An Innovative Traffic Analysis for “Il Centro” mall

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1 Introduction and background of the study

CitiEU Consultancy LTD is a UK-based company experts in transportation planning, traffic engineering, and the use of transport-related big data. Since 2012, the company has had a strong partnership with TomTom, which allowed us to use and resell TomTom's solutions. TomTom has recently launched a new innovative module, called Junction Analytics, that immediately caught our attention for its enormous potentials. Our initial goal has been to identify how the solution could potentially be of use for traditional consulting services, but we soon realised the strengths of Junction Analytics and stimulated the need to test it on a well-known critical area in the surroundings of Milan, that is the "Il Centro" shopping mall in Arese.

This report describes the TomTom data with a specific focus on the Junction Analytics module, its application in the analysed context, the main findings, and the huge benefits of such a solution not just for "traditional" transportation planning and traffic engineering studies but for a vast range of needs and users. We can undoubtedly say that this case study reports only one of the many possible uses of Junction Analytics, leaving space for more in-depth investigations and applications.

2 TomTom Data

2.1 Overview

Since the 1950s, different survey methods and mathematical formulas have been developed to quantify and create models to provide a better view of trip distribution in a certain area. Applying questionnaires using varied approaches and delivery methods, such as roadside interviews, traffic light questions, license plate surveys, as well as other telephone, internet, and mail surveys are all examples of high-effort, low-quality origin-destination methodologies. Until recently, many of these old-school methods were still being applied in different parts of the world.

With all the location data available today, these methods have evolved to complex algorithms analysing incredibly huge amounts of Floating Car Data (FCD) and identifying trip dynamics. Since 2008 TomTom has been collecting anonymous consumer-driven GPS based measurements from its global community. With these trillions of measurements, TomTom built a historical traffic database that is completely unique in the industry.
2.2 Junction Analytics

Junction Analytics is a brand-new module of TomTom’s MOVE 3 portal, launched in September 2021. TomTom Junction Analytics allows for real-time monitoring of junction turn rates, current delay, and other valuable traffic information based on TomTom’s Floating Car Data (FCD). Data for each junction is refreshed automatically every 60 seconds and provides information such as:

- **Delay** – which is the current delay (in seconds) for the whole approach length.
- **Usual delay** – information on how long (in seconds) it usually takes for the drivers to leave the junction after stopping.
- **Queue** – information on how long (in meters) the current line of vehicles waiting on the junction approach is.
- **Travel time** – information on how long (in seconds) it currently takes for the vehicles to travel through the approach line.
- **Free flow travel time** – information on how long (in seconds) it takes for the vehicles to travel through the approach line during free-flow conditions (e.g. when there is no traffic at night).
- **Stops** – the average number of stops per vehicle on the approach (calculated from all probes in the last 30 minutes).
- **Historical data** – a chart containing all the stored historical information for this approach. Gathered from the moment the junction was created or edited in the tool. Historical charts offer three different timeframes - 24 hours, 3 days, and 8 days.
- **Turn ratios** – information about the percentage of vehicles taking a turn in a specific direction while leaving the approach. Calculated based on observed turns in the last 30 minutes, normalised by the sum of all probes passing this approach.

Apart from the statistics above, this new feature presents something unique and fundamental for traffic analysis: the capability to quantify **volumes per hour**. This is an estimated value of how many vehicles we observe travelling through each approach, per hour.

Not only the module allows real-time analysis, but it also give the option to collect and store data, making possible the analysis on mobility patterns and phenomena along several days (such as an entire week).
3 The "Il Centro" Shopping Mall Case Study

3.1 Overview

The Arese (Milan) Shopping Centre – with more than 200 shops, 30 restaurants, a diagnostic centre, a sports centre and several play areas – has a surface area of 93,000 sqm, is served by a car park with 10,000 parking spaces and is located in a geographical area characterised by substantial traffic flows from Switzerland, the lakes and Milan Malpensa international airport. The centrality of its location and its proximity to the cities of Lainate (25,676 inhabitants), Arese (19,201 inhabitants), Garbagnate Milanese (26,888 inhabitants) and Rho (49,616 inhabitants) led us to test the new Junction Analytics tool in this context.

Three different areas have been identified as sensitive for the analysis and are monitored via Junction Analytics for a typical period, from 10th to 17th October 2021.

The first monitored area (Figure 1) is delimited by intercepting all the roads entering and exiting the shopping centre. The analysis of this report allows us to:

- understand the congestion points in the vicinity of the shopping centre and their criticalities,
- quantify the impact of the shopping centre on the motorway and the local roads,
- identify all OD pairs to and from the shopping centre, with specific turn ratios.

The second analysed area (Figure 2) includes two roundabouts with three entry/exit points from the shopping centre. The analysis of this report allows us to:
- Identify queues and journey times at exits,
- Identify queues and Level of Service at roundabout approaches,
- Observe Origin/Destination and road usage (identifying the share of vehicles entering the different mall's parking areas, and the percentage of vehicles passing through).

Figure 2 – Report 2: Viale Alfa Romeo (source TomTom Move3 portal)

The third area (Figure 3) covers the urban network of Lainate, located in the proximity of the shopping centre and the motorway entrance. The analysis of this report allows us to:

- Assess the impact on the urban area of flows connected to the shopping centre,
- Identify and separate commuter flows, and flows related to the shopping centre,
- Identify queues and level of service at all the roundabout approaches.

Figure 3 – Report 3: Urban Area (source TomTom Move3 portal)
3.2 Real-time Analysis

A significant advantage provided by Junction Analytics is the possibility to analyse, in real-time, the traffic conditions from the portal or via APIs (Figure 4 to Figure 7).

These values can be used to act effectively at times of severe traffic congestion. In addition, the easy-to-use interface shows real-time values of the queues, indicates the delay values at each approach and allows an immediate understanding of local conditions. There are at least two key elements, unique of this solution, that are worth mentioning:

**Origin/Destination Matrices:**
Starting from the turn ratios defined on the three reports, and the estimated absolute traffic volumes, the Origin/Destination matrices of the areas under analysis can be derived.
Preparing real-time OD matrices of large areas, such as the one of the "Il Centro" shopping mall, is almost impossible using traditional methods. As shown in Figure 4, we can derive in a single analysis the complexity of all the OD pairs, both for the flows leaving the motorway (blue arrows) and entering the area (green arrows).

**API capabilities:**
Junction Analytics API also provides input for efficient traffic signal operations that makes it possible to allocate green time better and reduce traffic delay. Service is designed for traffic signal hardware and software vendors who want to optimise signal operations and optimise traffic flows at intersections. The portal makes it possible for the user to view the configured signalised intersections on a map using a companion Web application, validate the important road segments, and obtain new statistics such as turning movements.

*Figure 4 - Highway to Shopping Mall real-time Values (source TomTom Move3 portal)*
Figure 5 - Enter to the Parking Area real-time Values (source TomTom Move3 portal)

Figure 6 - Via Circonvallazione Ovest real-time Values (source TomTom Move3 portal)

Figure 7 - Via Rho real-time Values (source TomTom Move3 portal)
3.3 Historical Data Analysis

Junction Analytics allows to obtain real-time data and allows to store and access them as historical data. The following sections will demonstrate the specific data and report attainable, focusing on four of the most relevant approaches part of this analysis.

The tool allows to view historical data on diagrams, and filter them by data type (Delay, Stops, Queue length, Volume, Travel Time), aggregation method (Average, Minimum, Maximum, customisable Percentage) and timeframe (24 hours, with 5 minutes aggregation intervals - 3 days, with 15 minutes aggregation intervals - 8 days, with 60 minutes aggregation intervals).

The first two approaches that we have analysed are particularly relevant regarding the flows accessing and leaving the shopping mall and allow us to understand the implications of such flows in terms of spillbacks on the surrounding roads and the parking area.

The second two analysed approaches are mainly related to how an urban roundabout in the mall's vicinity, but not necessarily impacted by the same, works.

3.3.1 Approach 1: Highway to the shopping mall

The first analysed section connects the motorway to the network leading to the "Il Centro" (Figure 8). It is undoubtedly one of the most critical approaches in the entire area: on weekends, queues of vehicles entering the shopping centre generate a significant spillback phenomenon, reaching the motorway exit ramp.

As can be easily visualised in the below diagrams, the time of formation of queues and their lengths can be identified. Another critical element of the analysed Saturday and Sunday (Figure 9) is the delay, which reaches average values of 210 seconds and a queue length up to 700 meters, while the approach's length is 400 meters.
In addition to the phenomena visible for the weekend, the report shows something extremely interesting and not intuitive at first sight. As highlighted from the blue arrow on the analysed Friday, the volumes are even higher than what has been recorded on weekends, but at the same time, delays, queues, and travel time (green arrows) are not significant, thus representing how traffic typically related to the shopping mall and the road design has a dramatic impact on the functionality of the system.

![Figure 9 – Highway to shopping mall | 3 days Charts: Delay, Queue, Volume, Travel Time (source TomTom Move3 portal)](image)

The weekly diagrams (Figure 10) clearly show that the traffic flows on working days are more significant than on Saturdays and Sundays, but they do not generate substantial queues and allow to easily understand and quantify how traffic related to the mall can cause significant congestion.
3.3.2 Approach 2: Exits from the Parking Area

The second analysis covers a set of roads representing some of the exit points from the parking area to Viale Luraghi. The first exit from the parking to Viale Luraghi is the most critical one: on the days of maximum traffic from and to the shopping mall (Saturdays and Sundays), the observed average queues are around 450 meters (Figure 11). The second and third exits (Figure 12 and Figure 13) are critical on Friday, Saturday, and Sunday: the observed average queues are around 150 meters.
3.3.3 Approach 3: Via Circonvallazione Ovest

The third analysed approach (via Circonvallazione Ovest) is critical inside the urban context (Figure 14). It can be appreciated that this road is part of a complex micro-network made of a sequence of roundabouts.

Figure 14 - Via Circonvallazione Ovest (source TomTom Move3 portal)
On the days of maximum traffic from and to the shopping mall (Saturdays and Sundays), the observed average queues are around 50 meters (Figure 15), hence not significant or impacting.

Figure 15 - Via Circonvallazione Ovest 3 days charts for Delay, Queue, Volume, Travel Time (source TomTom Move3 portal)

Weekdays, instead, are more critical as maximum average queues of up to 1km are reached, with maximum average delays of 170 seconds (Figure 16). The delays and queues are critical both in AM and PM peak periods, demonstrating how commuting/work-related traffic is impacting.
3.3.4 Approach 4: Via Rho

The "via Rho" approach is another critical element of the urban area under analysis, and so we have analysed and monitored it in detail (Figure 17).

On Saturdays and Sundays (Figure 18), there are maximum average queues of 150 meters. However, weekdays are more critical as maximum average queues of up to 550 meters are reached, with maximum average delays of 80 seconds. This phenomenon shows that the approach is in critical condition with weekday commuter traffic (Figure 19).
Figure 18 - Via Rho 3 days charts for Delay, Queue Length, Volume, and Travel Time (source TomTom Move3 portal)
4 Main findings and Conclusions

The study aims to test the possible applications of an innovative tool such as TomTom’s Junction Analytics in an area affected by significant traffic and build best practices applicable to other contexts. It has been proven a precious tool for understanding how a complex scheme such as the one under analysis performs with minimal effort.

4.1 Benefits and possible applications

As experts in transportation planning and traffic engineering, the use of TomTom’s Junction Analytics made us realise the enormous power and potential of such a solution. At first glance, a user might think about simply using the tool to understand, quantify, and visualise the available data: this already has immense value! However, we also realised how using Junction Analytics and collecting in a proper way the derived information could become of high importance for transportation planning and, finally, for monitoring the effectiveness of any mobility actions. And what about other possible users, such as traffic engineers or even the local police? Junction Analytics allows managing periods of emergency and extraordinary congestion (accidents, road works), leading to acting promptly and consciously.

4.2 Five Criteria to evaluate Junction Analytics

4.2.1 ORIGINALITY

To our knowledge (and when writing this report, October 2021), there is no solution such as Junction Analytics that allows checking in real-time, via a straightforward web portal, traffic conditions quantifying critical elements such as queues and delays and estimating traffic volumes. Before Junction Analytics, having access to accurate information was a challenging and frustrating activity given the need to physically install on ground devices, limit analysis time to a few days or weeks, and refer to specialised companies for such activities. Junction Analytics provides you with a web-based solution, accessible also by not experts, with a simple to use interface that gives you immediately the answers you need.
4.2.2 BUSINESS MODEL

Using TomTom's Junction Analytics in the "Il Centro" case study, we realised how simple the solution is, as well as its flexibility. Nothing on the market is even close to what Junction Analytics can do. Upfront a minimal investment that allows accessing the TomTom portal, users have "traffic in their hands" and can immediately and constantly track, check, plan and act.

4.2.3 CUSTOMER NEEDS

This case study has proven a solid base for understanding how Junction Analytics could be used in several different contexts, benefitting a considerable range of possible clients, such as, but not limited to:

- **Public bodies:** understand everyday problems and criticalities in the urban environment and, thanks to an easy-to-use tool, provide timely responses to issues of mobility, pollution, or congestion, or validate and monitor sustainable mobility actions provided by planning initiatives such as from SUMP(s) (Sustainable Urban Mobility Plans).

- **Engineering, architecture, and urban planning consultants:** quantify the functional elements of an urban road network (queues, volumes, delays, turnaround rates, travel times) without the need for costly hardware installations and by retrieving data quickly.

- **Managers** of any "traffic generator" area such as shopping centres, airports, ports, stadiums, theme parks, sports centres, tourist centres: continuously monitor the levels of service of the infrastructures surrounding, and internal to, their areas, and to test and validate solutions in real-time.

- **Real estate developers** and **retail operators:** deciding where to build a new site or plan a set of locations for services like gas stations, shops, restaurants, or supermarkets, requires assessing the flows in the vicinity of the place to be analysed. Junction Analytics makes it possible to estimate the flows and thus have an indication of the potential demand.

- **Marketing agencies:** defining the best location for a billboard is a complex task that requires much information, such as the potential traffic passing by the billboard, possibly associated with the speed of transit. Junction Analytics makes it easy to obtain all this information.

4.2.4 SOCIAL IMPACT

Quantifying traffic volumes and understanding their impacts has always an enormous importance on any community. Junction Analytics allows quantifying, tracking, and visualising how much traffic goes through a specific road or area: this can lead to **proper and accurate traffic analysis** not limited to a few streets, where traffic counting devices are set in
place for a minimal time (typically, a few days). TomTom's solution offers an enormous advantage to all communities and becomes the backbone of any traffic impact study and will allow for planning interventions such as traffic calming solutions in a very well-informed way. But not only this: quantifications of volumes, delays, queue lengths, and more allow to evaluate environmental-related elements such as air quality and noise.

4.2.5 SUSTAINABILITY

As mentioned in paragraph 4.2.4, the use of this tool will ensure that the actual effectiveness of sustainable mobility actions is monitored and areas for intervention identified. In addition, it is relevant to mention that critical elements in terms of pollution and noise are typically related to non-optimised signalised junctions in any urban context.

Although not tested for the "Il Centro" study, Junction Analytics can be used to optimise single and networked traffic lights, reduce the number of vehicles stops, and reduce pollution. Traffic Volumes on the approaches and Turn Ratios are strategic elements used by traffic engineers to calibrate green times at each approach and the duration of the traffic light cycles. With the possibility of observing the volume trend during an "eight-day" period and the option of displaying Turn Ratios, it is possible to design customised traffic light programmes for each part of the day and each part of the week.