# USING ADVANCED ANALYTICS TO UNDERSTAND TRAFFIC FLOW

*Gheorghe BADEA, Prof.PhD.Eng., Faculty of Geodesy, Technical University of Civil Engineering Bucharest, Romania, gheorghe.badea@utcb.ro*
*Ana Cornelia BADEA, Prof.PhD.Eng., Faculty of Geodesy, Technical University of Civil Engineering Bucharest, Romania, ana.badea@utcb.ro*

***Abstract**: In this article we highlight the current possibilities to understand traffic flow. There are many ways, among which we have chosen the use of TomTom and ArcGIS, to correlate the time of the week with the queuing queue length in the adjacent areas at the entrance and exit of the A3 highway, respectively, at the intersection with Petricani Street and Fabrica de Glucoza Street. Methods such as junction analysis, route monitoring and drive time areas were used. Using these methods it is possible to analyze other critical areas in Bucharest, and in the article we also considered the intersection of Lacul Tei Boulevard - Petricani Street - Doamna Ghica Street. Such methods can also be useful to analyze the area that emergency services can serve in a given timeframe. A secondary objective was to investigate the ModelBuilder Beta capabilities in 2025.*

***Keywords:** traffic; geospatial; analytics; TomTom; ArcGIS; ModelBuilder Beta*

## 1. Introduction

Real-time traffic information plays a crucial role in enhancing Advanced Driver Assistance Systems (ADAS) by providing detailed insights into traffic conditions. For instance, if a system like Traffic Incidents detects lane closures due to roadworks, it can collaborate with ADAS to safely redirect a vehicle into an open lane.
In complex scenarios involving contraflow and variable lane widths, the system can alert the driver to assume full control before reaching the hazard, thereby extending the capabilities of ADAS beyond its sensor range and enhancing safety. This integration ensures more informed and anticipatory driving assistance, contributing to safer and more efficient navigation. [1]

The research started by identifying the degree of interest on the problem, analyzing the results by identifying relevant articles from the Web of Science, obtaining 291 results.

In figure 1 are emphasized the main keywords identified in the papers.

Then these papers were analyzed by year, to indentify the existing trend and the degree of interest in this topic. (Figure 2)

The main domains in which the papers of interest have been published are pointed out in figure 3.

TomTom ranking from 2024 shows that in a ranking of the most congested cities, Bucharest is on the 5th place, havin a congestion level of 48%. (figure 1)

Congestion is recognized as the difference between free-flow or optimal traffic conditions and actual travel time. [1]

Congestion level is an increase in travel time due to excess traffic. A congestion level of 50 mean that, on average, journey times across that area's road network were 50% greater than when traffic is free-flowing.

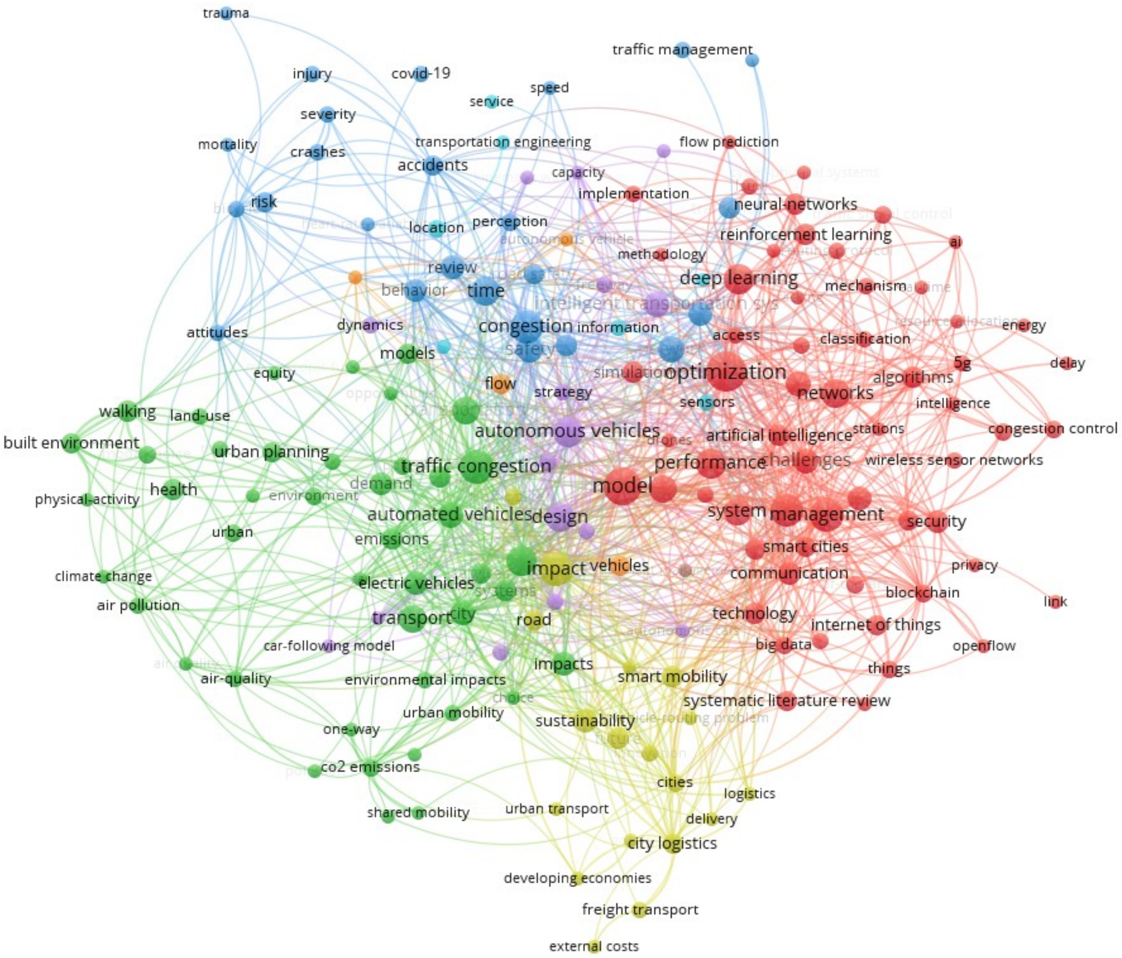



Figure 1 – The main keywords identified in the papers – co-occurrence map

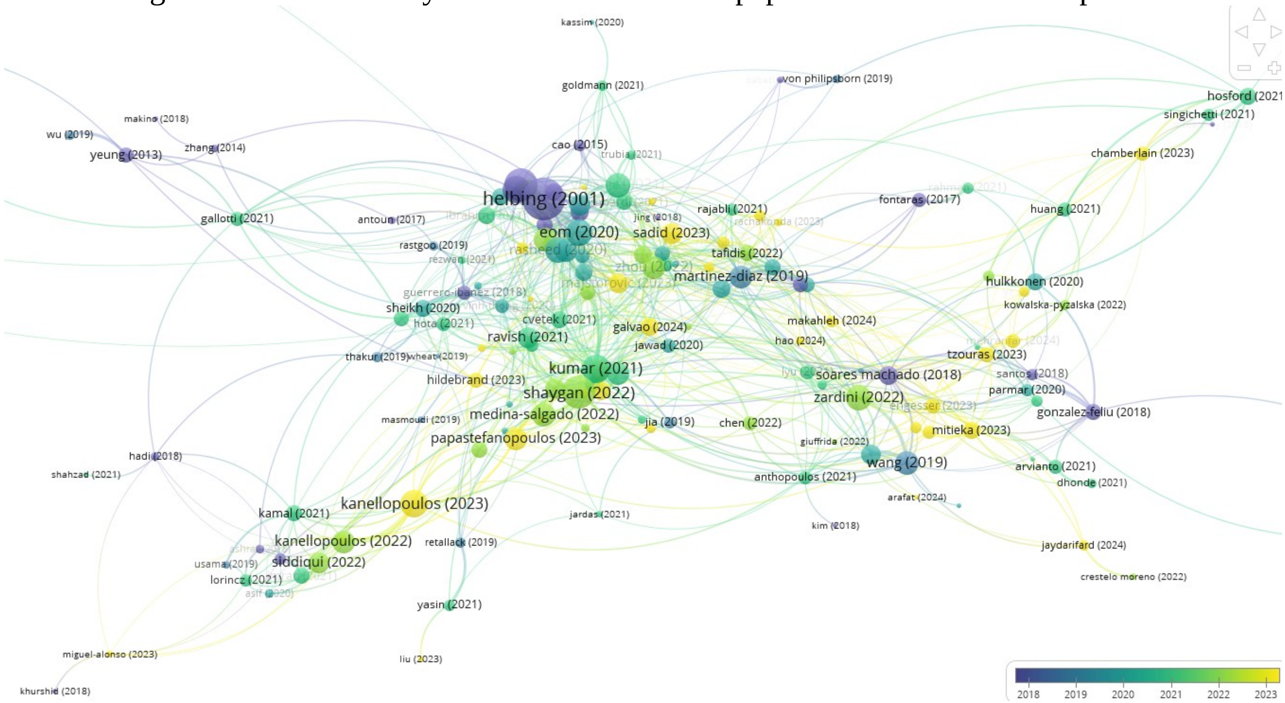



Figure 2 - Papers analyzed by publication year


Figure 3 – The main domains of the articles in WoS

Time lost in traffic means the time difference between the same trip in optimal conditions (free-flow travel times) and the current travel times including congestion. In the ranking of the cities by the time lost in traffic, Bucharest is on the 4th place, with 150 hours lost in traffic per year. (figure 4)

Analyzing figure 5, it can be observed that in a world rank Bucharest is on the position 22, with an average travel time of 31min 9s for 10 kilometers, with 20 seconds more than in 2023.

**Ranking of the world's most congested cities in 2024** tomtom

| RANK | CITY | CONGESTION LEVEL % | RANK | CITY | CONGESTION LEVEL % |
|---|---|---|---|---|---|
| 1 | Mexico City<br>Mexico | 52% | 6 | Plovdiv<br>Bulgaria | 48% |
| 2 | Bangkok<br>Thailand | 50% | 7 | Lodz<br>Poland | 48% |
| 3 | Davao City<br>Philippines | 49% | 8 | Bandung<br>Indonesia | 48% |
| 4 | Kumamoto<br>Japan | 49% | 9 | Lima<br>Peru | 47% |
| 5 | Bucharest<br>Romania | 48% | 10 | Dublin<br>Ireland | 47% |

**Ranking of cities where the most time was lost due to rush-hour traffic jams** tomtom

| RANK | CITY | TIME LOST PER YEAR AT RUSH HOUR | RANK | CITY | TIME LOST PER YEAR AT RUSH HOUR |
|---|---|---|---|---|---|
| 1 | Lima<br>Peru | 155 hours | 6 | Davao City<br>Philippines | 136 hours |
| 2 | Dublin<br>Ireland | 155 hours | 7 | Barranquilla<br>Colombia | 130 hours |
| 3 | Mexico City<br>Mexico | 152 hours | 8 | Manila<br>Philippines | 127 hours |
| 4 | Bucharest<br>Romania | 150 hours | 9 | Arequipa<br>Peru | 125 hours |
| 5 | Kumamoto<br>Japan | 149 hours | 10 | Bogota<br>Colombia | 119 hours |

Figure 4 - Congestion ranking in 2024 (left) and the ranking of the cities by the time lost in traffic (right) [1]

| Rank by filter | World rank ▼ | City | Average travel time per 10 km ▼ | Change from 2023 ▼ | Congestion level % ▼ | Time lost per year at rush hours ▼ | Congestion world rank ▼ |
|---|---|---|---|---|---|---|---|
| 1 | 5 | London<br>United Kingdom | 33 min 17 s | + 40 s | 32% | 113 hours | 150 |
| 2 | 10 | Dublin<br>Ireland | 32 min 45 s | + 40 s | 47% | 155 hours | 10 |
| 3 | 21 | Barcelona<br>Spain | 31 min 13 s | + 50 s | 26% | 87 hours | 299 |
| 4 | 22 | Bucharest<br>Romania | 31 min 9 s | + 20 s | 48% | 150 hours | 5 |

Figure 5 – Traffic index ranking [1]

## 2. Materials and Methods

TomTom services can be used to identify mobility pain points, assess the impact of road network changes. In 2024, TomTom covers 500 cities across 62 countries on 6 continents. Floating car data (FCD) is used to derive historic travel times on individual roads, as well as evaluate traffic data algorithms. FCD are based on GPS data obtained from navigation devices and applications, provides a vehicle's location and speed to feed live automated traffic management systems with essential information. [1] TomTom traffic services were used to analyze the weekly hourly traffic evolution at two major intersections in the 2nd District, located on the way to the A3 highway exit.

In the AGOL, traffic data is calculated in a different manner for historical and live traffic, because this service is a dynamic map service with capabilities for visualizing traffic speeds relative to expected averages as well as traffic incidents that can be visualized and located. [2]

In figure 6 is the data coverage splitted by the traffic type. [2] The real-time traffic information for different regions of the world is captured every five minutes. [3] Traffic speeds are displayed as a percentage of free-flow speeds, using color coded: Green (fast): 85 - 100% of free flow speeds; Yellow (moderate): 65 - 85%; Orange (slow); 45 - 65%; Red (stop and go): 0 - 45%.

The historical traffic involves creating a traffic profile based on the average expected speed from observations over a three-year period. The profile remains consistent across each day of the week, providing a static view of typical traffic conditions. The live traffic speeds are measured using real-time data from sources like GPS receivers and road sensors. These readings are stored for 12 hours, allowing users to view actual traffic conditions within that time frame. The recorded speeds can be displayed independently or supplemented with typical averages. Additionally, predictive traffic conditions can be shown for future times.


Figure 6 – Traffic data coverage [2]

The entire analysis workflow was performed using Data Pipelines and the premium tool ModelBuilder Beta.

ModelBuilder and Data Pipelines share a common trait: they both offer a low-code, drag-and-drop interface for creating repeatable workflows on the web. However, they serve distinct purposes. ModelBuilder is designed to automate analysis workflows by utilizing the tools available in Map Viewer, supporting feature layers and tables. In contrast, Data Pipelines focuses on automating data integration and preparation tasks. It supports a broader range of data types, including vector and tabular data from sources like Amazon S3, Google BigQuery, and more.

While ModelBuilder is an integrated functionality, Data Pipelines operates independently, allowing users to connect to various external data sources and prepare data for visualization and further analysis. [4]

Data Pipelines tools support a variety of workflows, as in figure 7.

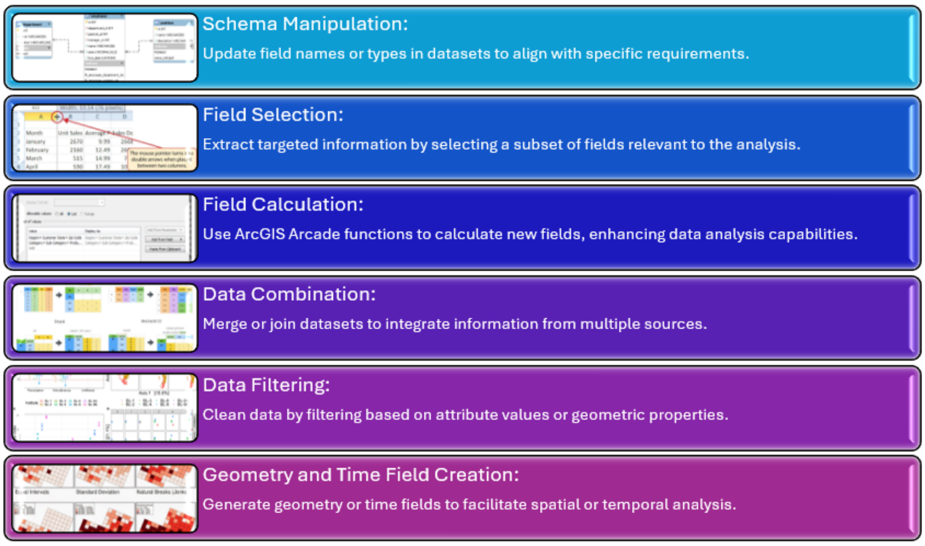



Figure 7 – Workflows in Data Pipelines

## 3. Case study

In figure 8 there are emphasized the hourly speed and congestion level in Bucharest, in real time, March, 17-23, 2025.

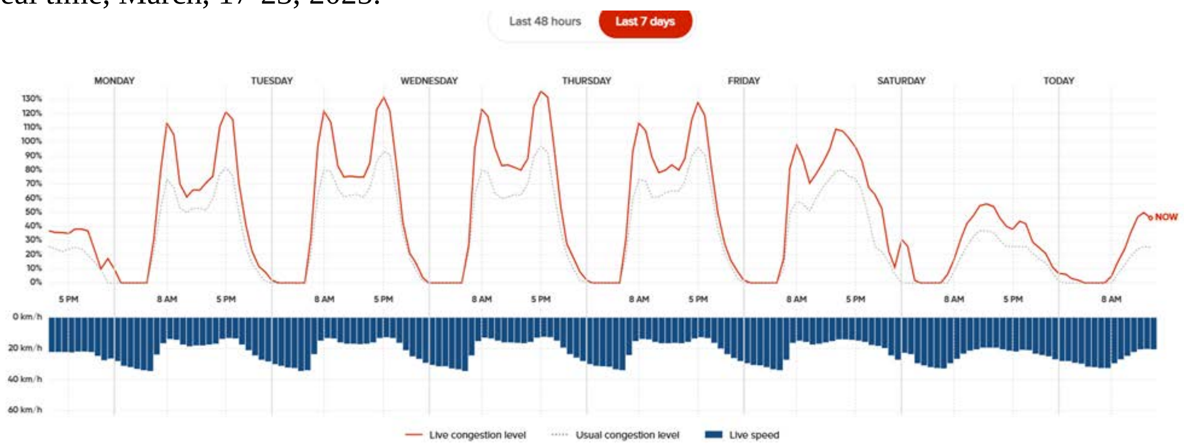



Figure 8 – Hourly speed and congestion level in Bucharest (real time, March, 17-23, 2025) (using [1])

In a previous paper we pointed out the importance to complete the works in the Colentina area - Doamna Ghica Passage because traffic suffers major disruptions and citizens' lives are much more difficult due to stopping works. [5]

Now we are investigating in the case study two intersections situated in the 2nd District, using TomTom services. [1]

First location is the intersection between A3 highway, Fabrica de Glucoză road and Petricani road and graphs were made to see the length of the queue that is formed on the entry directions in this intersection, on different days of the week, at different times of the day, taking into account the average values.

In the figures 9-12 there are pointed out the main entrances in the analyzed intersection, with focus on A3 highway, Petricani street, Fabrica de Glucoză street.

This analysis was done for the time period between March 17 and 22, 2025.

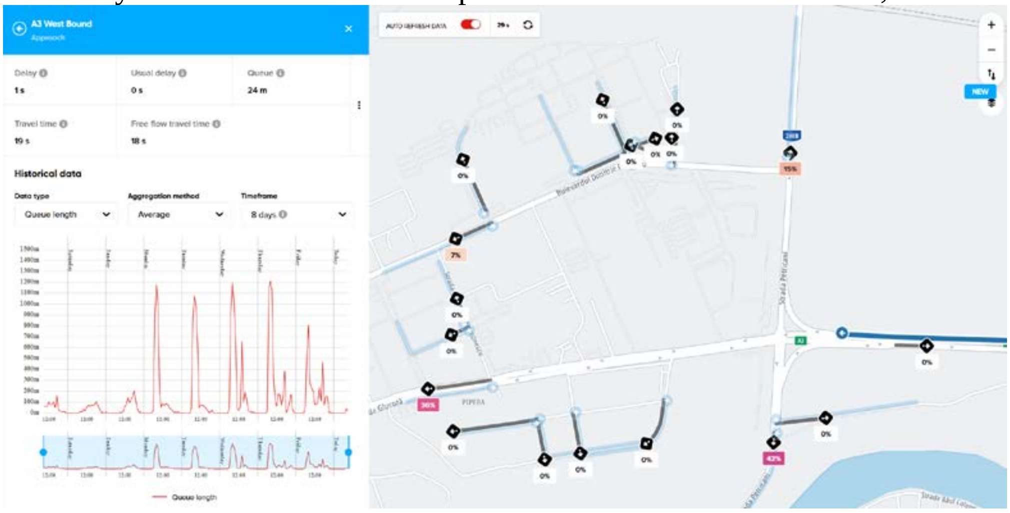



Figure 9 - A3 highway entrance on Petricani street

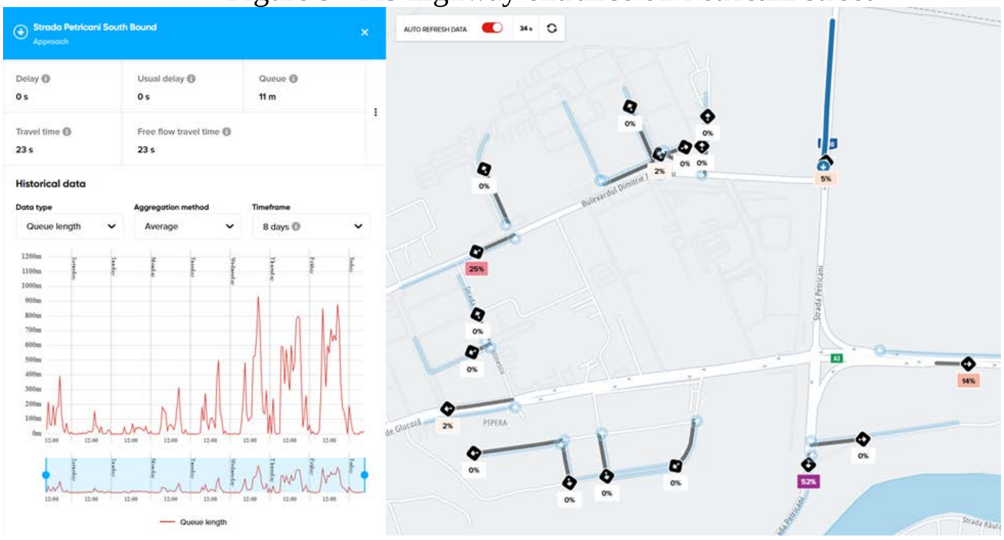



Figure 10 - Dimitrie Pompei - Petricani roundabout

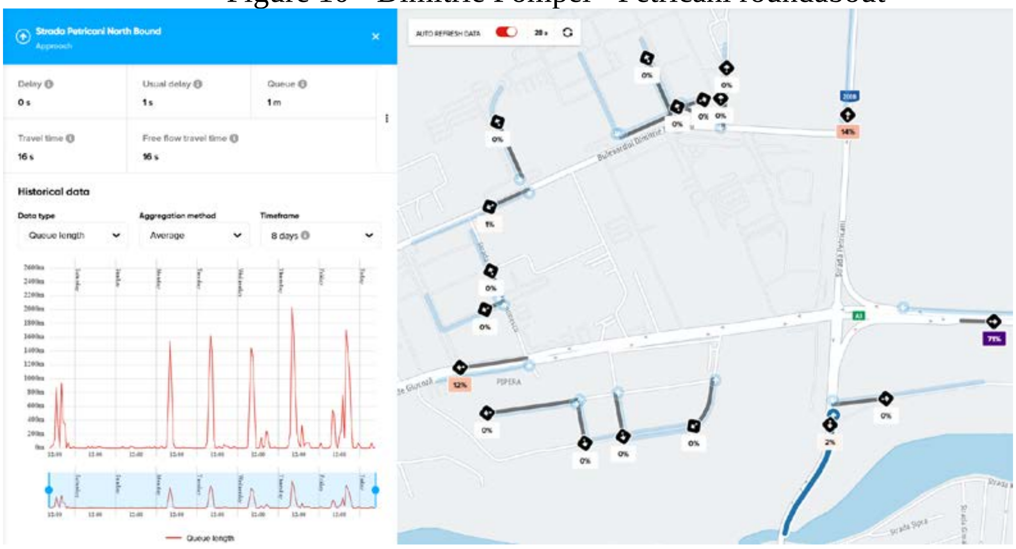



Figure 11 - Petricani street with Fabrica de Glucoză street intersection (exit)

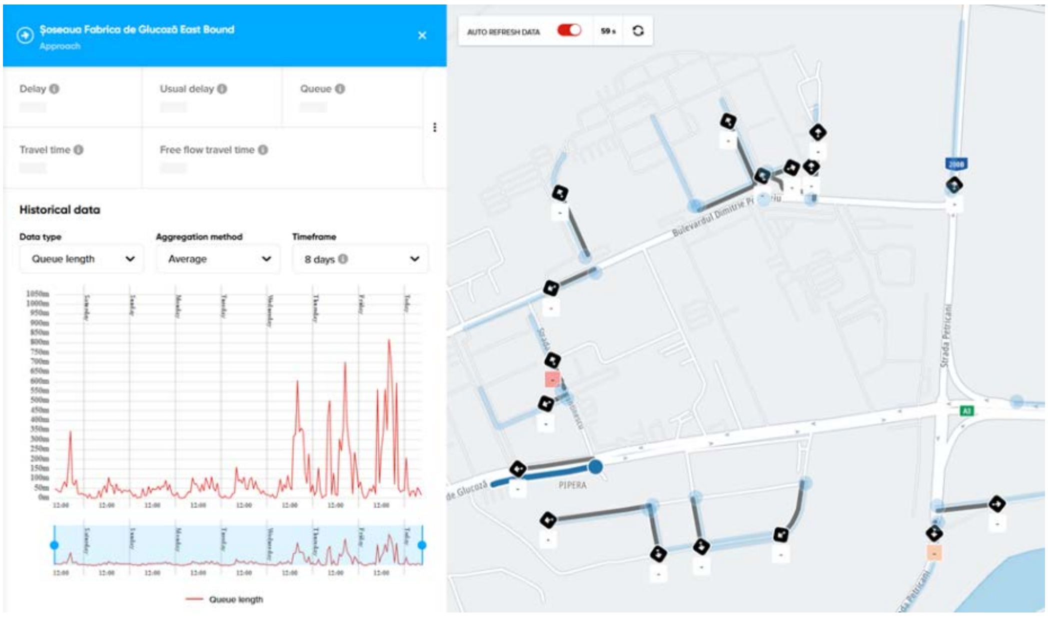



Figure 12 - Fabrica de Glucoză street (exit to A3 highway)

The second location is the intersection of Doamna Ghica Street, Petricani Street, Lacul Tei Boulevard, to be analyzed on different days, at different times of the day. For the second scenario, we also took into account the number of vehicles traveling in that direction. For example, for Saturday, at 14,30 we found that the queue length from Doamna Ghica Street to Petricani Street was 198m, with a maximum of 970m at 12 o'clock, and with a transit of 3582 vehicles per hour. (figure 13)

The variation in the number of vehicles can be seen in the figure on the left. An example of real-time identification of the congestion points is emphasized in figure 13.

The second intersection analyzed is Lacul Tei Blvd. – Petricani street – Doamna Ghica street (figure 15 and figure 16). On the direction from Lacul Tei Boulevard there are traffic jams of more than 2 km at rush hours, especially on Mondays and Fridays, in the second part of the day, and from Petricani there are queues of 4 km in the middle of the week (Tuesday, Wednesday, Thursday).

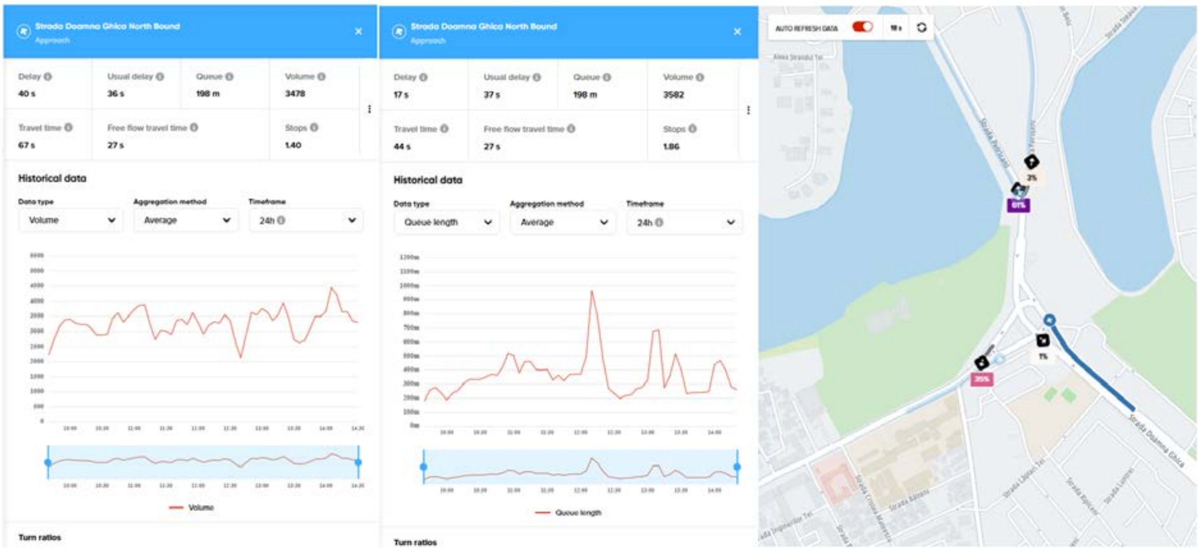



Figure 13 – No of vehicles correlated with the length of the queue

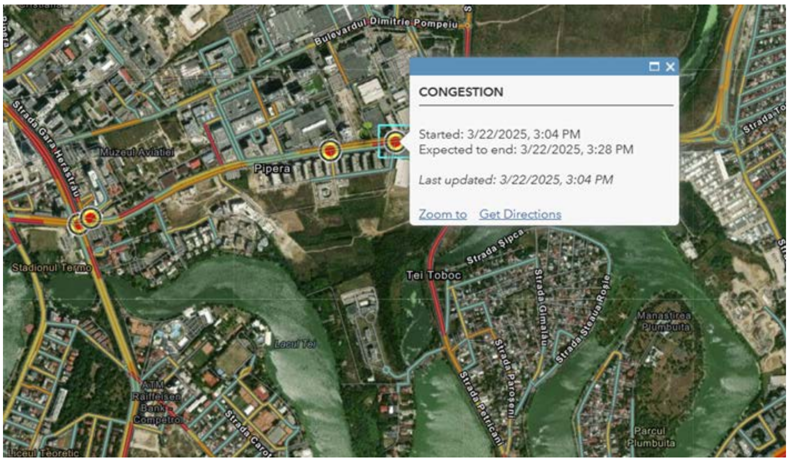



Figure 14 – Example of real-time identification of the congestion points (Saturday, March, 22, 2025)

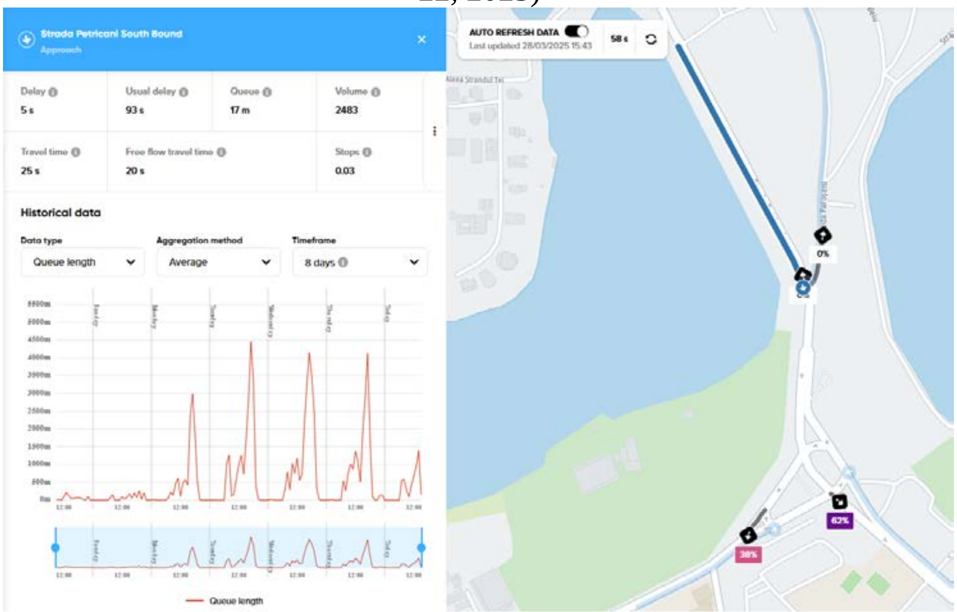



Figure 15- Petricani street (towards Doamna Ghica)

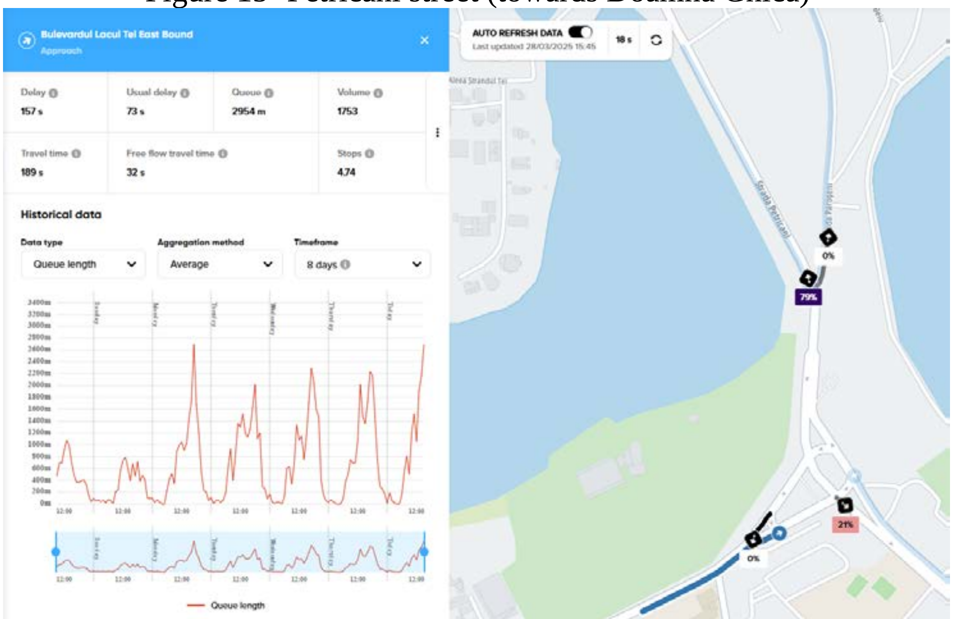
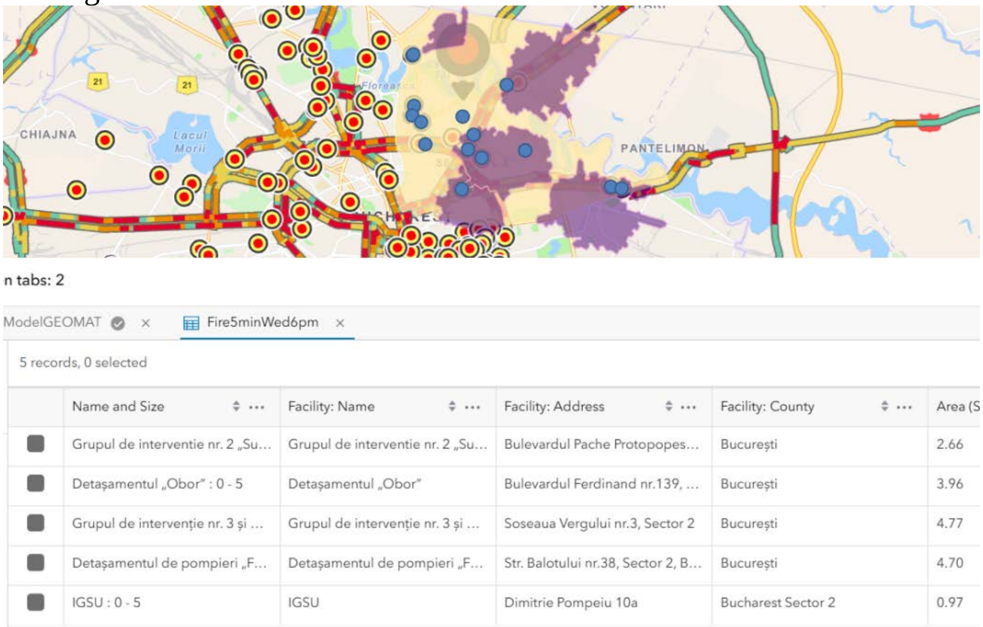



Figure 16 – Lacul Tei Blvd. (towards Petricani – A3)

After analyzing the traffic context in the area using of TomTom services, we wanted to see how much area would be covered starting from the sector 2 fire stations, on a Wednesday at 6 pm, in case of an incident. (figure 17) We extracted the traffic incidents and closed roads in the area, then these were considered as barriers in the analysis. The result can be seen in the figure, including the areas covered in case of fire.




| | Name and Size | Facility: Name | Facility: Address | Facility: County | Area (S |
|---|---|---|---|---|---|
| | Grupul de interventie nr. 2 „Su... | Grupul de interventie nr. 2 „Su... | Bulevardul Pache Protopopes... | București | 2.66 |
| | Detașamentul „Obor" : 0 - 5 | Detașamentul „Obor" | Bulevardul Ferdinand nr.139, ... | București | 3.96 |
| | Grupul de intervenție nr. 3 și ... | Grupul de intervenție nr. 3 și ... | Soseaua Vergului nr.3, Sector 2 | București | 4.77 |
| | Detașamentul de pompieri „F... | Detașamentul de pompieri „F... | Str. Balotului nr.38, Sector 2, B... | București | 4.70 |
| | IGSU : 0 - 5 | IGSU | Dimitrie Pompeiu 10a | Bucharest Sector 2 | 0.97 |

Figure 17 – The area covered in 5 minutes from the 2nd District firestations, on Wednesday, 6pm

We resumed the analysis and we took into account all the existing fire stations in Bucharest and Ilfov. The result is presented in figure . There is a small difference in the north-western part of the sector, where a detachment from sector 1, from Baneasa, can intervene. (figure 18)

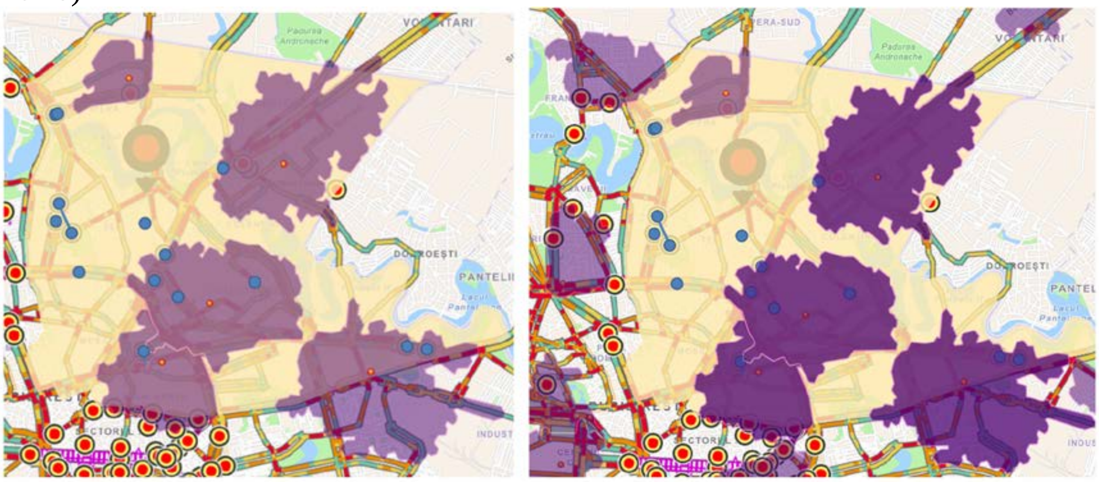


Figure 18 – The area covered in 5 minutes from the 2nd District firestations, on Wednesday, 6pm (left) and the area covered in 5 minutes from the Bucharest firestations (right)

An additional analysis was created to see how much the intervention speed depends on the traffic and we considered a travel time of 10 and 15 minutes respectively for Sunday at 13.00. (figure 19) As we emphasized in [6] and [7], geospatial planning needs to be done with modern technologies and software, in such a way that it allows scenario building and best decision making.

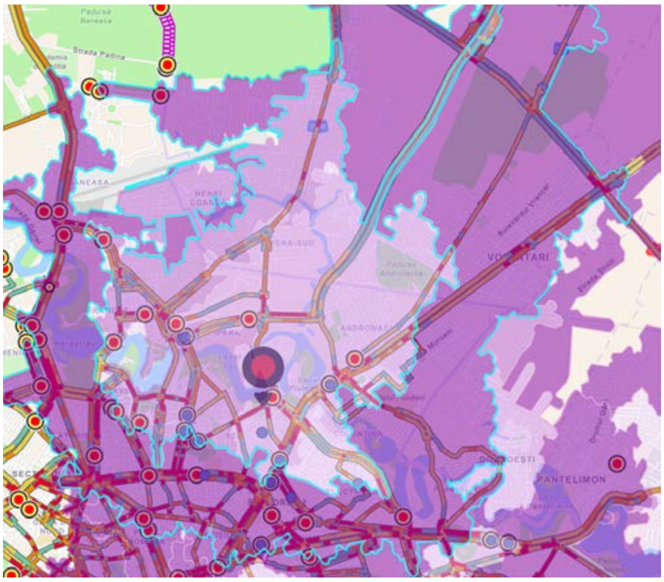


Figure 19 – Area covered in 10 min (light) and the extra area covered in 15 min compared to area covered in 10 min, for Sunday, March, 23, 2025, 1pm

## 4. Conclusions

The analysis has its limitations, as it cannot simulate the area covered in 5 minutes by a vehicle leaving a fire station with alarm on and lights flashing. However, it is obvious that a fairly large area of 2nd District cannot be secured in 5 minutes in extremely congested traffic conditions.

However, it can be concluded that, in general, it may be possible, with all warning alarm and warning lights switched on, to cover the entire area of the sector in 10 minutes.

One of the limitations of working in ModelBuilder Beta was that model inputs could not be copied to the model window to change only certain parameters and then reused. There are a number of other functionalities that are still missing, but the advantage of being able to use online workflows should be fully appreciated.

## 5. References

1. *https://www.tomtom.com/*
2. *https://www.arcgis.com/*
3. *https://www.esri.com*
4. *https://doc.arcgis.com/*
5. *Badea, A. C., Badea, G. (2021). Traffic Analysis Studies Using GIS Tools (11169), FIG Working Week 2021, https://fig.net/resources/proceedings/fig_proceedings/fig2021/papers/ts08.2/TS08.2_badea_badea_11169.pdf*
6. *Badea, G., Badea, A. C., Vasilca, D. (2019). Blockchain, Property Registration and Cadastre, ISSN 1314-2704, Vol. 19, Issue 2.2, 741-748 pp, https://doi.org/10.5593/sgem2019/2.2/S11.091*
7. *Grădinaru, A.P., Badea, A.C., Ene, A., Badea G. (2025). The integration of geospatial analyses based on AI in GIS in the context of the "15-minute city" concept. E3S Web of Conferences 608, 05008, EENVIRO 2024, DOI: https://doi.org/10.1051/e3sconf/202560805008*