Traffic Analysis Studies Using GIS Tools

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SUMMARY

This article highlights the advantages offered by current GIS technology to perform various traffic analyzes.
For this purpose, several areas in Romania that are very crowded at certain times of the week, for example on weekends using were chosen and analyzes using real-time traffic services and historical data for a certain date and time to make comparisons were performed. These traffic analyzes are extremely useful to substantiate the decisions of the authorities for the improvement of the road infrastructure in order to streamline the traffic.

REZUMAT

Acest articol evidențiază avantajele oferite de tehnologia GIS actuală pentru efectuarea diverselor analize de trafic.
În acest scop, au fost alese și analizate câteva zone din România care sunt foarte aglomerate în anumite momente ale săptămânii, de exemplu în weekend, folosind servicii de trafic în timp real și date istorice pentru o anumită dată și oră pentru a face comparații. Aceste analize de trafic sunt extrem de utile pentru a fundamenta deciziile autorităților privind îmbunătățirea infrastructurii rutiere în vederea eficientizării traficului.

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1. INTRODUCTION

There are currently a number of geospatial web solutions that provide real-time traffic status and some that include historical data. In this article we consider the main possibilities for the study of traffic, as well as the solutions that offer the possibility to perform geospatial analyzes using traffic services.
Traffic data provides information about how travel speeds on specific road segments change over time. It is important in network analysis because traffic affects travel times, which in turn affect results. [12] GIS has been applied widely in traffic safety studies in many countries for a long time. [5]
Therefore, the purpose of our paper was to explore to highlight the major changes in human behavior using the analysis of road traffic data as a representation of activities and interaction. Same-day traffic volumes for 2019 and 2020 in Bucharest were analyzed to identify especially temporal changes in behavior as a result of the disease or fear of it and governmental directives to limit person-to-person interaction.
It has been also considered the DN1 (national road) area: Comarnic - Sinaia - Busteni. It was performed an analysis in AGOL based on traffic services, the area that is transited especially on weekends by Bucharest residents who go to the mountains, on Prahova Valley.

2. A DISCUSSION ABOUT TRAFFIC IN BUCHAREST USING TOMTOM TRAFFIC DATA

The TomTom Traffic Index has been providing detailed insights on traffic congestion levels in over 400 cities around the world for the past 10 years, covering 416 cities across 57 countries on 6 continents and providing free access to city-by-city information. [10] Regarding traffic services and the analyzes that can be done, as traffic index, TomTom provides detailed information only in crowded urban areas and, therefore, there are data about Bucharest on site. On the index website is a ranking of cities from the most to the least congested, powered by real traffic data, highlighting all the changes on the roads in 2020.
The TomTom dashboard in real time highlights items such as: average congestion levels for each day and each week in 2021, as weighted averages derived from hourly data; congestion level in real time; live traffic jams; comparisons between different years and so on.
In Romania, as well as in the US, “governmental directives varied over time, beginning with voluntary stay-at-home requests and restrictions on large public gatherings, then, later, virtual statewide lockdown quarantines”. [4] The first set of drastic restrictions was applied on March 16, 2020 and lasted about two months. Traffic count data are objective, accurate, reliable, and collected continuously throughout cities and can be used as a basis of comparison between conditions before and during the Covid-19 pandemic.
In the following comparisons we started from the hypothesis that roadway traffic volume data could serve as an indicator of societal activity and by extrapolation, the likelihood of personal interaction.

The coronavirus pandemic has severely affected traffic, which can be seen using TomTom services as well. (figure 2)
Because the specific mechanisms for the transmission of the virus are consiedered still unknown in Romania and here is a limited ability to test for infection, public officials have few options to limit the rapid spread of the virus other than to call upon people to maintain physical distancing from one another, being also the situation in March and April 2021, because on March 31, 2021 the incidence rate of COVID-19 infections was 7,08 per thousand. [11] It can be seen the comparison for the first seven days of April in 2019, 2020, 2021. (figure 3)

Figure 1 – Comparison between Travel Patterns as Average Congestion Level in April (left side) and May (right side) 2019 (light blue) and 2020 (dark blue), according with TomTom Data [10]

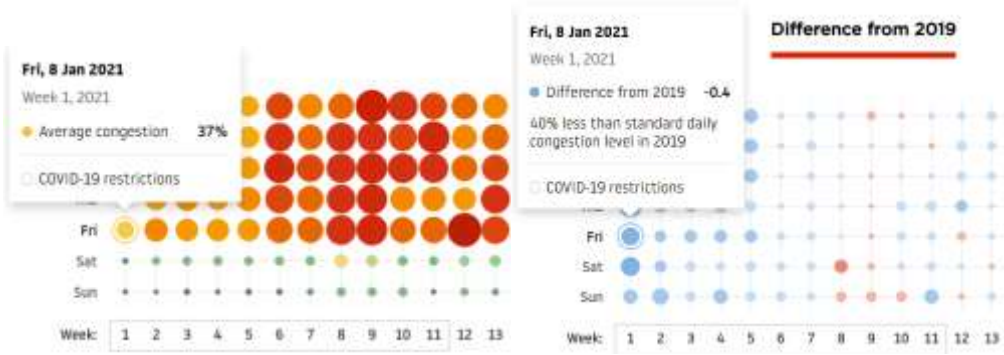

Figure 2 – Average Congestion in 2021 (left) and Difference from 2019 (right) – January, 8, 2021, according with TomTom Data [10]

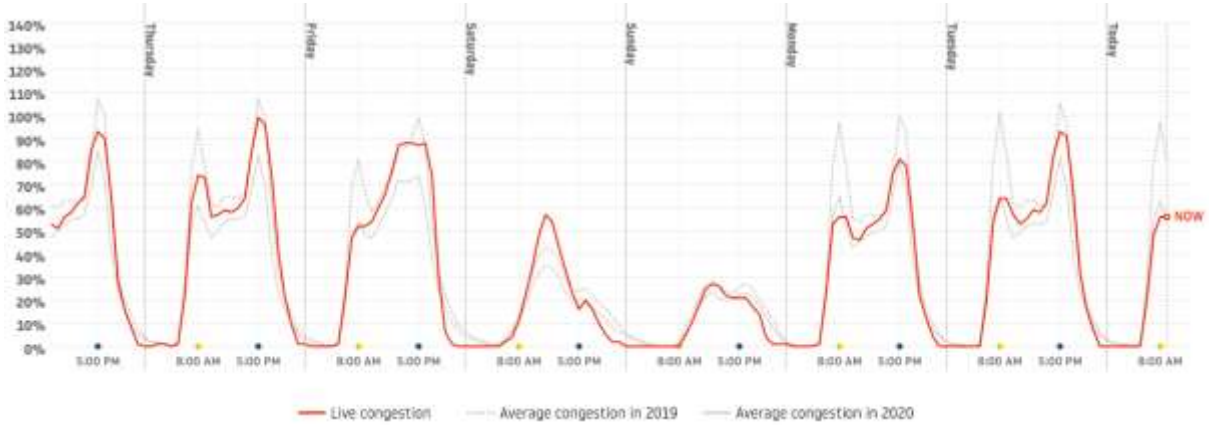

Figure 3 – Coronavirus Traffic Peak Analysis Based on TomTom Services (Live Situation vs Average Congestion in 2019 and 2020) [10]

According with [10], AM rush congestion and PM rush congestion in March 2020 decreased with 36% and respectively with 32% by comparison with March 2019. AM rush congestion and PM rush congestion in April 2020 decreased with 86% and respectively with 84% by comparison with April 2019. It was also a decrease of 2 days and 14 hours as time lost in rush hour in 2020 by comparison with 2019, having an absolute value of 6 days and 21 hours per year.
As historical data regarding the traffic in Bucharest, it can be seen that in 2020 there were 66 days with reduced traffic. As a type of traffic depending on the type of infrastructure used, this aspect is highlighted in the figure 4. It was also possible to highlight the time lost in traffic, related to a trip of 30 minutes. (figure 5)

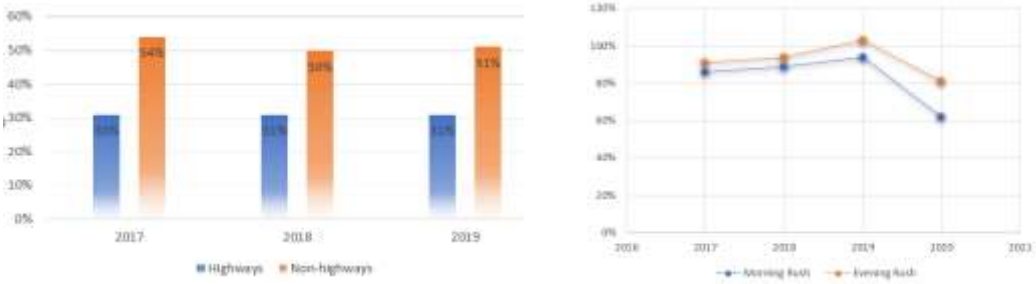

Figure 4 - Congestion Level in Bucharest [10] by Year and by Road Type (left side) and by Morning and by Evening Rush (right side)

Figure 5 – Time Lost [10] in Morning and Evening Rush

3. GENERAL ASPECTS ABOUT ACCESSING TRAFFIC DATA USING AGOL

Esri Living Atlas is a collection of maps, apps and data, available for use by the community, being made available by Esri, with content provided by Esri and partners, organizations, and users from around the World. The data can be explored and combined with the users own data and content to create maps, applications and to perform analysis.
Esri Living Atlas Traffic Service presents historical and near real-time traffic information for different regions in the world, in which the data is updated every 5 minutes, being a global service. [7] There can be used a dynamic traffic map service with data updated every five minutes and capabilities for visualizing traffic speeds relative to free-flow speeds as well as traffic incidents. The traffic incidents has also associated attributes which can be visualized and identified. There can be accessed the coverage map in which the countries color coded in dark green support visualizing live traffic.

Here provides historical, live, and predictive traffic feeds, based on billions of GPS and cell phone probe records per month, and uses sensor and toll-tag data to augment the probe data collected using an advanced algorithm to process the data at accurate speeds. [7]
The historical traffic records are based on the average of observed speeds over the past three years. There are included dynamic traffic incidents in real time, showing the location of accidents, construction, closures and other issues that could potentially impact the flow of traffic. These data are very useful to provide context for routing, navigation and field operations. The IncidentType field in the traffic incident layers can have the following values: Accident, Congestion, Construction, Disabled Vehicle, Lane_Restriction, Mass Transit, Miscellaneous, Other News, Planned Event, Road Hazard, Road_Closure, Weather. The Severity field in the traffic incident layers can have the following values: critical, major, minor, low impact, where critical indicates a road closure and major indicates a blockage of multiple lanes. [11] (figure 6)

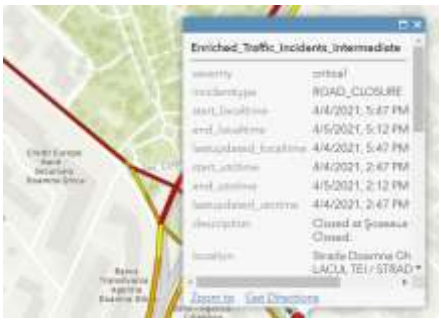

Figure 6 – Example of Incidents Attributes

4. TRAFFIC IN TOMTOM AND AGOL

To describe and analyze the situation from the past vs the present situation of traffic near the A3 highway in Bucharest, we created WebApps using two images from the digital archive of wayback imagery, one from 2020 October, 14 and the second from 2014 February, 20.

Figure 7 – WebApps Highlighting the A3 Area from 2014 and 2020

In order to be able to compare the visualization using the presented traffic services, first it is necessary to make certain mentions regarding the symbolization mode. TomTom is using four different colors indicating congestion levels in cities. (figure 8)
In AGOL, traffic speeds are displayed as a percentage of free-flow speeds (figure 9), which is frequently the speed limit or how fast cars tend to travel when unencumbered by other vehicles. [7] The traffic map layer is used to represent relative traffic speeds, providing context for routing, navigation and field operations. In the figure 9, the streets are color coded as follows: green (fast): 85 - 100% of free flow speeds, yellow (moderate): 65 - 85%, orange (slow); 45 - 65%, red (stop and go): 0 - 45%.

Figure 8 – TomTom Congestion Levels used for Symbolizing [10]

Figure 9 – Legend for Traffic in AGOL, based on Traffic Speeds

There are highlighted a similar situation regarding traffic in the mentioned area in figures 10 and 11.

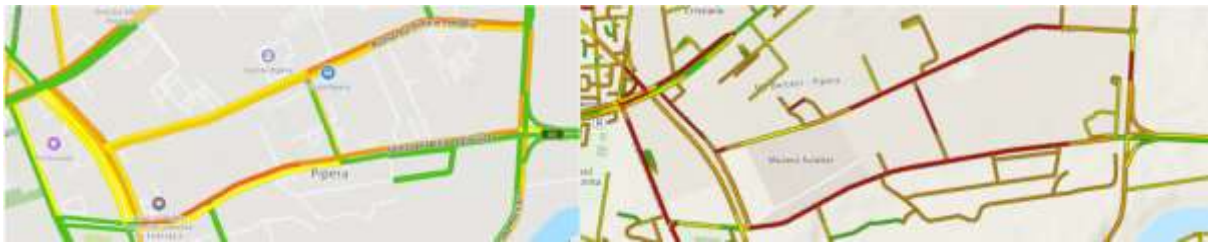

Figure 10 - Traffic in Real Time, Wednesday, 9 a.m., TomTom (left) and AGOL (right)

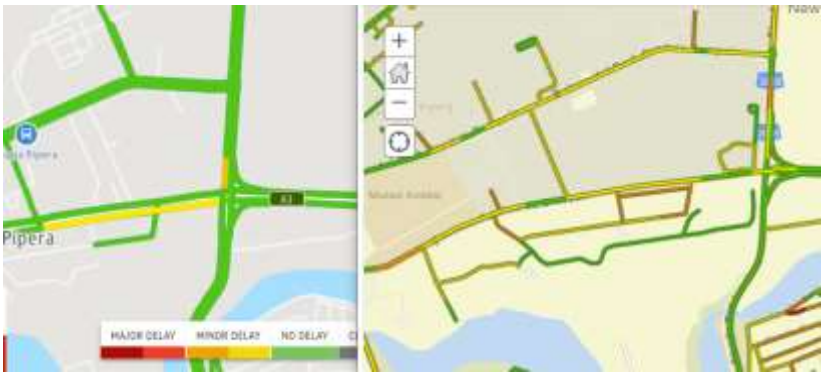

Figure 11 - Traffic in Real Time, Tuesday, 7 p.m., TomTom (left) and AGOL (right)

5. ANALYZES IN BUCHAREST AND DN1 AREA USING ESRI TRAFFIC SERVICE IN AGOL

Spatial planning and strategies created are based on different criteria, taking into account various indicators. One of these indicators should be those related to traffic analysis, in order to prioritize infrastructure works.

We can start with a density analysis of traffic incidents (figure 12), based on which we can focus on the critical area.

We chose two areas for analysis. The first area is in Bucharest, near the Technical University of Civil Engineering, where the traffic is affected by the A3 highway and the currently blocked works from the Doamna Ghica passage and where we highlighted the usefulness of traffic services, live and historical, to analyze the distance that can be traveled by car in 5 minutes, on different days and at different times.

The second study is carried out on a critical area of the national road no.1, which ensures the movement from and to Bucharest, especially to and from the mountainous area on the Prahova Valley. Here there are major traffic problems, almost every weekend, and during the holidays the situation is more serious, the tourist traffic greatly affecting the travel possibilities of the locals.

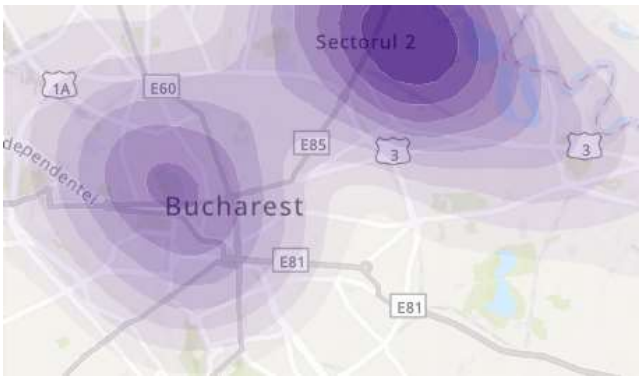

Figure 12 – Bucharest - Density Analysis of Traffic Incidents

By addressing in AGOL the problem of analyzes using traffic data, such analyzes can be performed, but also much more complex analyzes can be developed in ArcGIS Pro, and even the creation of automated, parameterized workflows, which could be a major advantage. [3]
First it was developed an analysis to find areas around locations that can be reached within a time period (5min).
Secondly there were measured the travel time or distance between pairs of points. As example we have chosen to find travel time from Comarnic, Sinaia and Busteni to Predeal. (figure 16)

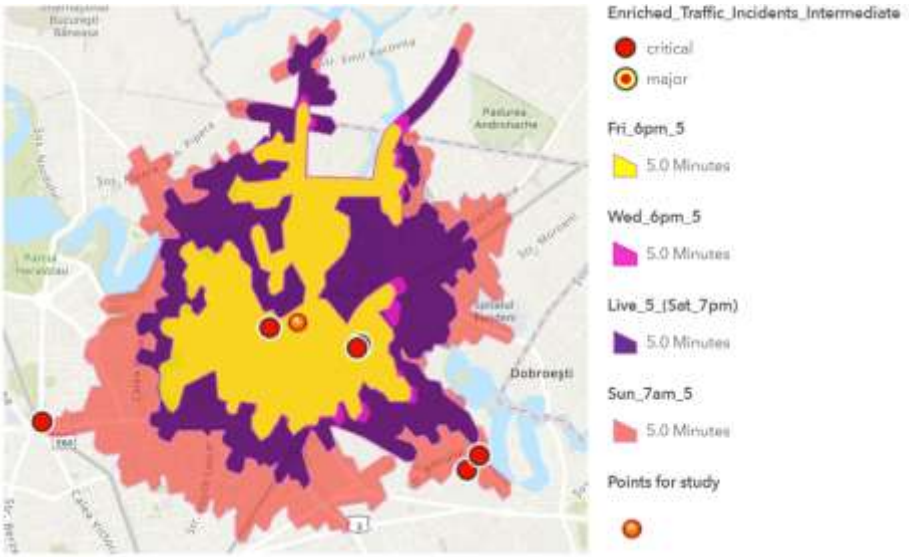

Figure 13 – Bucharest – Drive Time Areas Analysis for 5 min – from Technical University of Civil Engineering Bucharest

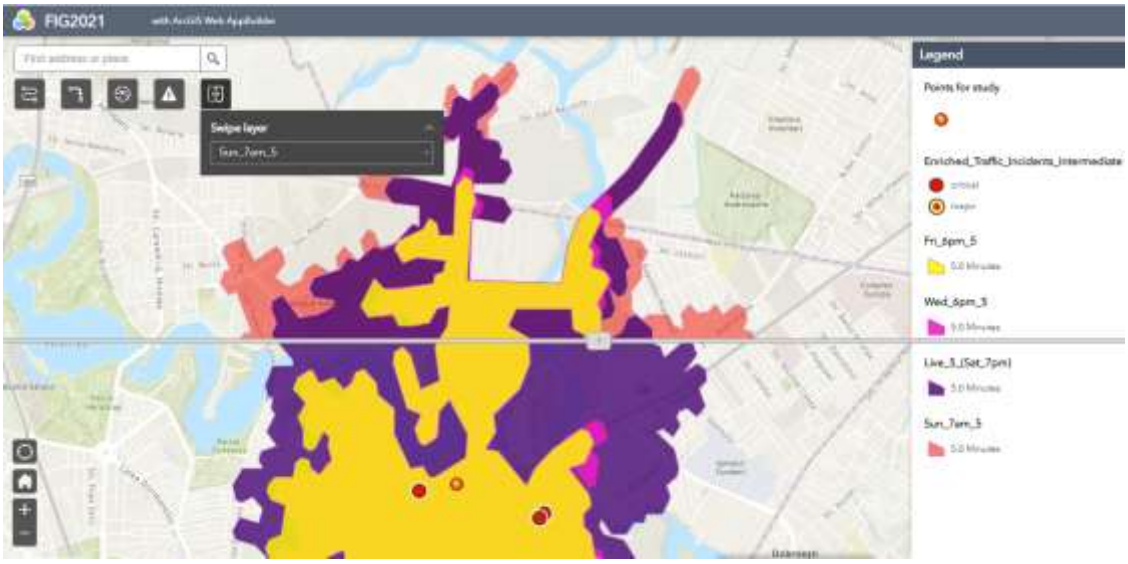

Figure 13 – Bucharest – WebApp

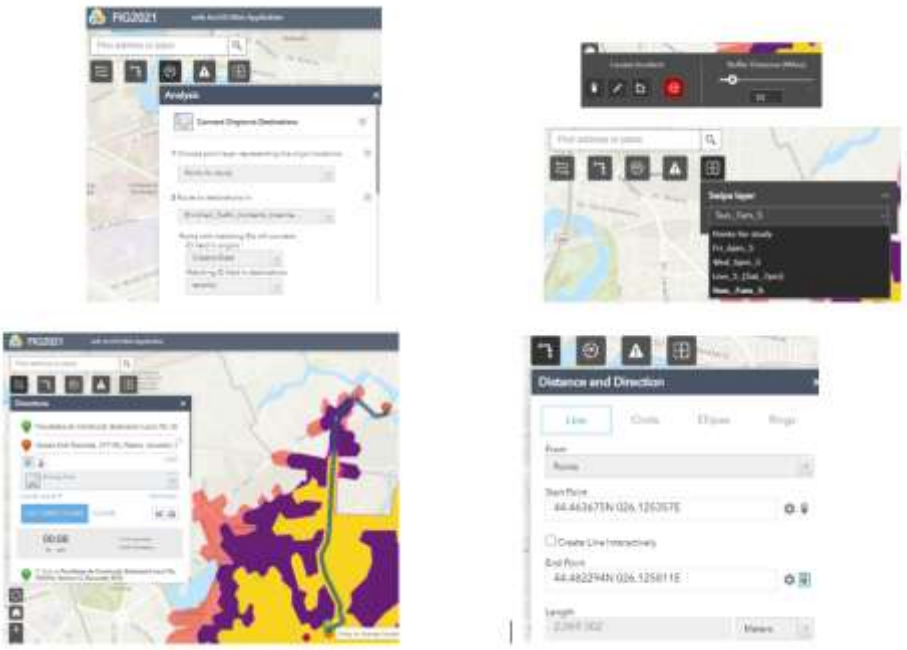

Figure 14 – Widgets Added in the WebApp

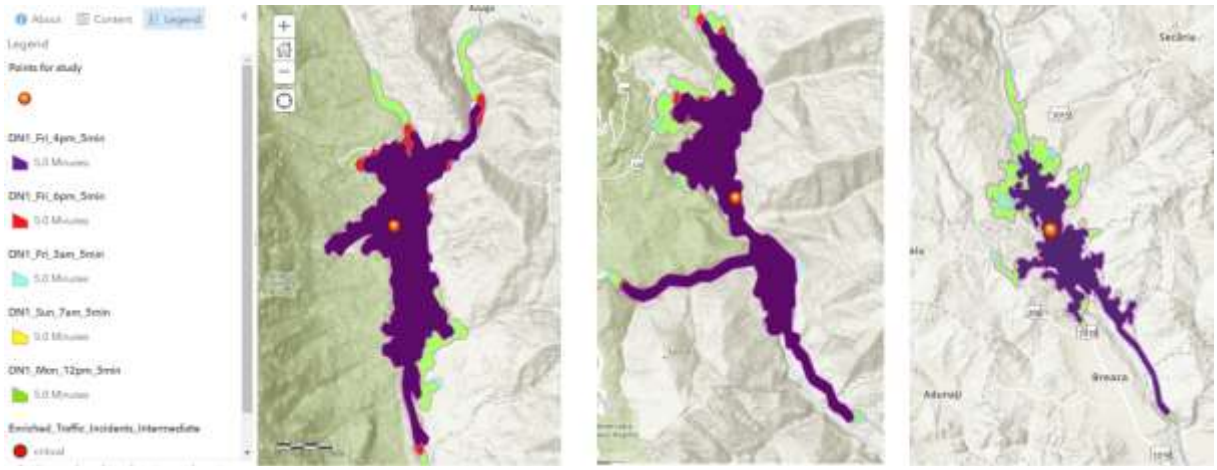

Figure 15 – DN1 Analysis: Busteni (left side), Sinaia (middle), Comarnic (right side)

DN1 toPredeal Live (Fri 12pm) (Features: 3, Selected: 0)			
Driving Distance (Kilometers)	Driving Time (Minutes)	Speed	Route
36.78	47.76	46.20	Comarnic Predeal
20.74	28.54	43.60	Sinaia Predeal
12.02	14.46	49.88	Busteni Predeal

Figure 16 – Travel Time from Comarnic, Sinaia and Busteni to Predeal – Friday, 12pm

6. CONCLUSIONS AND PROPOSALS

The article has shown that the combined analysis of space and time in identifying traffic situation enables authorities to capture the situation accurately and timely.
The analyzed data has shown that overall traffic volumes decreased over the period due to the governmental decisions implemented by local governments and employers that contributed to the changes in travel behavior. The data are useful in evaluating both the timing as well as the cumulative effects of orders and actions designed to increase social distance and limit contact to reduce the spread of the pandemic. There is needed supplementary analysis with data and analytical tools for investigating the relationships between infectious disease, containment strategies, and travel behavior.
Spatial planning is in fact a set of actions that concern the future states of space, taken up by the relevant public administration agencies on the basis of the existing state of space. [1] There are currently advanced methods for urban planning [2], in which traffic analysis should be included as criteria. It is presented the need to introduce spatial planning also based on traffic services. In the Colentina area - Doamna Ghica Passage - there is an urgent need to resume and complete the works, because, as can be seen from the analysis results, traffic suffers major disruptions and citizens' lives are much more difficult due to stopping works.
For many years there has been the problem of building a highway to streamline traffic in Prahova Valley area, and this type of rapid analysis, coupled with more additional population data, could be an additional means to substantiate the justification of the investment.

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BIOGRAPHICAL NOTES

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