Analysis of Traffic Accident Rates in the Czech Republic

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***Abstract*—This article presents an analysis of traffic accident rates in the Czech Republic, utilizing a comprehensive dataset from the official website of the Police of the Czech Republic. The primary objective is to identify patterns and trends in traffic accidents through the implementation of a web application developed using Oracle Application Express (APEX). The application allows for interactive and detailed visualization of accident data, focusing on time trends, weather conditions, and the presence of intoxicating substances. Key findings include the identification of peak accident periods, the impact of adverse weather, and the significant role of alcohol and drugs in traffic incidents. The study aims to contribute valuable insights for improving road safety measures in the Czech Republic.**

I. Introduction

The very rapid development in the field of information technologies has become an irreplaceable part of our lives. That is why many companies seek for young professionals, who are able to adapt to new or various changing trends very fast. One of the most affected subjects of these increasing changes are also the universities, which educate future experts in IT sector and various data specialists.

Data analysis plays a very important role in many currently developed information systems [3], [4], [7], [8], [17]. The amount of data needed to be stored and processed has been rising very fast and thus, the attention of programmers and other scientifically oriented experts has been paid to the completely sophisticated spectrum of data science [5], [6], [9], [10]. Because of data analyzing necessity, the research project [20] has been implemented. Presented research is also a part on mentioned project. Its main idea is based on using advanced database technologies in sophisticated data analysis [11]–[19].

Traffic accidents remain a significant public safety concern, with substantial economic and social impacts. Analyzing traffic accident data is crucial for understanding the underlying causes and for developing effective prevention strategies. This paper focuses on the traffic accident rates in the Czech Republic, leveraging data from the Police of the Czech Republic's open-access platform. The dataset includes detailed records of traffic accidents, GPS coordinates, vehicle information, accident consequences, and pedestrian involvement. By developing a web application using Oracle Application Express (APEX), we aim to provide a user-friendly interface for exploring this extensive dataset. This application facilitates the identification of trends and patterns in traffic accidents, thereby supporting the development of targeted road safety measures. You can access the application by this link here: https://bit.ly/3R9aP3a. [2]

II. Description of available dataset

The primary source of the traffic accident data is the official website of the Police of the Czech Republic. [1] This platform provides open access to detailed records of traffic accidents that occur within the country.

These data are structured into five main files: traffic accidents, GPS coordinates, vehicles, consequences, and pedestrians. Each file contains information relevant to its respective topic, collectively forming a comprehensive picture of the traffic situation in the Czech Republic.

- **Traffic accidents**
  The dataset of traffic accidents provides information about individual accidents, including location, time, accident type, number of injuries and fatalities, as well as the main causes of the accidents.
- **GPS Coordinates**
  This file contains geographic coordinates of the locations of traffic accidents. These data enable precise mapping of accident sites and their geographical distribution, which is important for identifying high-risk areas and planning safety measures.
  The coordinates are published in the S-JTSK (Súradnicový systém Jednotnej Trigonometrickej Siete Katastrálnej) coordinate system, which is not widely recognized or used. This coordinate system was primarily implemented for the territory of the former Czechoslovakia. Since displaying these coordinates on a map in Oracle APEX is not possible, a transformation into coordinate system WGS-84 will be necessary.
- **Vehicles**
  The vehicle data includes information about vehicles involved in traffic accidents, such as vehicle type, manufacturer, year of manufacture, and vehicle condition. These data allow for the analysis of characteristics of vehicles involved in accidents and identification of possible risk factors associated with vehicles.
- **Consequences**
  The dataset on accident consequences includes information about injuries and fatalities resulting from accidents as well as the other consequences. These data are im-

portant for assessing the severity of accidents and the effectiveness of healthcare provided.

- **Pedestrians**
  Pedestrian data contains information about participants in traffic accidents who were pedestrians. These data include pedestrian category, age, gender, nationality, and other characteristics. Analyzing these data can help identify high-risk pedestrian groups and develop measures to protect them.

III. Implementation of the Oracle APEX Application for Traffic Accident Rates Analysis

To facilitate the analysis of the traffic accident data, we developed a web application using the Oracle Application Express (APEX) platform. This application provides a user-friendly interface for examining the extensive dataset of traffic accidents in the Czech Republic. The primary goal of this application is to enable detailed and interactive analyses of the available data through various visualization techniques.

The application contains three important pages, each focused on a specific aspect of the data:

- Time Trends
- Weather Conditions
- Presence of Intoxication Substances

The application utilizes a range of visualization techniques, including line charts, bar charts and heatmaps, to present the data in an easily interpretable format. These visual tools enable users to quickly identify patterns and correlations within the data, facilitating a deeper understanding of the factors influencing traffic accidents.

In the following chapters, we will describe the results of the analyses conducted using this Oracle APEX application. Each chapter will provide insights and interpretations of the data. By presenting these analyses, we aim to contribute valuable knowledge to the field of traffic safety and support the development of effective measures to reduce traffic accidents in the Czech Republic.

IV. Analysis of Time Trends in Traffic Accident Rates

"The Time Trends" page deals with the statistical analysis of traffic accidents concerning time data. This allows users to delve deeper into the provided data to uncover time patterns and trends that may indicate certain regularities or irregularities in the occurrence of traffic accidents. The page ensures a comprehensive view of the frequency of traffic accidents across various time intervals and different regions of the Czech Republic. In the following charts, we have analyzed time trends across the entire Czech Republic for the year 2023.

A. Daily Traffic Accident Counts

"The Time Trends" section features an interactive line graph showing daily traffic accident counts, influenced by filter settings.

At first glance, it is possible to notice oscillations on this linear graph – regular rises and falls in the number of traffic accidents. These daily fluctuations are clearly depicted and provide insight into the variability of accident rates. After a detailed analysis of this graph, we identified that the minimum values of accident counts, which are noticeably lower than other days, consistently fall on Sundays. This finding suggests a lower frequency of traffic accidents on Sundays, which can be explained by a lower level of travel activity on this day compared to weekdays.

To smooth out these short-term fluctuations and better display long-term trends, the graph is complemented by a moving average. This moving average is shown on the graph as a smooth line that runs through the middle of the daily data, allowing for better visualization and interpretation of long-term changes in the number of accidents. This approach is particularly useful for identifying trends that might be overlooked when only looking at raw daily data.

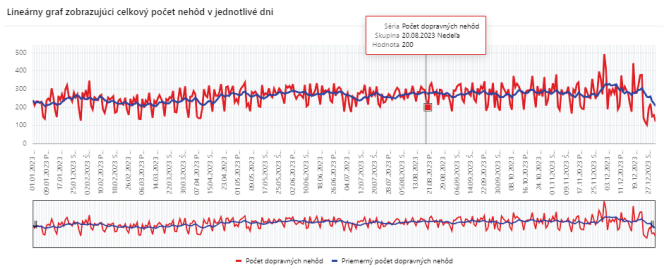

Fig. 1. Daily Traffic Accident Counts Chart

B. Weekly and Monthly Traffic Accident Counts

The second graph on the page is a bar chart displaying the total number of traffic accidents divided by days of the week. Each bar represents one day of the week, from Monday to Sunday, showing the number of accidents that occurred on that day. The graph is supplemented by a line chart that shows the average number of accidents for each day of the week over the period from 2017 to 2023.

From the analysis of the number of accidents by days of the week, it was found that Fridays are the most critical days with the highest number of accidents, reaching 15,616 accidents in 2023. Fridays also have the highest average number of accidents for each day of the week over the period from 2017 to 2023. This indicates that Fridays are consistently the most dangerous days of the week.

Sundays, on the other hand, represent the days with the lowest number of accidents, consistent with the average number of accidents for Sundays over the given period. This regularity in low counts suggests that Sundays are relatively safer on the roads.

Daily fluctuations indicate higher accident rates during weekdays, peaking on Fridays, which may be related to higher traffic volumes and more frequent vehicle use before the weekend.

The third graph provides an overview of the number of traffic accidents divided by months of the year. Each bar in the graph represents one month, from January to December,

showing the number of accidents that occurred in that month. The graph is again supplemented by a line chart that shows the average number of accidents for each month over the period from 2017 to 2023.

The analysis of the number of accidents by months of the year revealed that August and October are the months with the highest number of accidents, with August reaching 8,591 and October 8,728 accidents in 2023. These months also have high average numbers of accidents for the years 2017 to 2023, indicating that they are consistently periods with increased risk.

The lowest number of accidents was recorded in February, corresponding with the average data (6,457 in 2023 compared to an average of 6,912.429). This month may have a lower number of accidents due to its shorter length or a possible reduction in mobility during the winter period.

In order to take into account the number of days in a month, we normalized this data according to the number of days in a month. After normalization, February was still the month with the lowest rate of traffic accidents.

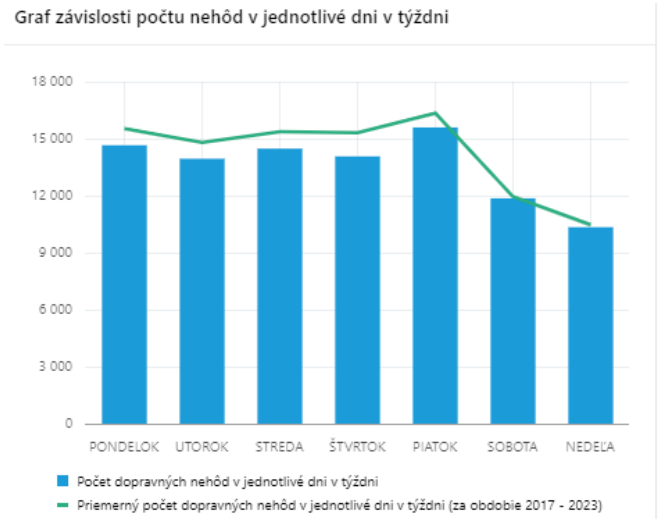

Fig. 2. Weekly Traffic Accident Counts Chart

C. Hourly Traffic Accident Distribution

Another graph on the page illustrates the distribution of traffic accidents throughout the day, with values for each hour. This graph helps identify times with the highest risk of traffic accidents. As with the previous graphs, a line chart is added, showing the average number of accidents for each hour over the period from 2017 to 2023.

Analysis of the graph showing the number of accidents by hour of the day revealed interesting trends. The graph shows that the lowest number of accidents is recorded in the early morning hours (between 2:00 AM and 4:00 AM). There is then a significant increase in accidents starting around 5:00 AM and continuing into the afternoon, peaking between 1:00 PM and 3:00 PM.

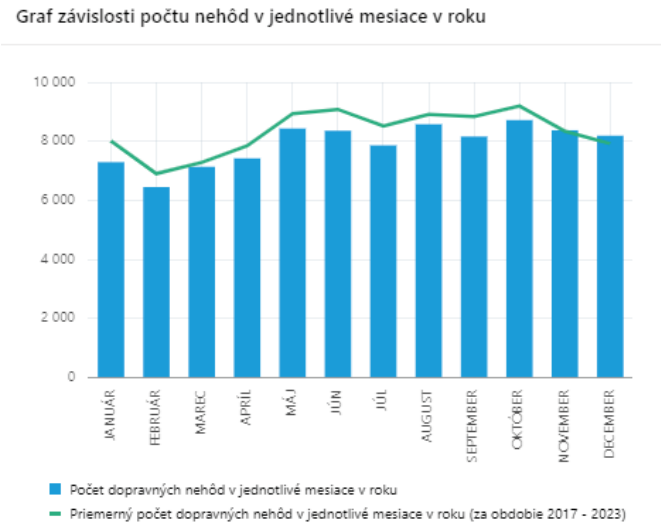

Fig. 3. Monthly Traffic Accident Counts Chart

After 3:00 PM, the number of accidents gradually decreases but remains relatively high until 7:00 PM. In the evening hours, the number of accidents drops again, with the fewest accidents occurring at night. This trend is consistent with the average accident counts for the period from 2017 to 2023, which show a similar daily pattern.

The line chart of the average number of accidents clearly shows that morning and afternoon hours are the most critical periods, with the highest number of traffic accidents. The peak average number of accidents at 3:00 PM indicates that this hour represents an especially dangerous time for drivers.

This analysis highlights the need for increased caution and potentially additional safety measures at certain times of the day.

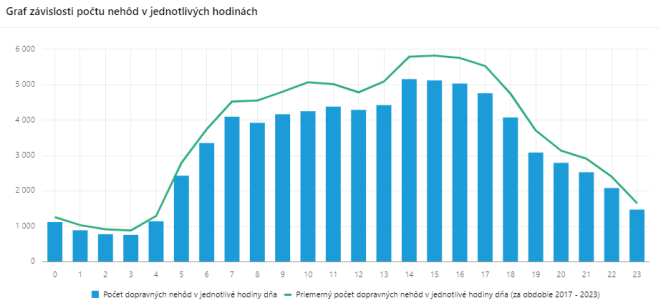

Fig. 4. Hourly Traffic Accident Distribution Chart

D. Parameter Dependency on Day of the Week and Month

On “The Time Trends” analysis page, you can find also an interactive pie chart that displays the dependence of the selected traffic accident parameter on the day of the week and the month of the year. This chart is specifically designed to provide a visual overview of the distribution of traffic accidents based on the selected parameter, regardless of the

page's applied filters, meaning it shows data for the entire available period.

Users have the option to select various parameters for analysis, such as the type of accident, the main causes of the accident, or the presence of intoxicants. Additionally, they can specify whether they want to display data for a specific day of the week, month of the year, or a combination of both. This flexibility allows users to change their perspective on the data, making the chart a powerful tool for deeper analytical work.

Thanks to its interactivity, users can quickly understand how the share of individual accident categories changes depending on the selected parameters, which is particularly useful for identifying trends or significant deviations in accident distribution. This chart not only provides a comprehensive summary but also enables dynamic exploration of the impact of various factors on traffic accidents.

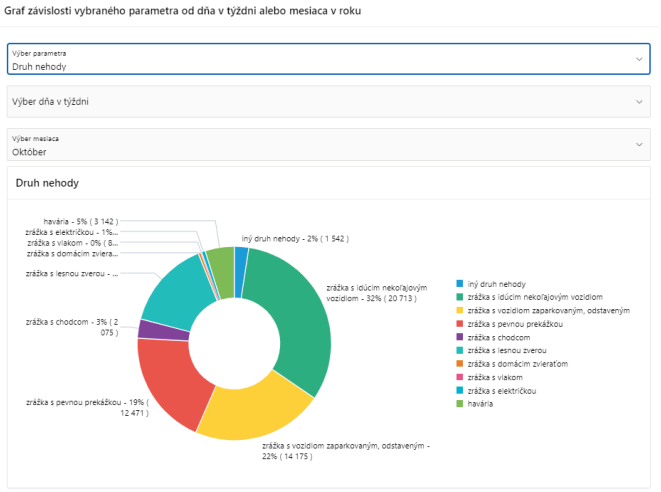

Fig. 5. Parameter Dependency on Day of the Week and Month Chart

E. Heat Maps of Average Traffic Accident Count

At the end of the time trends analysis, there are two heatmaps that visualize the average number of traffic accidents depending on the hour of the day within the week and the average number of traffic accidents depending on the hour of the day and the month of the year. These heatmaps are independent of the filters applied on the page, ensuring they provide data for the entire territory of the Czech Republic and can display information for individual years or the average number of accidents for the entire analyzed period.

The first heatmap is organized so that the columns represent individual hours (0-23) and the rows correspond to days of the week (Monday to Sunday). This arrangement allows us to quickly and efficiently identify patterns in the time distribution of traffic accidents.

The data analysis revealed several interesting patterns. During weekdays (Monday to Friday), there is a noticeable increase in the number of accidents in the early morning hours around 6 and 7 AM, corresponding to morning rush hours. The highest number of accidents occurs between 2 PM and 5 PM, matching the afternoon peak hours. Interestingly, the lowest number of accidents is during the nighttime between midnight and 4 AM, reflecting lower travel activity.

In contrast to weekdays, on weekends (Saturday and Sunday), the distribution of accidents throughout the day is relatively more even, with a higher number of accidents during the day and slightly fewer during the nighttime. This pattern may indicate different travel behaviours on weekends when people travel more for recreation or social activities.

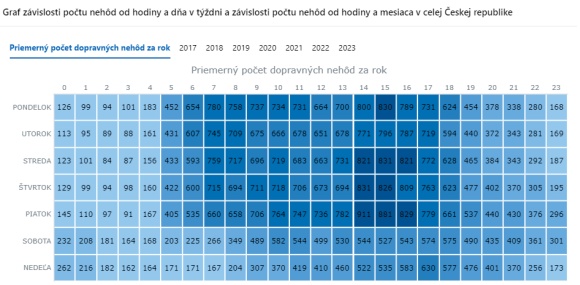

Fig. 6. Heat Maps of Average Traffic Accident Count (Hour/Day of the week)

The second heatmap on the time trends analysis page illustrates the dependence of the number of traffic accidents on the month of the year and the hour of the day. The heatmap is arranged so that the columns represent individual hours of the day (0-23), while the rows display the months of the year from January to December. This visual tool allows us to easily identify patterns and trends in accident rates based on time and season.

The data analysis revealed several patterns indicating seasonal fluctuations and daily peaks in the number of accidents. The number of accidents peaks in May, June, August, and September, which may be partially due to longer daylight hours and people spending more time outdoors, including during the evening and night. Conversely, February has the lowest number of accidents, likely related to lower travel activity during the winter months.

In each month, there is a significant increase in the number of accidents in the early morning hours around 7 AM, corresponding to the morning rush hour. Another significant increase occurs between 4 PM and 6 PM, aligning with the afternoon peak. This pattern is consistent throughout the year.

The number of accidents significantly decreases during the night hours, especially after 10 PM, which is associated with reduced travel activity. During the winter months, this decrease is even more pronounced, likely due to earlier nightfall and fewer nighttime activities. The minimal number of accidents is recorded in the late-night hours around 3 and 4 AM.

Summer months with longer daylight not only show a higher overall number of accidents but also a distribution of accidents into later evening hours compared to winter months, where most accidents are concentrated during hours with sufficient daylight.

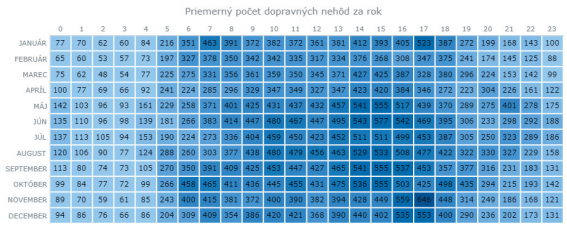

Fig. 7. Heat Maps of Average Traffic Accident Count (Hour/Month)

V. Analysis of Traffic Accident Rates Based on Weather Conditions

"The Weather Conditions" page focuses on analyzing the impact of various meteorological factors on traffic accidents. Similar to the Time Trends page, this page offers interactive graphs and heatmaps that allow users to explore in depth how different weather conditions affect the frequency of traffic accidents.

Each chart and heatmap on the page is dynamic, meaning they automatically update based on the selected filters. Additionally, dynamic descriptions provided along with the graphs explain the displayed data and highlight key insights, enhancing the informativeness of the analysis.

The interactive elements and comprehensive explanations make this page a powerful tool for understanding the relationship between weather conditions and traffic accidents, helping users identify trends and patterns that can inform safety measures and policy decisions.

A. The Impact of Weather Conditions on Traffic Accidents

We first focused on analyzing the impact of weather conditions on traffic accidents. An interactive pie chart is displayed on the page, presenting the distribution of traffic accidents according to various weather conditions. The chart reveals the percentage of accidents that occurred under each weather condition in the Czech Republic for the year 2023.

The analysis of the provided data shows that the largest portion of accidents (86%) occurred under normal conditions. This may indicate that the vast majority of traffic accidents are not directly related to weather factors, or that drivers are more cautious in adverse weather.

Accidents that occurred during or immediately after rain (including light rain and drizzle) account for 5% and 4% of all accidents, respectively. This suggests that the change in driving conditions caused by wet roads can increase the risk of accidents.

Interestingly, accidents during snowfall constitute only 2% of all cases. This could be due to reduced driving speeds and increased caution by drivers in such conditions, or the lower frequency of these weather conditions throughout the year compared to rain.

Conditions such as ice and frost, fog, and strong winds represent a smaller proportion of accidents, indicating that these conditions are less common or that drivers adjust their behavior on the road accordingly. The results suggest that improving road safety should also focus on driving conditions not directly related to weather influences.

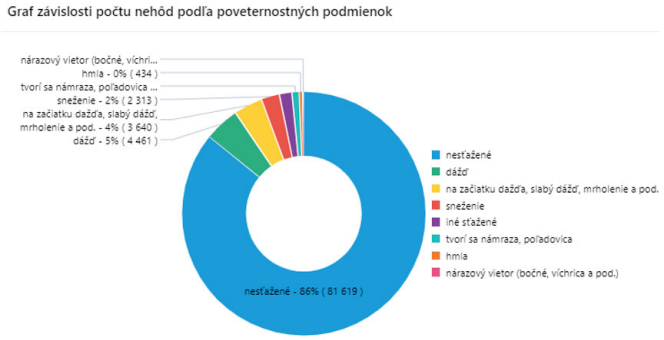

Fig. 8. The Impact of Weather Conditions on Traffic Accidents Chart

B. Dependency of Weather Conditions on the Month of the Year

Another graph on this page is a bar chart that presents the number of traffic accidents occurring under selected weather conditions across different months of the year. The graph illustrates the number of traffic accidents that occurred during fog in each month of the year for the entire period of our available data.

The analysis reveals that in January, there were 691 accidents, a high number compared to the rest of the first half of the year. From February to August, there is a significant decrease in fog-related accidents, with the lowest numbers in April and May. This trend suggests that during warmer months and periods with longer daylight hours, the occurrence of fog and related accidents is lower. The increase in accidents in September indicates probable changes in weather conditions, as the likelihood of fog increases with the arrival of autumn. The highest number of fog-related accidents is recorded in October and November, indicating that foggy days are more frequent and potentially more dangerous for drivers in these months. In December, the number of accidents is lower but still relatively high compared to the summer months.

The graph highlights the need for increased caution and adjustment of driving speeds by drivers during the autumn and winter months when the risk of accidents in foggy conditions is heightened.

C. Localization of Traffic Accidents Based on Weather Conditions

Another component of the page is a heatmap that visualizes the localization of traffic accidents across the Czech Republic, depending on weather conditions. This type of map provides a clear graphical representation of accident density, where darker and more intense colors indicate a higher number of accidents in a given location.

The heatmap highlights areas with the highest incidence of accidents, thus identifying potentially dangerous road sections.

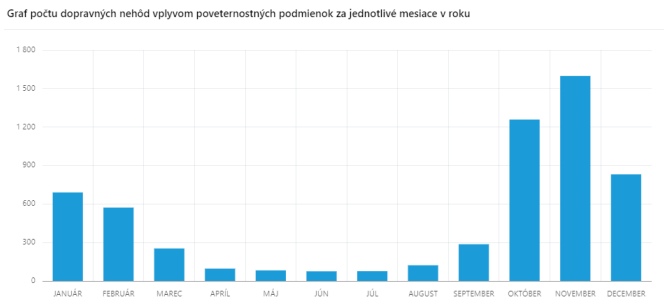

Fig. 9. Dependency of Weather Conditions on the Month of the Year Chart

Evaluating the heatmap enables the identification of high-risk zones where safety measures should be considered. Given that the map is based on weather conditions, it can aid in decision-making for road maintenance planning, especially during winter, or other intervention measures in case of extreme weather conditions.

For example, in areas with frequent foggy days, it would be prudent to consider the installation of lighting or warning signs.

The image displays a heatmap showing the distribution of traffic accidents that occurred during foggy conditions. Analysis has identified that the Ústí nad Labem Region exhibits an increased frequency of traffic accidents during fog compared to other regions in the Czech Republic. The density of points representing accidents in this area is significantly higher, which may indicate region-specific risk factors, such as more frequent meteorological conditions favorable for fog formation or complex road and terrain conditions that, combined with fog, increase the likelihood of accidents. Improving infrastructure, such as installing reflective traffic signs, early warning systems, and driver alerts, can help reduce the number of fog-related accidents in this area.

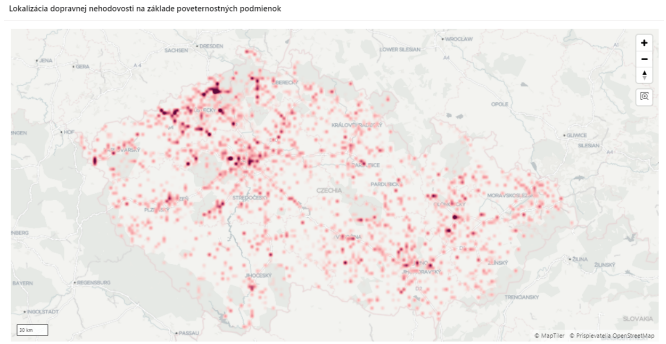

Fig. 10. Heatmap of Traffic Accidents Based on Weather Conditions

D. Dependency of Weather Conditions and Road Surface State on Selected Traffic Accident Parameters

The conclusion of the "The Weather Conditions" page is dedicated to two pie charts that illustrate the dependence of weather conditions or road surface state on selected traffic accident parameters.

The first chart displays the distribution of traffic accidents by type that occurred during rain. It is evident that the most common accident type in rainy weather is a collision with a fixed object, accounting for more than one-third of all accidents, followed by collisions with parked vehicles. This indicates an increased risk of losing control of the vehicle and crashing into fixed objects during rain.

The second chart illustrates the distribution of traffic accidents by type that occurred on untreated roads where ice had formed at the time of the accident. The chart shows that collisions with fixed objects are the most frequent type of accident under these road conditions, highlighting the high risk of losing control on icy roads. The second most common type is collisions with moving non-rail vehicles, followed by collisions with parked or stopped vehicles. There were 1,759 instances of crashes, a significant number, indicating that the risk of serious incidents on icy roads is high.

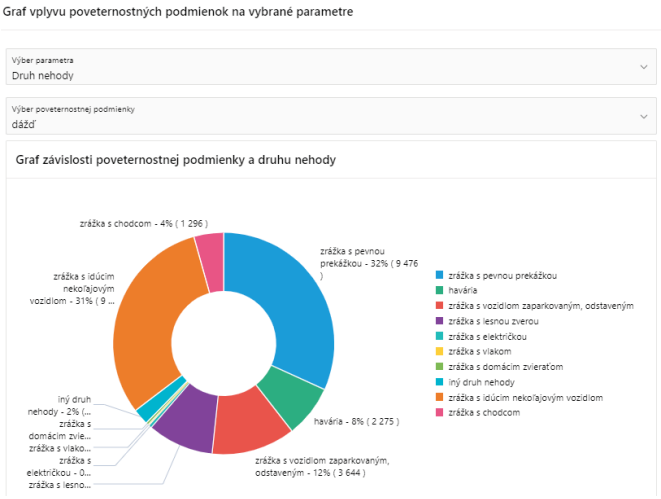

Fig. 11. Dependency of Weather Conditions on Selected Traffic Accident Parameters Chart

VI. Analysis of Traffic Accident Rates Based on Presence of Intoxication Substances (Alcohol and Drugs)

The "The Presence of Intoxicating Substances" page is dedicated to analyzing the impact of intoxicating substances on traffic accidents in the Czech Republic. Similar to previous analytical pages, users have access to filters allowing the selection of date range (from date and to date) and geographic area (region). The goal is to provide an overview of how the consumption of intoxicating substances such as alcohol or drugs affects road safety. Interactive elements of the page, such as charts and heatmaps, assist users in analyzing specific patterns and trends related to the presence of intoxicating substances in accidents.

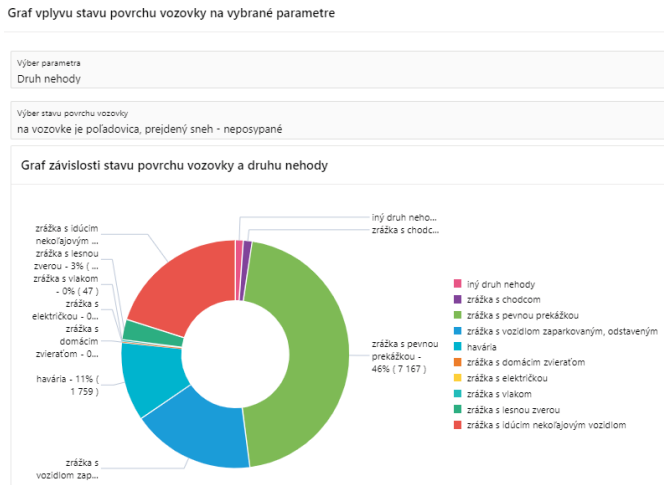

Fig. 12. Dependency of Road Surface State on Selected Traffic Accident Parameters Chart

A. Daily Number of Traffic Accidents Caused by Intoxicating Substances

The first element on this page is an interactive line graph visualizing the daily number of traffic accidents caused by intoxicating substances.

In the image, we can see this graph zoomed in for the period from 2021 to 2023. The graph exhibits significant oscillations with clear peaks, representing days with a higher number of accidents. These fluctuations suggest certain patterns regarding the occurrence of accidents involving intoxicating substances.

Upon closer analysis of the graph, we observe that from 2017 to the present day, there is not a single day without a traffic accident caused by intoxicating substances. This highlights the constant presence of this issue on the roads.

Another notable finding is that the maximum values, indicating days with the highest number of traffic accidents, always fall on weekends, especially on Saturdays. This trend may indicate a higher likelihood of intoxicating substance consumption during weekends, consequently leading to an increased number of traffic accidents.

The consistent occurrence of traffic accidents every day and peaks during weekends reveal critical periods when preventive and enforcement measures should be strengthened, along with increased awareness of the risks of driving under the influence.

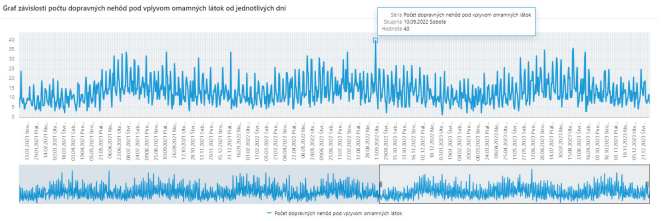

Fig. 13. Daily Number of Traffic Accidents Caused by Intoxicating Substances Chart

B. Impact of the Presence of Intoxicating Substances on Traffic Accident Rates

The second graph on the Presence of Intoxicating Substances page is an interactive pie chart that illustrates the distribution of traffic accidents based on whether the drivers were under the influence of intoxicating substances. It is divided into three sections, showing the number of accidents where the driver was under the influence of intoxicating substances, where the driver was not under the influence, and where the presence of intoxicating substances was not determined.

The image displays this chart, showing the number of accidents in each category for the entire observed period, from 2017 to 2023.

The analysis of this graph reveals that in more than half of the accidents, it was not determined whether the drivers were under the influence of intoxicating substances. This may indicate potential shortcomings in police procedures or data recording practices. The fact that such a high proportion of accidents lack this crucial information could impact the accuracy of analyses and accident prevention strategies.

The noticeable number of accidents caused by drivers under the influence of intoxicating substances underscores the importance of continuous education about the dangers of driving in such a state and the need for stronger measures to detect and penalize such drivers.

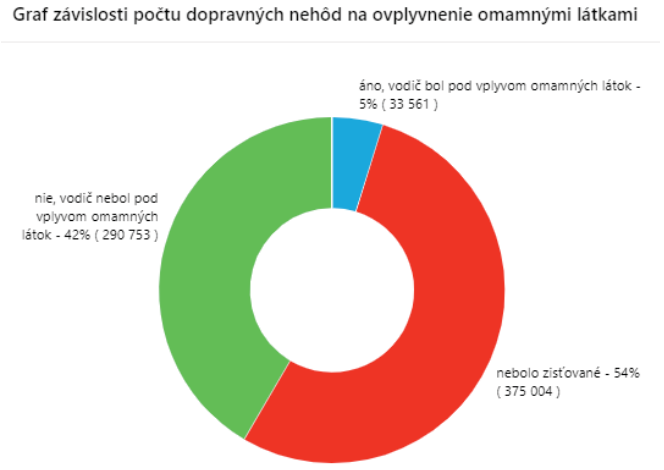

Fig. 14. Impact of the Presence of Intoxicating Substances on Traffic Accident Rates Chart

C. Number of Traffic Accidents Caused by the Influence of Intoxicating Substances on Different Days of the Week

Another graph on this page is a combined bar and line chart that provides two visualizations: a line chart showing the daily number of traffic accidents caused by the influence of intoxicating substances, and a bar chart that distinguishes the characteristics of the presence of intoxicating substances for each day of the week.

The image shows the number of accidents for the entire observed period, which means from 2017 to 2023 inclusive.

Analysis of the line chart reveals clear oscillations with high peaks, primarily concentrated on weekends, with a maximum on Saturdays. This trend may indicate an increasing likelihood of involvement in traffic accidents under the influence of intoxicating substances during leisure days, when people are more likely to engage in social activities where they may consume alcohol or other intoxicating substances.

Regarding the bar chart, we see that the highest number of accidents caused by drivers with a blood alcohol content over 1.5 ‰ occurs on Saturdays and Sundays, again confirming the trend of increased risk of accidents during the weekend. Interestingly, there is also a relatively high number of accidents on Mondays associated with higher alcohol levels, which may indicate irresponsible behavior by drivers even after weekend activities. Across all days, there is a relatively stable participation in accidents caused by drug influence, as well as accidents where the blood alcohol content was less than 0.8 ‰. The most critical days for accidents associated with higher blood alcohol content are those following days off, such as Friday and Saturday, when people are most likely to gather.

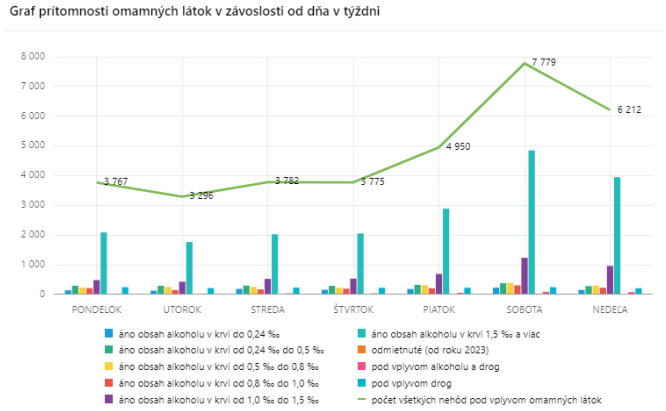

Fig. 15. Number of Traffic Accidents Caused by the Influence of Intoxicating Substances on Different Days of the Week Chart

D. Number of Traffic Accidents Caused by the Influence of Intoxicating Substances in Different Months of the Year

This interactive bar chart provides an overview of the number of traffic accidents caused by the influence of intoxicating substances in each month of the year. The chart displayed in the image represents data from the entire observed period, from 2017 to 2023.

At first glance, the chart clearly shows that the number of traffic accidents gradually increases as the summer season approaches, peaking in July when the highest number of accidents is recorded. Summer months see increased social activity, with people frequently attending various events and spending more time away from home, which may contribute to the higher incidence of traffic accidents caused by the influence of intoxicating substances. Following July, there is a gradual decline, but the numbers remain higher compared to the beginning of the year.

In the winter months, such as January and February, the number of these traffic accidents is lower. This could indicate that colder weather and poorer road conditions may deter people from excessive drinking or using intoxicating substances before driving, or people are generally more cautious when driving in winter conditions. Conversely, the decline in the number of accidents in November and December, despite the holiday season when an increase in social activities might be expected, could suggest the effectiveness of preventive campaigns and police checks during this period.

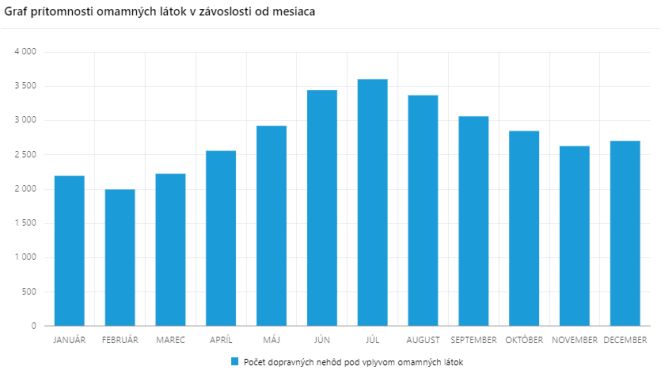

Fig. 16. Number of Traffic Accidents Caused by the Influence of Intoxicating Substances in Different Months of the Year Chart

E. Number of Traffic Accidents Caused by the Influence of Intoxicating Substances Throughout the Day

Another chart on our analytical page is a bar chart that provides an overview of the number of traffic accidents caused by the influence of intoxicating substances at different hours of the day. The chart reveals clear trends regarding the times of day when the highest incidence of traffic accidents caused by intoxicating substances occurs.

The chart shows that the fewest accidents caused by intoxicating substances happen in the early morning hours, particularly around 3:00 and 4:00 AM. This corresponds to a time when the roads are less busy, and most people are at home. The number of accidents then slightly increases in the early morning hours, indicating that some individuals may still be under the influence of alcohol from the previous night.

Throughout the day, the number of accidents remains relatively stable but starts to rise again around 1:00 PM, continuing with a significant increase into the evening hours. The highest number of accidents caused by intoxicating substances occurs between 6:00 PM and 8:00 PM, which corresponds to the time after work when people engage in social activities, such as dining at restaurants or attending parties, and then attempt to travel home.

F. Average Number of Traffic Accidents Caused by the Influence of Intoxicating Substances in Different Parts of the Day

To provide a more detailed examination of traffic accidents caused by the influence of intoxicating substances throughout

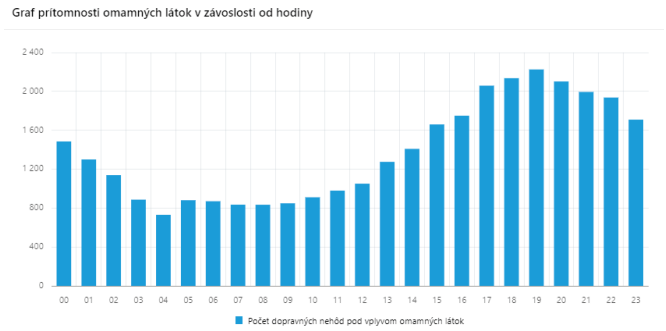

Fig. 17. Number of Traffic Accidents Caused by the Influence of Intoxicating Substances Throughout the Day Chart

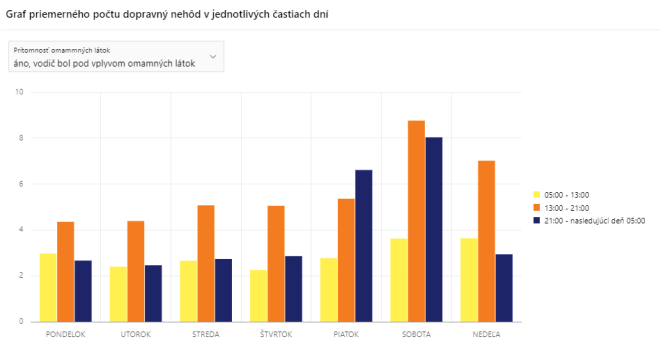

Fig. 18. Average Number of Traffic Accidents Caused by the Influence of Intoxicating Substances in Different Parts of the Day Chart

the week, another chart on this page displays this data. This bar chart shows the average number of traffic accidents caused by alcohol not only for each day of the week but also divides each day into three time segments: morning (5:00 AM - 1:00 PM), afternoon (1:00 PM - 9:00 PM), and nighttime (9:00 PM - 5:00 AM the next day). This breakdown allows users to observe how the likelihood of traffic accidents varies throughout the day and identify critical intervals.

The chart, which shows the average number of traffic accidents caused by intoxicating substances according to different parts of the day, reveals an interesting pattern in accident distribution. The results clearly indicate that the lowest average number of accidents occurs during the morning hours (5:00 AM - 1:00 PM), suggesting a lower probability of accidents due to residual alcohol from the previous night or early morning. The afternoon hours (1:00 PM - 9:00 PM) show a significant increase, which may be related to activities such as afternoon and evening social events. Notably, there is a marked increase on Fridays and Saturdays, continuing into the nighttime hours (9:00 PM - 5:00 AM the following day), indicating that the most critical period for alcohol-related accidents is at night during the weekends.

The highest average number of accidents is recorded during the nighttime hours on Fridays and Saturdays, reflecting the typical pattern of alcohol consumption peaking during weekend nightlife. The significant rise on Friday evening may indicate the start of the weekend, when people are more likely to visit bars, restaurants, and clubs, and various parties and celebrations may also take place. This trend continues and is even more pronounced on Saturday, with the highest average numbers of accidents, likely influenced by similar activities as on Friday.

G. Localization of Traffic Accidents Based on the Presence of Intoxicating Substances

At the end of the Presence of Intoxicating Substances page, there is a heatmap. This map provides a visualization of the distribution of traffic accidents in the Czech Republic where the driver was under the influence of intoxicating substances.

Analysis of the map reveals that there is a higher concentration of accidents involving intoxicating substances in urban and densely populated areas. These findings are consistent with the assumption that areas with higher population density and greater availability of alcohol see more such incidents. Significant hotspots are observed around major urban centers such as Prague, Plzeň, Brno, Olomouc, and Ostrava. These areas are likely more prone to alcohol-related incidents due to higher traffic density as well as social and nightlife activities.

Thanks to the interactivity of the map, users can further explore the data based on specific days or months, which can help identify locations with a higher concentration of traffic accidents caused by intoxicating substances. For example, users can pinpoint increased frequencies of accidents during weekends or holidays. This map can uncover critical areas with respect to accidents involving intoxicating substances.

Fig. 19. Heatmap of Traffic Accidents Based on the Presence of Intoxicating Substances

VII. Conclusion

The analysis of traffic accident data in the Czech Republic using the Oracle APEX application provides valuable insights into the patterns and trends associated with road incidents. The findings highlight critical periods and conditions associated with higher accident rates, such as specific days of the week, weather conditions, and the influence of intoxicating substances. These insights can inform targeted interventions and policy decisions aimed at reducing traffic accidents and enhancing road safety. The use of interactive visualization

tools in the application enables a deeper understanding of the data, promoting data-driven decision-making. Future work could expand the application to include more variables and broader geographic analysis, further contributing to traffic safety research and practice. By utilizing advanced technologies, the information system offers a valuable resource for policymakers, researchers, and the public in making decisions, formulating effective strategies, and addressing the challenges associated with traffic accidents. As the application continues to evolve and expand, it has the potential to contribute significantly to the field of traffic accidents monitoring and prevention not only in Czech Republic, but also in Europe, ultimately making safer and more secure societies.

By presented application and analytical results we have confirmed that our system significantly helps and extends available software tools for making more secure life on roads.

Future development could be aimed at some new features involving artificial intelligence, sophisticated statistical and analytical methods or other features based on users experience and new demands. Another goal for future development could focus on more extensive evaluation of system performance and user feedback, which would enhance the practical contribution of the information system. Even if the paper's focus is primarily on descriptive analytics, we would like to address also expanding into predictive analytics or proposing traffic management interventions. Such improvements could increase the contribution to the field. We hope that information systems and new technologies in Applied Informatics will be appreciated also by various groups of people using transportation networks.

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REFERENCES

[1] Police of the Czech Republic, Statistical data on accident rates in the Czech Republic, 2024, Web: https://www.policie.cz/clanek/statistika-nehodovosti-900835.aspx
[2] Lucia Konštiaková, Analyticko-reportovací nástroj pre dopravnú políciu ČR, 2024, Web: https://bit.ly/3R9aP3a
[3] Abhinivesh, A., Mahajan, N.: The Cloud DBA-Oracle, Apress, 2017
[4] Anders, L.: Cloud computing basics, Apress, 2021
[5] Cunningham, T.: Sharing and Generating Privacy-Preserving Spatio-Temporal Data Using Real-World Knowledge, 23rd IEEE International Conference on Mobile Data Management, Cyprus, 2022.
[6] Greenwald, R., Stackowiak R., and Stern, J.: Oracle Essentials: Oracle Database 12c, O'Reilly Media, 2013.
[7] Hansen, K.: Practical Oracle SQL: Mastering the Full Power of Oracle Database, Apress, 2020
[8] Idreos, S., Manegold S., and Graefe, G.: Adaptive indexing in modern database. In: ACM International Conference Proceeding Series, 2012
[9] Kuhn, D. and Kyte, T.: Expert Oracle Database Architecture: Techniques and Solutions for High Performance and Productivity. Apress, 2021.
[10] Kuhn, D. and Kyte, T.: Oracle Database Transactions and Locking Revealed: Building High Performance Through Concurrency, Apress, 2020.
[11] Kvet, M.: Developing Robust Date and Time Oriented Applications in Oracle Cloud: A comprehensive guide to efficient date and time management in Oracle Cloud, Packt Publishing, 2023, ISBN: 978-1804611869
[12] Kvet, M., Papán, J.: The Complexity of the Data Retrieval Process Using the Proposed Index Extension, IEEE Access, vol. 10, 2022.
[13] Lewis, J.: Cost-Based Oracle Fundamentals, Apress, 2005.
[14] Liu, Z., Zheng Z., Hou, Y. and Ji, B.: Towards Optimal Tradeoff Between Data Freshness and Update Cost in Information-update Systems, 2022 International Conference on Computer Communications and Networks (ICCCN), USA, 2022.
[15] Roske, E., McMullen, T., et. al: Look Smarter Than You Are with Oracle Analytics Cloud Standard Edition, Lulu.com, 2017
[16] Shanbhag, S.: Oracle Cloud Infrastructure 2023 Enterprise Analytics Professional, 2022
[17] Steingartner W., Eged, J., Radakovic, D., Novitzka V.: Some innovations of teaching the course on Data structures and algorithms, In 15th International Scientific Conference on Informatics, 2019.
[18] Su S.Y.W., Hyun S.J. and Chen, H.M.: Temporal association algebra: a mathematical foundation for processing object-oriented temporal databases, IEEE Transactions on Knowledge and Data Engineering, vol. 4, issue 3, 1998.
[19] Yao, X., Li, J., Tao, Y. and Ji, S.: Relational Database Query Optimization Strategy Based on Industrial Internet Situation Awareness System, 7th International Conference on Computer and Communication Systems (ICCCS), China, 2022.
[20] Erasmus+ project EverGreen dealing with the complex data analytics: Web: Web:\url{https://bit.ly/3R9aP3a}