QROWD - Because Big Data Integration is Humanly Possible

Innovation Action

Grant agreement no.: 732194

D1.1 – Datasets Release for Model Region

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<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tr>
<td>CDS</td>
<td>Credit Default Swap</td>
</tr>
<tr>
<td>DSS</td>
<td>Decision Support System</td>
</tr>
<tr>
<td>EC</td>
<td>European Commission</td>
</tr>
<tr>
<td>EOB</td>
<td>End-of-Business</td>
</tr>
<tr>
<td>ICT</td>
<td>Information and Communication Technology</td>
</tr>
<tr>
<td>IE</td>
<td>Information Extraction</td>
</tr>
<tr>
<td>ITF</td>
<td>Independent Text File</td>
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<tr>
<td>RTD</td>
<td>Research and Technological Development</td>
</tr>
<tr>
<td>UC</td>
<td>Use case</td>
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<tr>
<td>WP</td>
<td>Work Package</td>
</tr>
<tr>
<td>CTM</td>
<td>Custom Traffic Monitoring</td>
</tr>
<tr>
<td>CTT</td>
<td>Custom Travel Time</td>
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<td>CPC</td>
<td>Custom Probe Count</td>
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EXECUTIVE SUMMARY

This document describes the QROWD business case related to “Advanced Road Information Services for Urban Areas Business Case”. The business case is comprised by three use cases, that were elicited from the needs of the city of Trento in mobility and traffic management: 1) Touristic network - Analysis of travel time on strategic roads in the context of tourism, 2) Parking services - Accurate information on where to find parking spots, 3) Traffic Services - Impact of cultural and weather events on traffic. For each use case, we describe its context, goal and scope, datasets required to realise it, and further business interest. We also present the results of data analysis conducted with the already available data, to assess the feasibility of the services and assess the requirements from additional data and tools to be provided by the QROWD Platform.

The deliverable will serve as a reference for the technical team of the QROWD on the implementation of the tools required to realise the use cases, towards their delivery in D1.3. It will also be of interest for organisations working on urban mobility related projects, as they reflect the needs of a real city and outline the datasets that the QROWD consortium considered necessary for their realisation.
I. INTRODUCTION

In the context of QROWD, new smart mobility services will be built using the city of Trento as a model region, exploiting the integration of data collected, processed and analysed thanks to the QROWD platform, and private data shared by TomTom.

In this document, we describe the three use cases which has been defined during the first running-year of the project in collaboration with the Municipality of Trento. They reflect real requirements of the municipality, that are expected to be similar to the ones of similar regions, therefore, being potentially replicable.

Trento, situated in a mountain valley, does not offer many possibilities for developing a large urban road infrastructure. Furthermore, the city is crossed by the heavily used Brenner highway. Consequently, Trento suffers of traffic congestion especially during the winter season as many visitors come to enjoy winter sports in one of the thirty-one ski resorts located around. Such a traffic situation in addition of causing even more pollution, affects directly the mood of people. Therefore, providing more reliable and accurate services in Traffic management would lead to a better understanding of traffic and delay, leading to the reduction of traffic disturbances. During the runtime of QROWD the main goal is to achieve significant improvement in the driving time in urban areas (by more than 5%).

Recent measures have been taken by the municipality in order to discourage road users to drive within the city-center. A limited traffic zone has been created, and pay parking zones with variable fees have been implemented. Several open parking garages surrounding the limited traffic zone allow drivers to park close to the city-center. However, during the tourist seasons parking garages seem insufficient because of the high number of visitors. Consequently, finding a parking lot in Trento can be challenging. Therefore, providing reliable parking services supporting drivers in finding parking lots will reduce congestions and thus lower CO₂ emissions. It will also enable the city to better understand and manage street parking inventory to improve urban mobility.
1. DESCRIPTION OF THE BUSINESS CASE

The business use case comprises three use cases that will build upon the integration of datasets provided by the municipality of Trento, collected during the execution of the QROWD project and TomTom data. The required datasets, potential setbacks and risks are described.

The three use-cases are:

- **BC1-UC#1: Touristic network - Analysis on travel time on strategic roads in the context of tourism**
- **BC1-UC#2: Parking services**
- **BC1-UC#3: Traffic Services**

### A. Use cases identification

The three use cases described in this document include sub-use cases which details the various facets of the services developed. The following plan outlines the different use cases presented in the document:

- **BC1-UC#1: Touristic network - Analysis of travel time on strategic roads in the context of tourism**
  - Route monitoring
  - Visualization using schematic map
- **BC1-UC#2: Parking services**
  - Off-street parking
  - On-Street parking
- **BC1-UC#3: Traffic Services**
  - Historical Analysis:
    - Cultural Events impacts on traffic (e.g. Christmas Market)
    - Weather impacts analysis
      - Extreme weather impacts
      - Correlation between weather & traffic
      - Correlation between weather & parking
  - Road Event Reporter
  - TomTom City platform
II. USE CASES DESCRIPTION

1. BC1-UC#1: TOURISTIC NETWORK – ANALYSIS OF TRAVEL TIME ON STRATEGIC ROADS IN THE CONTEXT OF TOURISM

Context

As Trento is located into the valley surrounded of mountains, the city’s access is limited by few routes and a major highway connecting Trento to Verona and Bolzano, Innsbruck and Munich. Trento is a major touristic destination for winter sports as well as cultural events like the Christmas Market. Indeed, there are thirty-one ski resorts in the Trentino region. Consequently, the number of visitors is very high during the high peak ski season, which drastically increases the number of vehicles on roads, leading to traffic disturbances like congestions in the city and in the routes leading to the ski resorts. Such a situation in addition of causing even more pollution, affects directly the moral of people who came to spend enjoyable vacation in the surroundings of Trento.

Goal and scope

In order to reduce congestion around the entertainment areas and in the city-center, the main idea is to suggest travelers which touristic hotspots to visit based on current travel time, so they can avoid traffic and potentially long queues. In a first step, this service will be offered for reaching the ski resorts only, but is potentially extensible to any type of touristic infrastructure. This information will be displayed using various dynamic visualizations into the QROWD dashboard and potentially variable-message signs. It will emphasize the meaning and the current situation of single parts of the network in a schematic map, summarizing the strategic routes which are essential to reach the touristic hotspots. Current travel time and eventual delays for each segment of road will be displayed. The visualization will cover a larger regional area (e.g. from Munich in Germany, Innsbruck in Austria, Milan in Italy) to help potential travelers and tourists from more distant regions.

Figure 1: The Touristic Network to reach most of the ski resorts around Trento
Two steps are required in order to make possible the implementation of the Touristic Network:

1) The first step consists of collecting datasets, in the form of a table, on travel time and on eventual delay for each segment of strategic roads in the Touristic Network. The main roads leading to the ski resorts are the road selected to constitute the Touristic Network. This important amount of data will be collected by TomTom using the platform called Route Monitoring. It is a platform currently developed by TomTom Polska ZOO. It gives detailed information on travel time and delays for each route selected. Once acquired and stored, this dataset can be analyzed by the city in order to enable better traffic studies and to be well-informed on the traffic condition on roads leading to the ski resorts during the winter season.
2) The second steps consists on developing the visualization of the service. The data produced by Route Monitoring will be displayed in various visualizations as the schematic map. The schematic map will be used to simplify the understanding of the live traffic information. This approach is currently being experimented. One of the output of this research is the necessity of fusing data from multiple sources (Municipality of Trento, Trentino Region, and TomTom) in order to well inform citizens about reaching every touristic hotspots.

This enables a quick overview, visualizing the travel time needed to reach each ski resorts in the region. Therefore it allows a reliable planning and a safe journey for individual visitors being informed. People having access to the tool may choose to reach a resort which is closer in terms of travel time for more efficiency.
Data Description

On the table below are the data available, enabling us to implement this relevant service.

Table 1: Data required in order to implement the Touristic Network

<table>
<thead>
<tr>
<th>ID</th>
<th>Dataset</th>
<th>Owner</th>
<th>Data Category</th>
<th>Type format</th>
<th>Open Data</th>
</tr>
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<tr>
<td>1056</td>
<td>Ski Resorts</td>
<td>Provincia di Trento</td>
<td>Static</td>
<td>SHP</td>
<td>Y</td>
</tr>
<tr>
<td>2001</td>
<td>TomTom Map</td>
<td>TomTom</td>
<td>Static</td>
<td>SHP</td>
<td>N</td>
</tr>
<tr>
<td>2002</td>
<td>Point of Interest</td>
<td>TomTom</td>
<td>Static</td>
<td>SHP</td>
<td>N</td>
</tr>
<tr>
<td>2006</td>
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<td>Real-Time data</td>
<td>Datex II</td>
<td>N</td>
</tr>
<tr>
<td>2007</td>
<td>TomTom Traffic Incident</td>
<td>TomTom</td>
<td>Real-Time data</td>
<td>Datex II</td>
<td>N</td>
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<td>2008</td>
<td>TomTom Route Monitoring</td>
<td>TomTom</td>
<td>Dynamic</td>
<td>CSV</td>
<td>N</td>
</tr>
</tbody>
</table>

[1056] Ski Resorts: On this shapefile all the ski resorts in the Trentino region are located in the form of polygons composed by points. The name of the ski stations are given for each polygon.

[2001] TomTom Map: The TomTom MultiNet database is a highly accurate and comprehensive digitized reproduction of today’s road, street and transportation network that also includes land cover features. Complete database updates are released four times a year. Source: https://www.tomtommaps.com/en_us/maps/

[2002] Point of Interest: The Point of Interest dataset, as indicated by his name, contains coordinates of relevant locations. These relevant locations can be hotels, restaurants but also viewpoint, shops, etc. Source: https://www.tomtommaps.com/en_us/maps/

[2006] TomTom Flow: TomTom Traffic Flow delivers a real time, detailed view of traffic speeds on the entire road network, designed for easy integration into traffic management systems or routing engines to calculate current travel times. Source: https://developer.tomtom.com/online-traffic

[2007] TomTom Traffic Incident: TomTom Traffic provides precise locations and delays caused by congestion on the road network, allowing routing
programs to provide the fastest route based on actual current travel times.  
Source: https://developer.tomtom.com/online-traffic

[2008] TomTom Route Monitoring: This tool, implementing into a portal, enables you to select strategic routes on a map. The current travel time and the possible delays are given for the selected routes only. The data showing current travel times and delays will be extracted in order to collect more data in the scope of QROWD.

Sequence diagram

Figure 3 shows the sequence diagram of the use case. Using data from the CKAN component, described in deliverable 4.1, the TomTom component integrates with live traffic information from TomTom’s database to generate a visualization that can be queried by citizens.

Figure 3: The Touristic Network’s sequence diagram

For further development

Once the Touristic Network is launched and used by citizens and visitors, various improvements of the tool can be done in order to develop its functionalities. For instance, additional information describing the ski resorts and the strategic routes (e.g. viewpoint, ski trail difficulty ratings, snow shortage) may be added in order to support travelers choosing the right place to spend
their free time. This improvement is possible using the TomTom's POI and the city's datasets. Moreover, we can always imagine displaying information on how to reach the ski resorts using, for example, public transportation. The authorities can also use this tool for safety measures and to inform in a real time drivers on frosts, snow and other dangers.

To test the quality of the information displayed by the Touristic Network service, we will explore the use of crowdsourcing strategies through mobile application interaction, using the participatory framework defined in D3.1

**Business interest**

As part of our work in the project we committed to provide a model that can be implemented in other cities famous for winter activities, with the expectation of exploring market opportunities in the Smart Cities context.
2. BC1-UC#2: PARKING SERVICES

Context

Driving around looking for a parking spot causes frustration for drivers resulting from the wasted time and late arrival at their appointments. It affects their comfort levels in terms of anxiety, awareness, and stress. According to the research paper entitled “How Much Urban Traffic is Searching for Parking?”¹, it takes on average between 3.5 and 14 minutes in a typical search to find a parking spot. More than 60% of the drivers have abandoned their search because they couldn't find parking. Drivers who are frustrated not finding any proper parking spot might be inclined to park in forbidden areas or further away from their final destination. In addition to contribute to increased traffic congestion, searching for parking spot also adds to noise pollution and CO2 emissions.

The city of Trento is no exception to this common problem of cities. Indeed, finding a parking spot in the city-center of Trento has proven to be a growing challenge. In order to reduce the traffic within the city-center, the municipality has restricted the access to the city-center to all vehicles. It is now a limited traffic zone. Several open parking garages are located near the city-center. However, the parking garages are still insufficient during the peak touristic seasons, as the city welcomes lots of visitors every year.

Goal and Scope

One approach to reduce the parking searching time is to keep citizens and visitors informed about available parking spots both Off-Street and On-Street. This can contribute to reduce the creation of traffic jams due to parking search.

http://shoup.bol.ucla.edu/Cruising.pdf
A. Off-Street Parking

Description of the service offered

Off-Street Parking is defined as spaces for vehicles to park which are located on private property rather than on public streets, usually in parking facilities like garages and lots. The following information can be provided as part of this service depending on the available datasets: real-time availability of parking spaces, pricing information, operating hours and maximum stay restrictions, additional services information, e.g., security surveillance, car-wash, etc.), and vehicle sizing constraints.

Figure 4: Off-street parking visualization

Description of required datasets

The Municipality of Trento owns enough datasets on garage location, restriction, associated services to properly implement this service with good quality results. The available datasets are presented below:

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<thead>
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<td>Comune di Trento</td>
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<td>1018</td>
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<td>Comune di Trento</td>
<td>Real-Time data</td>
<td>JSON</td>
<td>Y</td>
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</tbody>
</table>
### List of underground parking

It contains several names of streets where it is allowed to park. In addition to this, it gives some indications on restrictions and pricing.

### Occupation of underground parking places

This data will keep citizens informed about real-time availability of parking spaces in addition to the location and capacity of the garages.

### Parking for people with disabilities

This contains precise information about garages as it is required for disabled drivers to decide if parking is possible.

### TomTom Map

The TomTom MultiNet database is a highly accurate and comprehensive digitalized reproduction of today's road, street, and transportation network that also includes land cover features. Complete database updates are released four times a year.


### Point of Interest

The Point of Interest dataset, as indicated by his name, contains coordinates of relevant locations. This includes hotels, restaurants but also viewpoint, shops, etc.

B. On-street parking

Description of the service offered

On-Street Parking is defined as parking for a vehicle that is permitted at the side of the driving street. The TomTom On-Street Parking service provides drivers with historical information about the expected parking availability on public streets in certain city areas. TomTom derives this parking information by analyzing the traces from our community of over 500 million connected devices that are contributing to TomTom services. TomTom uses sophisticated algorithms to detect parking searches from trace data. There are certain driving characteristics that help in detecting parking searches such as speed, turns, loops, etc.

The service provides the following layers of data:

- Parking Profiles: indicating the probability of finding a parking spot on each permitted road stretch in the city - for each specific hour of the day and day of the week. (i.e. the chance a driver can park on a particular road segment)

- Average Search Time: An indication of the average time spent searching for an on-street parking spots based on your current location - for each hour of the day and for each day of the week. (i.e. the average time it will take a driver to find a parking spot after crossing a particular road segment)

- Parking Restriction and Pricing information: The parking restriction and pricing information must come from the city data. Displaying such a very accurate information to the service we want to build, assures the high quality of it.

TomTom generates this information for every time of the day, day of the week which will result in historical parking profiles. Using six years of historical trace data makes possible the creation of parking profiles for every road segment.
With ever-increasing parking search times, drivers are seeking better ways and alternatives to park. Parking profiles enable navigation applications to route drivers to a parking space quickly and in the most comfortable way. By selecting the quickest route to park the benefits for the driver are numerous. The parking search time gets reduced, it also means less fuel consumption and less stressful journeys.

The number of parking event coming from the TomTom data has been calculated for every month since the 1st January 2011. In figure 5, we can observe that the number of events has increased since 2016.
Figure 6: The parking events calculated per month in Trento

**PARKING EVENTS PER MONTH**

![Graph showing parking events per month from January 2011 to November 2016.]

Figure 6 highlights the impact in the dates the Christmas market is running.

Figure 7: The impact of Christmas market on parking in Trento

**PARKING EVENTS PER MONTH**


The chart shows that we can not conclude of any recurrent impact on parking during the Christmas market.

Moreover, from the analysis we conclude that TomTom has enough probe data in order to implement the parking probabilities. However, six years of data are needed in order to build relevant and accurate probabilities because Trento is a medium city so less probe data should be available. In bigger cities, TomTom needs to compute only two years of data in order to build relevant probabilities.

In the scope of providing highly accurate parking probabilities, we would like to analyze the Parking Payment dataset, in other words “Information from Mobile
Payment Parking” [1036], which would most likely improve the quality of parking probabilities by extending the available sources. In fact, the Parking Payment’s data will be a very valuable output as it gives more precise information on parking availability and can be seen a trustworthy source of ground truth. Therefore, the Parking Payment dataset will be used in order to compare the parking probabilities computed by TomTom. This comparison shall give us a clear indication on the accuracy of the parking probabilities.

In use case BC2-UC#3 described in deliverable 2.2, the consortium will tackle the measurement of the occupancy of parking mobility infrastructure using both crowdsourcing and citizen sensing. This data will be used to assess the quality of the probabilities computed from historical values, and to provide better estimates when relevant. In turn, TomTom's historical dataset will help the municipality to understand historical variations of parking.

**Description of the dataset required**

<table>
<thead>
<tr>
<th>ID</th>
<th>Dataset</th>
<th>Owner</th>
<th>Data Category</th>
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<td>GML/SHP/KML/DXF</td>
<td>Y</td>
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<tr>
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<td>JSON</td>
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<td>JSON</td>
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</tr>
<tr>
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<td>Taxi Stations</td>
<td>Comune di Trento</td>
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<td>JSON</td>
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<tr>
<td>1035</td>
<td>Information from mobile payment parking (Tbd)</td>
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<td>Static</td>
<td>SHP</td>
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<td>3001</td>
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<td>Real-Time data</td>
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<tr>
<td>3002</td>
<td>iLog generated user feedback streams (Tbd)</td>
<td>University of Trento</td>
<td>Real-Time data</td>
<td>Tbd</td>
<td>N</td>
</tr>
</tbody>
</table>
[1022] Paid parking zones: This data defines several polygons which correspond to regions with different pricing. This is completed with a table indicating different pricing according to the regions.

[1023] Zone ZTL / RTZ restricted traffic zones: In Trento, there are many restricted zones for parking and circulating in the city-center. This data lists all of them. These restricted areas will be removed from the parking probabilities datasets to avoid any mistake in the probability of finding a parking spot there.

[1052] Parking meter: This data indicates only the location of parking meters. From the location of parking meters, we should be able to deduce the possibility of on-street parking in the areas around.

[1053] Parking Street: The parking street gives a list of streets and slots of parking. Some restrictions information is available. This is static data and not live data.

[1041] Taxi Stations: This dataset gives point-location information of taxi stands. Taxis stop and depart from these areas very frequently. Since taxis are algorithmically hard to distinguish from ordinary drivers, this leads to a high amount of wrong parking events. This, in turn, leads to a high parking probability close to taxi stands. Excluding the regions in the dataset might lead to more realistic parking probabilities.

[1035] Information from mobile payment parking: The Parking Payment is not available yet. It gives information about the parking machines which is extremely precious when it comes to count entries and exits of parking zones and garages to define their availability.

[2005] Parking Probabilities: Information that indicates the likelihood/chance for a driver to find a free parking spot on a particular street. Source: https://developer.tomtom.com/on-street-parking

[3001] & [3002] iLog: The University of Trento is currently developing an app called iLog. This app is expected to be launched in December 2017. The goal of this app is to collect streaming data in a raw format from the users, in other words, the citizens. Furthermore, users will be asked regularly behavioral questions, in particular about their daily mobility. Their answers will be collected and used to improve the data quality as well as to compute mobility related statistics for the city, e.g., the modal split. On the other hand, this app also collects a certain number of sensor data from the phones themselves. The end goal of the app is to be used by the Council as the most effective way of collecting a certain amount of data.

[2001] TomTom Map: The TomTom MultiNet database is a highly accurate and
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A comprehensive digitalized reproduction of today's road, street, and transportation network that also includes land cover features. Complete database updates are released four times a year.

Source: https://www.tomtommaps.com/en_us/maps/

[2002] Point of Interest: The Point of Interest dataset, as indicated by his name, contains coordinates of relevant locations. This includes hotels, restaurants but also viewpoint, shops, etc.

Source: https://www.tomtommaps.com/en_us/maps/

Sequence Diagram

Figure 8 shows the sequence diagram for the on-street parking version of this use case. From the QROWD database, The TomTom component integrates the trips made by car that were collected as part of BC2-UC#1 - Modal Split Use Case (described in deliverable 2.2) and the time series of parking meters with the traces from the TomTom database to compute more accurate parking probabilities, that are written at both sides.

Figure 8: The on-street parking's sequence diagram
3. BC1-UC#3: TRAFFIC SERVICES

Context

In Trento, several strategic roads are congested during commutes and high peak tourist seasons but also during cultural events as Christmas Market and Economics Festival. This phenomenon is aggravated by the fact that the city is surrounded by mountains. It means that the possibility of constructing new roads in order to spread the traffic is very limited. Consequently urban congestion causes delay, rises up crashes risks, provokes additional stress and can even penalize vacation time.

Goal and Scope

The right first thing to do in order to reduce the traffic is to generate traffic reports to better understand the specificities of the concerned place. This will allow authorities to transform the city in the most efficient way according to the results of the traffic studies and the citizen’s behavior. Additionally, it enables the tracking of any change in the traffic condition. TomTom City is a platform which enable authorities keep an eye on the current traffic condition and on recent improvement or alteration. It also compares the situation with similar cities. Thus, cities can share their experiences. Authorities also want to have a complete control on the road network to manage it in the most efficient way. The Road Event Reporter is a platform developed by TomTom which can be integrated into the command control of the urban management in the city. It enables traffic managers to have an overview of the traffic in live and to be active on it. With a few clicks they can report road closures, road works, accidents and other disruptions that are affecting traffic in the city. The information is then sent to drivers using PND and can be display on roadside messages to inform all citizens.

We want to develop a complete traffic management service which ensures congestion improvement in Trento. It will allow citizens to be better informed and the city to better control the traffic.
Here are the different services developed in order to improve the traffic management in Trento:

A. Historical Analysis:
   1) Cultural Events impacts on traffic (e.g. Christmas Market)
   2) Weather impacts analysis
      a. Extreme weather impacts
      b. Correlation between weather & traffic
      c. Correlation between weather & parking

B. Road Event Reporter
C. TomTom City platform
A. Historical Analysis

1) Impacts of cultural Events on traffic (e.g. Christmas Market)

The Trentino region is dynamically active organizing cultural events all year. Several festivals take place every year and are very reputed such as the TrentoFilmFestival, Festival of Economics and TrentinoJazz. In addition, the Christmas Market in Trento is very famous and attracts lots of visitors. In 2015, the Christmas Market totalized 730 thousand visitors in forty-six days. This obviously contributes to a rise in traffic congestion.

Goal and Scope

In order to improve the road management during the Christmas Market in Trento, a historical analysis will be ran. This analysis will compare the period the Christmas Market takes place with the average situation. The results should show impacts caused by this particular event on several strategic routes. Once the results are known and are relevant, traffic managers can define a more adapted strategy for managing the traffic during the Christmas Market for the coming years. Therefore, the jam tendency should be reduced thanks to a better understanding of the traffic condition during exceptional cultural events.

Description of the analysis

To run precise historical analysis combining the whole period selected, small stretch of roads will be selected. Moreover, a date range needs to be defined. For this specific analysis, the Average Speed profile and the amount of Traffic will be measured every hours during the day. Data will be output in the form of excel tables to the shared data space.

Features of the analysis of the Christmas market

The Christmas market of Trento takes place in Piazza Fiera and Piazza Cesare Battisti which are two main squares in the city-center. In 2015-2016, the Christmas market has started on November 18th in 2016 and ended on January 6th in 2017. Therefore, the analysis will be run from November 18th 2016 to January 6th 2017 in relevant streets located around Piazza Fiera and Piazza
Cesare Battisti.

Figure 10: Piazza Fiera and Piazza Cesare Battisti location

Source map: mydrive.tomtom.com

1. Relevant streets:
   - Close to Piazza Fiera: Via Dietro le Mura, Via F. Barbacovi, Via Piave, Via S. Croce, Via del Torrione, Via G. Mazzini
   - Close to Piazza Cesare Battisti: Via G. Manci / Via S. Pietro / Via del Simonino / Via A. Diaz / Via P. Oss-Mazzurana

2. Date range: From 18/09/2016 to 06/01/2017 (with the exception of 25th December)

3. Time range:
   - Every day from 10AM to 7.30PM
   - From 8/12 to 11/12: from 10AM to 8.30PM
   - On 26/12 and 1/01: from 12PM to 7.30PM
Description of the required datasets

Table 4: Data required for running a relevant historical analysis on the traffic during the Christmas Market

<table>
<thead>
<tr>
<th>ID</th>
<th>Dataset</th>
<th>Owner</th>
<th>Type format</th>
<th>Data Category</th>
<th>Open Data</th>
<th>Data time range</th>
</tr>
</thead>
<tbody>
<tr>
<td>2003</td>
<td>Historical Traffic States</td>
<td>TomTom</td>
<td>CSV/SHP</td>
<td>Static</td>
<td>N</td>
<td>from 2008-01-01 to latest available</td>
</tr>
<tr>
<td>2004</td>
<td>Historical Traffic Analysis / Traffic Stats</td>
<td>TomTom</td>
<td>SHP/KML/XLS</td>
<td>Static</td>
<td>N</td>
<td>from 2008-01-01 to latest available</td>
</tr>
</tbody>
</table>

**[2003] Historical Traffic States:** This contains all the historical traffic data stored since 2008. In total, TomTom’s historical traffic database has trillions of anonymously-collected data points, providing analysis to predict driving behavior across the road network.

**[2004] Historical Traffic Analysis / Traffic Stats:** Stored data for the whole world can be extracted via the TomTom Traffic Stats portal. As the University of Trento and the Municipality of Trento have access to this portal, they can freely run analysis on particular roads or areas and extract datasets. As output, analysis on Speeds (Median, Average, and Percentiles), Standard Deviation, Travel Times and Sample Size can easily be done directly on the portal. 

*Source: [https://developer.tomtom.com/traffic-stats](https://developer.tomtom.com/traffic-stats)*
Sequence Diagram

Figure 11 shows the sequence diagram of the use case studying the impact of cultural events on traffic. Using information shared by the city council and historical traffic data from the TomTom database, described in deliverable 4.1, the TomTom component computes the traffic analysis.

Figure 11: The Historical Analysis’ sequence diagram

Initial feedback

Some preliminary evaluations have been conducted. However, the results so far did not indicate any significant traffic impacts during Christmas Market. We conclude that a closer collaboration with the Municipality of Trento is essential to better understand the relevance of the various road segments (and possibly other factors) for this type of analysis.

Figure 12 shows the traffic during the Christmas Market in the Georgio Bridge and during non-market times. The speed profile shows some noise during the night time because, as we can see in the traffic density chart, the number of samples very low. During the day, we get more samples so the speed profile better represents the reality on the road. Moreover, looking at the two charts we can see that there is no obvious difference on the road condition during the Christmas Market and other times. Several reasons can explain this. It can be because this particular road was not saturated during this event as it was not an inevitable road leading to the Christmas market. We learn from this first evaluation that the coming analysis needs to be more precise. The lack of perceived difference may also result in the fact that there are less available data for Trento than for bigger cities (Milan for instance).
Figure 12: Charts representing the traffic condition on the Giorgio Bridge during the Christmas Market in Trento
2) Weather impacts analysis

Context

As an Alpine town, Trento might be impacted by some extreme weather events like snow, black ice, heavy rain or fog. Bad weather might cause disturbances on roads because drivers lack of visibility. Thus, lots of accidents can be related to a bad weather condition.

Goal and Scope

In the scope of improving the safety measures, an analysis of weather impacts on traffic will be conducted. This study shall demonstrate the traffic disturbances during extreme weather events. According to a better understanding on weather impacts, the prediction on travel time will get more precise and people will be better informed on risks.

In addition to this analysis, two others will be run in order to study potential impact of weather on parking and traffic. The final objective is to take notice of existing correlation between weather and traffic, and weather and parking. We indeed assume that weather influences tourism. For instance, a nice weather might have an influence on tourism activities in the surroundings of Trento because more people would like spending enjoyable time in the lakesides. Consequently, roads may be more congested and parking spots may be harder to find than it is usually.

Thus, these analysis of weather impacts will be used by the traffic managers of Trento in order to improve the security measures and to anticipate traffic jams:

The three running analysis of weather impacts:

- Extreme Weather Event
- Correlation between weather & traffic
- Correlation between weather & parking
a. Extreme Weather Event

**Description of the analysis**

Traffic historical datasets will be computed for the days with extreme weather events. For now, we have pinpointed several of these events which are relevant to study. They are:

- Frosts in end of April 2016
- Strong wind in March 5th 2015 and from January 9th to 11st 2015
- Heavy rain from June 23rd to 24th 2013

The result of the analysis will be compared with the average traffic condition. Comparing the results will in fact enable to detect any behavior change of drivers during a heavy rain, a snow or other extreme weather events.

**Description of the data required**

Table 5: Data required in order to run an historical analysis of impacts on roads during extreme weather events

<table>
<thead>
<tr>
<th>ID</th>
<th>Dataset</th>
<th>Sector</th>
<th>Owner</th>
<th>Data Category</th>
<th>Type format</th>
<th>Open Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>-</td>
<td>Extreme weather events 2016</td>
<td>Weather</td>
<td>Provincia di Trento</td>
<td>Static</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>2003</td>
<td>Historical Traffic States</td>
<td>Geo</td>
<td>TomTom</td>
<td>Static</td>
<td>CSV/SHP</td>
<td>N</td>
</tr>
<tr>
<td>2004</td>
<td>Historical Traffic Analysis / Traffic Stats</td>
<td>Geo</td>
<td>TomTom</td>
<td>Static</td>
<td>SHP/KML/XLS</td>
<td>N</td>
</tr>
</tbody>
</table>

**Extreme weather events 2016:** As we would like to study several events to detect changes in the driver's behavior, we need to make a list of Extreme Weather Event in order to study them.

**[2003] Historical Traffic States:** This contains all the historical traffic data stored since 2008. In total, TomTom’s historical traffic database has trillions of anonymously-collected data points, providing analysis to predict driving
behavior across the road network.

**[2004] Historical Traffic Analysis / Traffic Stats:** Stored data for the whole world can be extracted via the TomTom Traffic Stats portal. As the University of Trento and the Municipality of Trento have access to this portal, they can freely run analysis on particular roads or areas and extract datasets. As output, analysis on Speeds (Median, Average, and Percentiles), Standard Deviation, Travel Times and Sample Size can easily be done directly on the portal. 
*Source: [https://developer.tomtom.com/traffic-stats](https://developer.tomtom.com/traffic-stats)*

**Sequence diagram**

Figure 13 shows the sequence diagram of the use case studying the impact of extreme weather events on traffic. Using data from the CKAN component, described in deliverable 4.1, the TomTom component computes historical traffic information from TomTom’s database to generate an evaluation of the impacts of extreme weather events on traffic.

*Figure 13: The Extreme Weather Event’s sequence diagram*
b. Correlation between weather & traffic

Description of the analysis

Here the idea is to observe if weather has any impact on traffic. To produce such an analysis, we need to compare historical weather data with historical traffic data. Comparing these two datasets will make possible to detect any impact. It should show phenomenon as, when the weather is rainy people tend to use more their car for even very short travels. However, it is also possible that when it is sunny, more people go to the lakes and other recreation areas around Trento, with the consequent impact in traffic. Thus, the output of this study will be to define some phenomenon happening on roads that is strongly influenced by weather condition.

Another way of observing the correlation between weather and traffic is to look at different car accidents and see if weather was a cause of accident.

Description of the required data

The Municipality of Trento owns lots of data describing the weather and also lots of data on road accidents. However, the Municipality may not have stored the weather data. In this case, the stored historical weather data of TomTom will be used to complete this analysis.

<table>
<thead>
<tr>
<th>ID</th>
<th>Dataset</th>
<th>Sector</th>
<th>Owner</th>
<th>Data Category</th>
<th>Type format</th>
<th>Open Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>1001</td>
<td>Meteo stations</td>
<td>Weather</td>
<td>Provincia di Trento</td>
<td>Static</td>
<td>XML</td>
<td>Y</td>
</tr>
<tr>
<td>1003</td>
<td>Daily weather forecast</td>
<td>Weather</td>
<td>Provincia di Trento</td>
<td>Dynamic</td>
<td>XML</td>
<td>Y</td>
</tr>
<tr>
<td>1004</td>
<td>Weather forecast for Trento (East)</td>
<td>Weather</td>
<td>Provincia di Trento</td>
<td>Dynamic</td>
<td>XML</td>
<td>Y</td>
</tr>
<tr>
<td>1005</td>
<td>Weather forecast for Trento (North)</td>
<td>Weather</td>
<td>Provincia di Trento</td>
<td>Dynamic</td>
<td>XML</td>
<td>Y</td>
</tr>
</tbody>
</table>
Traffic contains the all data traffic States: Historical [2003]

Source: https://developer.tomtom.com/tabular-weather/tabular-weather-api

Advanced Weather: It provides real time weather information as simplified polygons over a specific area which results in detailed, granular and bandwidth efficient weather information. 
Source: https://developer.tomtom.com/advanced-weather

Historical Traffic States: This contains all the historical traffic data stored since 2008. In total, TomTom’s historical traffic database has trillions of anonymously-collected data points, providing analysis to predict driving behavior across the road network.
Datasets Release for Model Region

[2004] Historical Traffic Analysis / Traffic Stats: Stored data for the whole world can be extracted via the TomTom Traffic Stats portal. As the University of Trento and the Municipality of Trento have access to this portal, they can freely run analysis on particular roads or areas and extract datasets. As output, analysis on Speeds (Median, Average, and Percentiles), Standard Deviation, Travel Times and Sample Size can easily be done directly on the portal. Source: https://developer.tomtom.com/traffic-stats

Sequence Diagram

Figure 14 shows the sequence diagram of the use case studying the correlation existing between weather and traffic. Using data from the CKAN component, described in deliverable 4.1, the TomTom component computes historical traffic information from TomTom’s database to generate the analysis.

Figure 14: The sequence diagram representing the study correlating weather with traffic
c. Correlation between weather & parking

Description of the analysis

Historical weather condition will be compared with parking availability. This analysis will indicate to the traffic managers of Trento any correlation between weather and parking. In the case, there is a correlation as for instance more parking slots are available because of the rain. In this case, it can certainly be interpreted that the people are less willing to go out when the weather is rainy.

Description of the required data

To run such an analysis, the city’s datasets describing weather and parking availability will be computed. In case the weather datasets owned by the city is not store, the weather data owned by TomTom will be used to complete successfully this analysis.

Table 7: Data required to study the correlation between weather and parking

<table>
<thead>
<tr>
<th>ID</th>
<th>Dataset</th>
<th>Sector</th>
<th>Owner</th>
<th>Data Category</th>
<th>Type format</th>
<th>Open Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>1001</td>
<td>Meteo stations</td>
<td>Weather</td>
<td>Provincia di Trento</td>
<td>Static</td>
<td>XML</td>
<td>Y</td>
</tr>
<tr>
<td>1003</td>
<td>Daily weather forecast</td>
<td>Weather</td>
<td>Provincia di Trento</td>
<td>Dynamic</td>
<td>XML</td>
<td>Y</td>
</tr>
<tr>
<td>1004</td>
<td>Weather forecast for Trento (East)</td>
<td>Weather</td>
<td>Provincia di Trento</td>
<td>Dynamic</td>
<td>XML</td>
<td>Y</td>
</tr>
<tr>
<td>1005</td>
<td>Weather forecast for Trento (North)</td>
<td>Weather</td>
<td>Provincia di Trento</td>
<td>Dynamic</td>
<td>XML</td>
<td>Y</td>
</tr>
<tr>
<td>1006</td>
<td>Heat Index</td>
<td>Weather</td>
<td>Provincia di Trento</td>
<td>Dynamic</td>
<td>XML</td>
<td>Y</td>
</tr>
<tr>
<td>2011</td>
<td>Tabular weather</td>
<td>Weather</td>
<td>TomTom</td>
<td>Dynamic</td>
<td>JSON</td>
<td>N</td>
</tr>
<tr>
<td>2012</td>
<td>Advanced Weather</td>
<td>Weather</td>
<td>TomTom</td>
<td>Real-time data</td>
<td>JSON</td>
<td>N</td>
</tr>
</tbody>
</table>
[1001] **Meteo stations**: it gives a list of automated weather stations in Trentino.

[1003] **Daily Weather forecast**: This gives weather forecast day by day for the next five days.

[1004] **Weather forecast for Trento (East)**: This is not forecast but data collected from the weather stations every 15 minutes. Temperature, Humidity and Rain are collected.

[1005] **Weather forecast for Trento (North)**: This is not forecast but data collected from the weather stations every 15 minutes. Temperature, Humidity and Rain are collected.

[1006] **Heat index**: It gives information about humidity level for each stations in Trentino.

[2011] **Tabular weather**: The Tabular Weather API delivers current and predicted location-based weather conditions in different temporal resolutions.

[2012] **Advanced Weather**: It provides real time weather information as simplified polygons over a specific area which results in detailed, granular and bandwidth efficient weather information.

[1035] **Information from mobile payment parking**: The Parking Payment is not available yet. It gives information about the parking machines which is extremely precious when it comes to count entries and exit of parking zones and garages to define their availability.

**Sequence Diagram**

Figure 15 shows the sequence diagram of the use case studying the correlation between weather and parking. The datasets from the CKAN component, described in deliverable 4.1, will be computed and compared in order to generate the analysis.
Figure 15: The sequence diagram representing the study correlating weather with parking.
B. Road Event Reporter

Context

In the context of smart cities, cities are willing to improve traffic management for more urban efficiency and resiliency. An important capability for city authorities is the ability to monitor the status of traffic and roads.

Goal and Scope

With the aim of improving traffic management services of Trento, a free access to the Road Event Reporter will be offered to the city. The Road Event Reporter is an online service developed by TomTom. This console allows the city to get an overview of all the happening road events. Also, traffic managers are able to create road events which can be communicated to road users in minutes. Road Event Reporter allows traffic managers within few clicks to inform in an easy way citizens about live and also coming incidents as accidents, road closures, road works, marathons, etc. This way it aids in minimizing disruptions caused by events. The city can always improve the way they want to display this information to reach a wider audience. For instance, installing information boards at the entries of Trento is advised in order to display road information.

This service can potentially become essential for the traffic management center of Trento. It should be noted that this service promotes crowdsourcing and smart mobility as traffic experts can directly contribute for a better traffic management indicating location of incidents.

Description of the service

Road Event Reporter is a web-based interface allowing traffic managers to input traffic incidents. Thus, users need to log in on their personalized account. They can then search and scroll the map of their attributed region. Using the mouse, a user can in a few clicks indicate the road segments affected by an incident. A form then pop ups where the user can input structured and detailed information about the event. Once saved, the event is submitted to the Traffic Fusion Engine which will validate it against live probes and other reports. If the report is valid, it will be communicated in the next update of the TomTom Live Traffic feed.

Figure 16: Real time road closures enabled by TomTom Road Event Reporter
In addition, Road Event Reporter allows traffic managers to get an overview of TomTom Traffic Incidents and TomTom Traffic Flow (speed) available within the tool to monitor traffic. Therefore, what is already being reported is already visible on the principal view of the city.

Description of the required data

The Road Event reporter is the opportunity to enhance the traffic incident dataset.

<table>
<thead>
<tr>
<th>ID</th>
<th>Dataset</th>
<th>Sector</th>
<th>Owner</th>
<th>Data Category</th>
<th>Type format</th>
<th>Open Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>2009</td>
<td>Road Event Reporter</td>
<td>Traffic</td>
<td>TomTom</td>
<td>Real-time data</td>
<td>-</td>
<td>N</td>
</tr>
</tbody>
</table>

Sequence Diagram

Figure 17 shows the sequence diagram of the use case Road Event Reporter. When the Municipality requests a road closure on the Road Event Reporter, this request is sent to the TomTom component. This new information is checked and flow to the TomTom database. This information is added to the live traffic information (TomTom Traffic Incident: ID 2007). Then, this information flows to the QROWD database. The Community is informed by the road closure directly via TomTom.

Figure 17: The Road Event Reporter’s sequence diagram
C. TomTom City Platform

Description of the service offered

TomTom City is a free to access web portal that provides live and historical traffic and travel information services to help all transport and mobility stakeholders - from consumers through to traffic management experts who are dealing with traffic and congestion on a daily basis in cities. It is indeed a showcase for the extensive range of traffic information available on a city by city basis and provides a platform to connect traffic authorities, businesses and citizens to jointly manage sustainable and efficient mobility. TomTom City, which can be found at http://city.tomtom.com, is also now available for 156 cities around the worlds.

In the framework of QROWD, Trento will be added to the displayed cities on TomTom City. It will enable citizens, traffic managers and authorities to have an overview of the traffic condition in Trento. It also allows a proper comparison between Trento and other cities. It is indeed a very valuable tool for traffic managers of Trento because they will have the opportunity of increasing the number of traffic reports.

The most relevant elements presented into the TomTom City platform, like the two maps showing the traffic flow and the traffic incident in Trento, shall be displayed into the QROWD dashboard in order to reach a large audience.

Moreover, this platform displaying the traffic condition of Trento should be used as an input to the other use cases into the WP1 and WP2. This, because it shows some of the difficulties encountered by Trento to manage its traffic, difficulties that we try to solve using QROWD.
Description of the service offered:

Figure 18: TomTom City displayed on several devices

Figure 19: Overview of the traffic condition supported by charts

- Map with traffic flow in a real time: gives an overview very accurate on the traffic situation in live | the tendency of the jam (e.g. getting worse, stable, getting better) and the jam lifetime.
- Roads covered (km)
- Live traffic speed
- Live traffic level
- Live traffic reports (Roadworks, jams, closures)
- Live traffic delay
- Weather in real time and for the next three days (precipitation, wind, T°, sun-cloudy-rain-snow)
- Traffic Index Congestion Level: informs on the cities having a similar congestion level. It also gives an overview on extra travel time per day/per year, on the historical congestion level and on the evening peak & morning peak.
- Link to “Report Map change” – “Road event reporter” – “Plan your route”: (special access in needed.)
- Layer on traffic incident: Services deliver traffic for overlaying on a background map to illustrate the current road stretches with congestion or incidents.
- Layer on parking view to be informed on probabilities of finding a parking spot.

**Description of the required data**

In TomTom City, there is no additional dataset required. It simply displays TomTom data in form of charts and maps.

<table>
<thead>
<tr>
<th>ID</th>
<th>Dataset</th>
<th>Sector</th>
<th>Owner</th>
<th>Data Category</th>
<th>Type format</th>
<th>Open Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>2009</td>
<td>TomTom City</td>
<td>Traffic</td>
<td>TomTom</td>
<td>Real-Time data</td>
<td>HTML (visualization)</td>
<td>Y</td>
</tr>
</tbody>
</table>
### III. DELIVERED DATASETS

Table 8: Data available for the first business case

<table>
<thead>
<tr>
<th>Id.</th>
<th>Description</th>
<th>Format</th>
<th>Frequency</th>
<th>Ownership</th>
<th>Notes (privacy, security, APIs…)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2001</td>
<td>Advanced Navigable (Map)</td>
<td>SHP</td>
<td>Historical quarterly / Static</td>
<td>TomTom</td>
<td>N</td>
</tr>
<tr>
<td>2002</td>
<td>Point of Interest</td>
<td>SHP</td>
<td>Static</td>
<td>TomTom</td>
<td>N</td>
</tr>
<tr>
<td>2003</td>
<td>Historical Traffic States</td>
<td>CSV/SHP</td>
<td>Static</td>
<td>TomTom</td>
<td>N</td>
</tr>
<tr>
<td>2004</td>
<td>Historical Traffic Analysis / Traffic Stats</td>
<td>SHP/KML/XLS</td>
<td>Static</td>
<td>TomTom</td>
<td>N</td>
</tr>
<tr>
<td>2005</td>
<td>Parking probabilities</td>
<td>XML</td>
<td>Static</td>
<td>TomTom</td>
<td>N</td>
</tr>
<tr>
<td>2006</td>
<td>TomTom flow</td>
<td>Datex II</td>
<td>1 minute / Dynamic</td>
<td>TomTom</td>
<td>N</td>
</tr>
<tr>
<td>2007</td>
<td>TomTom traffic incident</td>
<td>Datex II</td>
<td>1 minute / Dynamic</td>
<td>TomTom</td>
<td>N</td>
</tr>
<tr>
<td>2008</td>
<td>TomTom Route monitoring</td>
<td>JSON</td>
<td>1 minute / Dynamic</td>
<td>TomTom</td>
<td>N</td>
</tr>
<tr>
<td>2009</td>
<td>TomTom City</td>
<td>HTML (visualisation)</td>
<td>1 minute / Dynamic</td>
<td>TomTom</td>
<td>Y</td>
</tr>
<tr>
<td>2010</td>
<td>Traffic Index (Delay Hotspots)</td>
<td>CSV</td>
<td>1 minute / Dynamic</td>
<td>TomTom</td>
<td>N</td>
</tr>
<tr>
<td>2011</td>
<td>Tabular weather</td>
<td>JSON</td>
<td>Daily / Dynamic</td>
<td>TomTom</td>
<td>N</td>
</tr>
<tr>
<td>2012</td>
<td>Advanced</td>
<td>JSON</td>
<td>Real-Time data</td>
<td>TomTom</td>
<td>N</td>
</tr>
<tr>
<td>Weather</td>
<td>2013</td>
<td>Origin-Destination</td>
<td>XLS</td>
<td>Static</td>
<td>TomTom</td>
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CONCLUSIONS

The document has presented the different use cases composing the first business case of QROWD. These use cases are of various kinds as they cover several specific areas as parking, weather, traffic management, strategic routes, etc. Thus, Trento and its citizens will benefit from a complete service which may drastically improve the traffic condition of the city-center and the surroundings. It will indeed allow the traffic managers to have a better understanding on traffic and parking issues. Therefore, they will be able to make better informed decisions which will directly influence the traffic management of the area. Moreover, the people will also be more informed about the possibility of finding a parking slot and also about the most efficient way to reach any touristic hotspots. Finally, the business case is expected to be replicable to other cities and regions.

The services presented here will benefit from collaborative data exchange technologies involving different partners within QROWD. This business case makes use of a large quantity of data collected by the Municipality of Trento which will be merged in order to design the services. Data collected through crowdsourcing and citizen engagement will be integrated, in order to improve both their quality and their outreach. Because of the diversity of formats and, data will be extensively curated using the crowdsourcing services developed in WP4.
REFERENCES