Passenger	0	-	3	F: 3	2	F: 2
Driver of a goods vehicle	0	-	1	F: 1	0	-
Motorcycle rider	0	-	0	-	2	M: 2
Pedestrian	0	-	1	F: 1	0	-
Pedestrian – child	0	-	1	F: 1	1	F: 1

In the continuation of the text, **Tables 1 and 2** present the structure of injured persons by category and gender. Table 1 shows the distribution of seriously injured persons, indicating that drivers and pedestrians are the most affected categories. **Table 2** presents slightly injured persons, where a significantly higher number of cases is observed, with a noticeable increase in 2022, especially among drivers and passengers of passenger vehicles.

DISTRIBUTION OF TRAFFIC ACCIDENTS IN TIME AND SPACE

In order to assess the dynamics and spatial characteristics of traffic accidents on the observed road section, an analysis of their distribution in time and space was conducted for the period 2020–2022.

Description of the Observed Road Section

The observed section covers a part of the main road M-1-101 (Banja Luka – Gradiska), specifically the Laktasi – Klasnice 1 section, with a total length of approximately 4 km (around 4000 m). The section is located within the territory of the City of Laktasi and passes through the settlements of Jakupovci and Laktasi. In Jakupovci, the section runs along Omladinska Street, while in Laktasi it continues along Karadjordjeva Street. On the observed section, mixed traffic takes place, with pronounced linear development and a large number of direct access points from residential and commercial buildings to the main road. The observed road section is characterized by a very high access density. A total of 35 intersections with local roads and 95 direct access points from residential and commercial properties were identified along a section of approximately 4 km, resulting in an overall access density of about 32.5 access points per kilometer. Such a high density of access points significantly increases the number of conflict points and represents a major contributing factor to the occurrence of traffic accidents on the analyzed section. In Jakupovci, Svetosavska Street (Glamocani settlement) connects to the section, while in Laktasi the section is linked with other segments of the main road M-1-101, including the direction towards Aleksandrovac and the connection to the motorway. The characteristics of the section, such as high traffic volume, numerous intersections with local roads, and direct access to properties, significantly affect the level of road safety and represent the reason for selecting this section as the subject of analysis. The analysis of temporal distribution shows that the highest concentration of traffic accidents was recorded in the period from 10:00 to 18:00, with a pronounced peak interval from 14:00 to 16:00. This pattern is consistent across all three observed years, with the highest number of accidents in 2022 recorded precisely within this period. The increased frequency of accidents in this time interval can be associated with the afternoon traffic peak, intensive daily activities of the population, and transit flows on the main road, as shown in **Figures 3 and 4.**

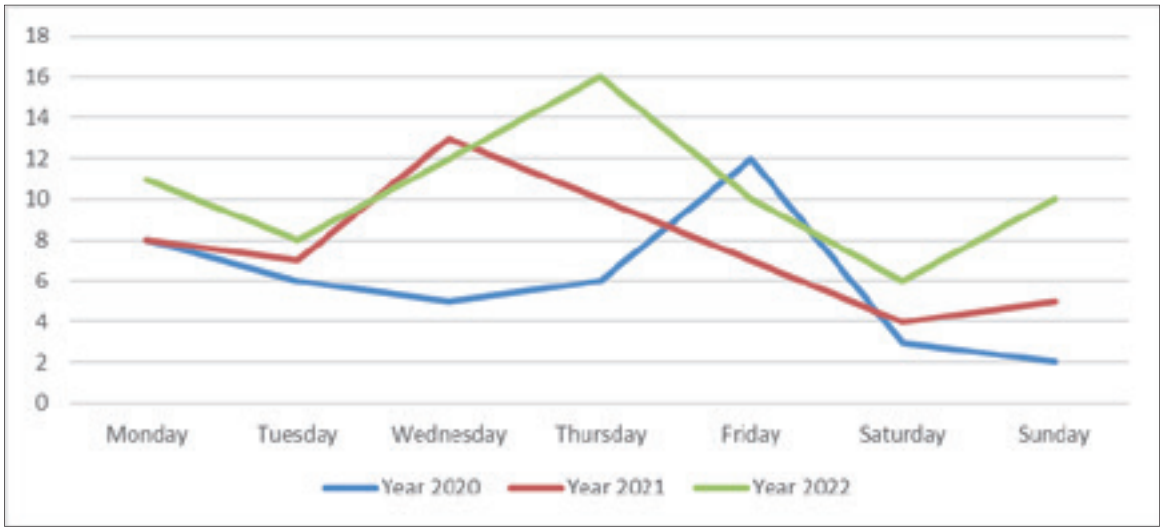

Figure 3. Graphical presentation of traffic accidents by days

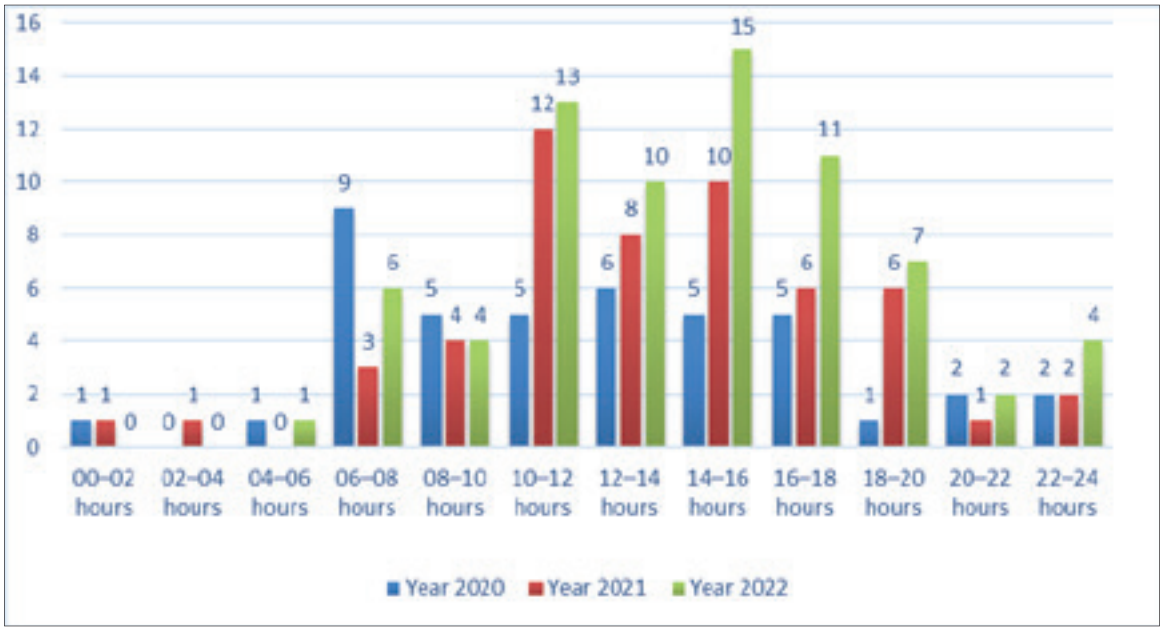

Figure 4. Graphical presentation of the hourly distribution of traffic accidents during the day

Spatial Analysis

The spatial analysis was conducted using the method of mapping traffic accident locations and identifying sections with an increased concentration of accidents (black spot analysis). A hazardous location was identified as a zone with a statistically significant frequency of accidents compared to the rest of the section. The spatial distribution of accidents was further examined using GIS-based visualization.

Identification of Hazardous Locations

The spatial analysis of traffic accidents was carried out by mapping the locations of accidents that occurred in the period 2020–2022. Based on the geographical distribution, sections of the road with an increased concentration of traffic accidents were identified.

The spatial analysis of a total of 169 traffic accidents recorded in the period 2020–2022 determined that the distribution of accidents along the observed section is not uniform. The highest concentration of accidents was observed in sections with intensive linear development along the main road, where there is a large number of direct access points from residential and commercial buildings. The absence of collector roads and an organized access system results in frequent vehicle entry and exit maneuvers, which increases the number of conflict points and the risk of traffic accidents. A lower concentration of accidents was observed in sections with fewer access points, indicating that the structure of access to the main road is a significant factor in the spatial distribution of accidents. The spatial distribution of accidents is shown in **Figure 5**. The identified hazardous location is situated in the settlement of Laktasi, on Karadjordje-

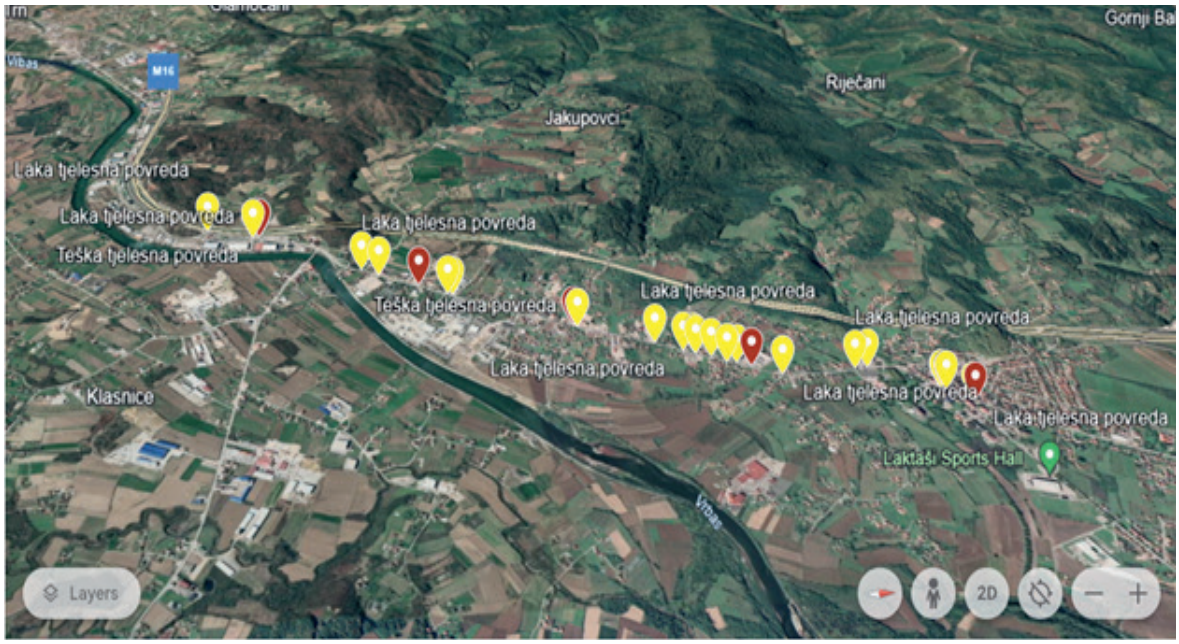

Figure 5. Mapping of traffic accidents with consequences for persons

va Street, within the zone of a public road in a built-up area. During the observed period (2020–2022), a total of six traffic accidents with consequences for persons were recorded at this location, including two with seriously injured persons and four with slightly injured persons. At the identified hazardous location, with a length of approximately 138 m, significant infrastructural and traffic-related factors influencing the increased risk of traffic accidents are present. Observed in the direction Banja Luka – Gradiska, this section is characterized by multiple direct access points to the main road, including access from individual residential buildings, access for collective housing users, as well as a bus stop area used for vehicle entry into the traffic flow. It is particularly important to note that within this zone there is a road widening of approximately 50 m in length, which, in addition to serving public transport purposes, is also used for vehicle stopping (e.g., by users of nearby commercial facilities). This leads to additional conflict situations during vehicle entry and merging into the traffic stream. Furthermore, two pedestrian crossings are located within this section, which significantly increases the number of interactions between vehicles and pedestrians. Traffic at the observed location is characterized by high intensity, as it represents a main road with significant transit function and the presence of heavy vehicles. Traffic is conducted in both directions, with one traffic lane per direction and without physical separation of flows, while the speed limit is 50 km/h. Although sidewalks are present on both sides of the road, the presence of pedestrian crossings and direct access points contributes to increased complexity of traffic conditions. The combination of a high number of direct access points, intensive traffic flow, the presence of pedestrians, and additional maneuvering activities in the bus stop zone leads to an increased number of conflict points and a higher level of infrastructural risk. Such conditions result in a higher probability of traffic accident occurrence, which is confirmed by their spatial concentration at the identified location. The analysis of the structure of traffic accidents at the identified location further confirms the increased level of risk. Out of a total of 6 traffic accidents with consequences for persons, pedestrians were involved in 3 cases, including 2 accidents with slightly injured persons and 1 accident with a seriously injured person. This structure of accidents indicates a pronounced risk for vulnerable road users, which is directly related to the presence of pedestrian crossings, the bus stop, and intensive interactions between vehicles and pedestrians at the observed location. According to the Rulebook on the Identification of Hazardous Locations, Methods and Criteria for Determining Priorities for Their Elimination, and Methods of Hazardous Location Treatment , a hazardous location in a built-up area is defined as a road section up to 100 meters in length where at least six traffic accidents with consequences for persons have occurred over a period of three consecutive years. Since the required number of accidents within the three-year period has been recorded at the observed location, the normative condition for identifying a hazardous location has been fulfilled. The spatial concentration of accidents covers a section approximately 138 meters in length. The measurement of this section was performed by determining the distance between the outermost accident locations, i.e., between the first and the last recorded accident. In order to define a single hazardous zone, an analysis of the distances between consecutive accident locations was conducted. The results showed that all recorded accidents are located in close spatial proximity, without significant gaps in their distribution along the observed road section. The criterion for grouping acci-

Figure 6. Identification of Hazardous Locations

dent locations into a single hazardous zone was based on spatial continuity. Accident locations were considered part of the same zone if they formed a continuous spatial sequence without pronounced gaps that would indicate the existence of separate and independent locations. Based on this approach, a continuous spatial cluster of accidents was identified, representing a functionally connected zone in which accidents occur under similar infrastructural and traffic conditions. Although the Rulebook prescribes a maximum length of 100 m, previous research indicates that hazardous locations should not be defined strictly by fixed geometric limits, but rather by spatial clustering and functional homogeneity of accidents . Therefore, the analyzed section was defined as a single hazardous location, as it represents a continuous and unified risk zone. The location is shown in **Figure 6**.

Public risk

In order to more precisely assess the severity and intensity of traffic accidents on the observed section, relative indicators of public and traffic risk were calculated for the period 2020–2022.

The analysis of relative indicators of public and traffic risk indicates an upward trend in safety indicators during the observed period. The increase in public risk of participation and public risk of casualties per 10,000 inhabitants, as well as the growth of traffic risk in relation to the number of registered vehicles, indicate a deterioration of the safety situation on the observed section. For the purpose of assessing the severity and intensity of traffic accidents on the observed section, relative indicators of public and traffic risk were defined for this research.

Public risk (PR) is defined as the ratio of the number of traffic accidents (by structure) and the number of casualties (by structure) per 10,000 inhabitants of the City of Laktasi, i.e., it represents the risk for each resident to be involved in a traffic accident or to suffer consequences from a traffic accident per 10,000 inhabitants (period 2020–2022).

Public risk of participation in traffic accidents:

PR_n = number of accidents × 10,000 / population = 56 × 10,000 / 34,210 = 16 accidents (per 10,000 inhabitants)

Total public risk of casualties or probability of injury for residents of Laktasi per 10,000 inhabitants:

PR_s = number of casualties × 10,000 / population = 28 × 10,000 / 34,210 = 8 casualties (per 10,000 inhabitants)

Public risk by consequence structure:

PRs_i = (22 × 10,000) / 34,210 = 6 persons (per 10,000 inhabitants)

PR_{si} = (6 × 10,000) / 34,210 = 2 persons (per 10,000 inhabitants)

During the observed period, no fatal outcomes were recorded; therefore, the public risk of fatality is equal to zero.

PR_n (2020) = (42 × 10,000) / 34,210 = 12 persons

PR_s (2020) = (5 × 10,000) / 34,210 = 1 person

PR_n (2021) = (54 × 10,000) / 34,210 = 16 persons

PR_s (2021) = (8 × 10,000) / 34,210 = 2 persons

PR_n (2022) = (73 × 10,000) / 34,210 = 21 persons

PR_s (2022) = (15 × 10,000) / 34,210 = 4 persons

The obtained results indicate that, in the observed three-year period, the public risk of participation in traffic accidents amounted to 16 accidents per 10,000 inhabitants, while the public risk of casualties amounted to 8 persons per 10,000 inhabitants.

Observed by year, a continuous increase in the public risk of participation is evident, from 12 in 2020 to 21

in 2022. A similar trend is observed for the public risk of casualties, which increased from 1 in 2020 to 4 in 2022.

The structure of consequences shows that slight injuries dominate (6 per 10,000 inhabitants), while serious injuries are significantly less represented (2 per 10,000 inhabitants). No fatal outcomes were recorded during the observed period, which positively affects the overall safety assessment of the section.

Traffic risk (TR) is defined as the ratio between the number of traffic accidents and the number of registered vehicles per 1,000 registered vehicles, i.e., it represents the risk of vehicle involvement in traffic accidents in relation to the level of motorization.

The formula is:

TR = (Number of accidents × 1,000) / Number of registered vehicles

Total traffic risk (2020–2022)

Total number of registered vehicles (sum):

17,442 + 18,410 + 19,194 = 55,046

TR_n = (169 × 1,000) / 55,046 = 3 accidents (per 1,000 registered vehicles)

TR_s = (28 × 1,000) / 55,046 = 1 casualty (per 1,000 registered vehicles)

TR_n (2020) = (42 × 1,000) / 17,442 = 2 accidents (per 1,000 registered vehicles)

TR_s (2020) = (5 × 1,000) / 17,442 = 0 casualties (per 1,000 registered vehicles)

TR_n (2021) = (54 × 1,000) / 18,410 = 3 accidents (per 1,000 registered vehicles)

TR_s (2021) = (8 × 1,000) / 18,410 = 0 casualties (per 1,000 registered vehicles)

TR_n (2022) = (73 × 1,000) / 19,194 = 4 accidents (per 1,000 registered vehicles)

TR_s (2022) = (15 × 1,000) / 19,194 = 1 casualty (per 1,000 registered vehicles)

The obtained results indicate a gradual increase in the traffic risk of vehicle involvement in traffic accidents during the observed period 2020–2022. The traffic risk of participation increased from 2 accidents per 1,000 registered vehicles in 2020 to 4 accidents in 2022, indicating a deterioration of safety indicators in relation to the level of motorization. Although the number of registered vehicles increased year by year, the growth in the number of traffic accidents was more pronounced, which led to an increase in relative risk.

The traffic risk of casualties, observed in relation to the number of registered vehicles, remains relatively low in all three years of analysis. In 2020 and 2021, the values were below one casualty per 1,000 registered vehicles, while a slight increase was recorded in 2022. However, the absence of fatal outcomes during the observed period indicates that, although the frequency of accidents increased, the severity of consequences did not reach a critical level.

Overall, the traffic risk on the Laktasi – Klasnice 1 road section can be assessed as moderate, but with a clearly noticeable upward trend, indicating the need for timely implementation of preventive and infrastructural measures in order to stabilize and reduce the risk in the coming period.

DISCUSSION OF RESULTS

The results of the analysis indicate a continuous increase in the number of traffic accidents on the observed road section during the period 2020–2022, with the most significant increase recorded in 2022. Although no fatal traffic accidents were recorded, the increase in the number of accidents involving injured persons indicates a deterioration in safety indicators. It should be noted that the year 2020 included a period of restricted movement due to the COVID-19 pandemic, which may have influenced reduced traffic volume and a lower number of recorded accidents. However, the increase observed in 2022 cannot be explained solely by the normalization of traffic flows. When relative indicators are considered, the public risk of participation increased from 12 to 21 accidents per 10,000 inhabitants, while the public risk of casualties increased from 1 to 4 persons per 10,000 inhabitants. These indicators suggest an increased exposure of the local population to traffic risk. Traffic risk, observed in relation to the number of registered vehicles, also shows an upward trend, indicating that the increase in the number of accidents is not exclusively a consequence of motorization growth, but also of the structural characteristics of the road section. Spatial analysis confirms that accidents are not evenly distributed, but rather concentrated in the urban segment of the section, where infrastructural complexity and traffic interactions are most pronounced. Similar findings have been reported in previous studies, which indicate that human factors represent the dominant cause of traffic accidents, accounting for the majority of crash occurrences ,. However, numerous studies also emphasize the significant role of infrastructural characteristics, particularly in urban environments with a high density of access points and mixed traffic conditions . The analyzed section exhibits these characteristics, including multiple direct access points, the presence of pedestrian crossings, a bus stop zone, and high traffic intensity, which together increase the number of conflict points and the likelihood of accidents. This is further supported by the calculated access density of approximately 32.5 access points per kilometer, which can be considered very high for a road with a dominant transit function, as also indicated in previous research on access management. The identified hazardous location accounts for a significant share of the total number of accidents involving injured persons, indicating the need for targeted infrastructural and organizational interventions. The observed upward trend in public and traffic

risk indicates that the safety problem on the observed section has a continuous character rather than representing isolated incidents. The combination of increased population exposure to risk, the rise in the number of accidents relative to the level of motorization, and the spatial concentration in the urban sector points to structural deficiencies in traffic organization and the access system to the main road. The obtained results are consistent with previous research, which emphasizes the significant influence of infrastructural characteristics on traffic accident occurrence, **.** Research conducted in the Western Balkan region indicates that road sections with intensive linear development, a high density of direct access points, and mixed traffic conditions represent locations with an increased safety risk due to the higher number of conflict points . The analyzed location in this study exhibits these characteristics, including multiple direct access points, the presence of a bus stop, pedestrian crossings, and high traffic intensity. Such conditions lead to frequent interactions between vehicles and vulnerable road users, which increases the probability of traffic accidents. A limitation of the study is the absence of traffic volume data (AADT), which restricts the possibility of calculating exposure-based risk indicators and performing a more precise risk assessment. This limitation is consistent with previous studies which emphasize the importance of traffic exposure data . In addition, the accuracy of spatial analysis depends on the precision of the geolocation data of traffic accidents. Although more advanced spatial analysis methods, such as kernel density estimation, can provide more precise identification of accident clusters, the applied GIS-based approach is considered sufficient for the scope and objectives of this research. Overall, the results indicate that the increase in traffic risk is not caused by a single factor, but rather by the combined influence of infrastructural characteristics, traffic flow conditions, and road user behavior, which confirms the need for a comprehensive approach to road safety improvement.

PROPOSED MEASURES FOR IMPROVING ROAD SAFETY

Based on the results of the analysis, the spatial concentration of accidents, and the identified hazardous location, the following road safety improvement measures can be defined:

Short-term measures – measures that can be implemented without significant financial investments, including: installation of shock absorbers (protective barriers) or relocation of public lighting poles further from the edge of the carriageway; rehabilitation and proper design of the beginnings and ends of guardrails; renewal of horizontal road markings (pedestrian crossings, edge lines); replacement of worn-out vertical signage and alignment with the current road classification; installation of traffic signage on access roads.

Medium-term measures – regulation or removal of unsignalized access roads; development of collector roads to reduce direct access to the main road; improvement of traffic organization in the zone of the identified hazardous location.

Long-term measures – permanent removal of roadside obstacles; construction of sidewalks along the urban section of the road; construction of bicycle lanes to protect vulnerable road users.

CONCLUSION

The conducted road safety analysis on the Laktasi – Klasnice 1 section of the main road indicates a clear trend of deterioration in safety parameters during the observed period. Although no fatal outcomes were recorded, the increase in the number of accidents and the growth of relative risk indicators point to increased exposure of road users and greater severity of consequences on this section. Relative indicators of public and traffic risk confirm that the increase in the number of accidents is not solely a result of increased motorization, but is also related to the structural characteristics of the section. In particular, the urban segment of the road, characterized by the presence of access points, pedestrian crossings and mixed traffic conditions, creates increased interaction between traffic streams and consequently a higher number of conflict situations. The spatial analysis enabled the identification of a hazardous location that meets the regulatory criteria and represents a priority for intervention. The results indicate that the identified safety problems are not isolated, but reflect typical patterns observed on urbanized road sections with combined transit and local access functions, which is consistent with findings reported in previous studies , . Furthermore, the application of spatial analysis methods proved to be an effective tool for identifying accident concentration zones, as confirmed in recent research , . The obtained results indicate that the safety problem has a systemic nature and requires a coordinated approach that includes infrastructural, organizational, and preventive measures. This paper provides a professional basis for planning further activities aimed at stabilizing and reducing risk on the observed road section, as well as a contribution to understanding similar safety issues in comparable traffic environments.

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