QROWD - Because Big Data Integration is Humanly Possible

Innovation Action

Grant agreement no.: 732194

D2.5 – Final Trento Pilot

Due Date	30 November 2019
Actual Delivery Date	30 November 2019
Document Author/s	Giacomo Fioroni, Alex Tomasi, Andrea Leveghi, Mistral Garzoglio, Cristina Maia Buzuleciu
Version	2.0
Dissemination level	PU
Status	Final
Document approved by	Denis Kangeldi, Luis-Daniel Ibáñez

Project co-funded under Horizon 2020 Research and Innovation EU programme

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EXECUTIVE SUMMARY

This document reports on the results of the QROWD business case “Intelligent urban transportation and mobility” (cfr. “D2.2 – Use case requirements specification”, hereinafter “D2.2”).

The document recalls the use cases in the same order and priority as defined in D2.2 and reports on the results achieved for each and every use case.

The document also provides a detailed description of the main citizen engagement activities that provided input to shape and fulfill the use cases.

Finally, the analysis of the KPIs as defined in D2.2 offers an objective overview of the results achieved.

This deliverable is public.

1 INTRODUCTION

1.1 Purpose of the document

This document is the fifth and final deliverable of the QROWD business case "Intelligent urban transportation and mobility" (WP2). It reports on the results of the business case requirements and design (T2.1), extensively described in D2.2 *Use case requirements specification*. The document also describes the means to achieve those results, namely the Ideas competition and the QROWDLab. Finally, the document examines the KPIs defined in D2.2 in order to point out what has been achieved.

1.2 Structure of the document

The document is divided into 14 sections.

Section 1 gives an overview of the purpose and structure of the deliverable.

Section 2 to section 10 provides a summary of each use case defined in D2.2 followed by a description of the results achieved.

Section 11 provides an account of the Ideas competition while section 12 describes the setup and implementation of the QROWDLab.

Section 13 examines the KPIs defined in the initial phase of the project.

Finally, section 14 concludes this deliverable.

2 SUMMARY OF THE USE CASES

The following table provides a summary of the use cases as defined in D2.2.

Use Case ID	Short Name	Brief description	Target	Priority
BC2-UC#1	Modal Split	Computation of multimodal transport in Trento: how people use different means of transport	Municipality	Mandatory
BC2-UC#2	Parking Availability	Information about the probability to find a parking spot for four- and two-wheeled vehicles	Municipality	Mandatory
BC2-UC#3	Completing mobility infrastructure information	Information about mobility infrastructure retrieved through spatial crowdsourcing	Municipality	Mandatory
BC2-UC#4	Municipality dashboard	A dashboard that can be accessed by employees of the Municipality and other public stakeholders displaying aggregate data about mobility in Trento	Municipality	Mandatory
BC2-UC#5	Personal Modal Split	Personal modal split providing	Citizens	Mandatory

		general information about how a user moves around the city		
BC2-UC#6	Citizen dashboard	A dashboard where citizens can access useful information about mobility in Trento	Citizens	Mandatory
BC2-UC#7	Customized traffic service	A personalized service of traffic information	Citizens	Optional
BC2-UC#8	Services provided by the QROWD platform	A set of services will be made available on the QROWD platform in order to allow businesses and citizens to query these services and develop new ones	Citizens	Optional

Table 1: Use Cases Priority and Target

3 MODAL SPLIT USE CASE (mandatory)

One of the more important necessities for the Municipality of Trento is the computation of the modal split, that is the percentage of travellers using a particular type of transport for everyday travel.

The QROWD project made available a set of innovative tools and processes to compute the modal split:

- Data collection - i-Log app
- Data analysis - AI & ML
- Data visualization - Municipality dashboard

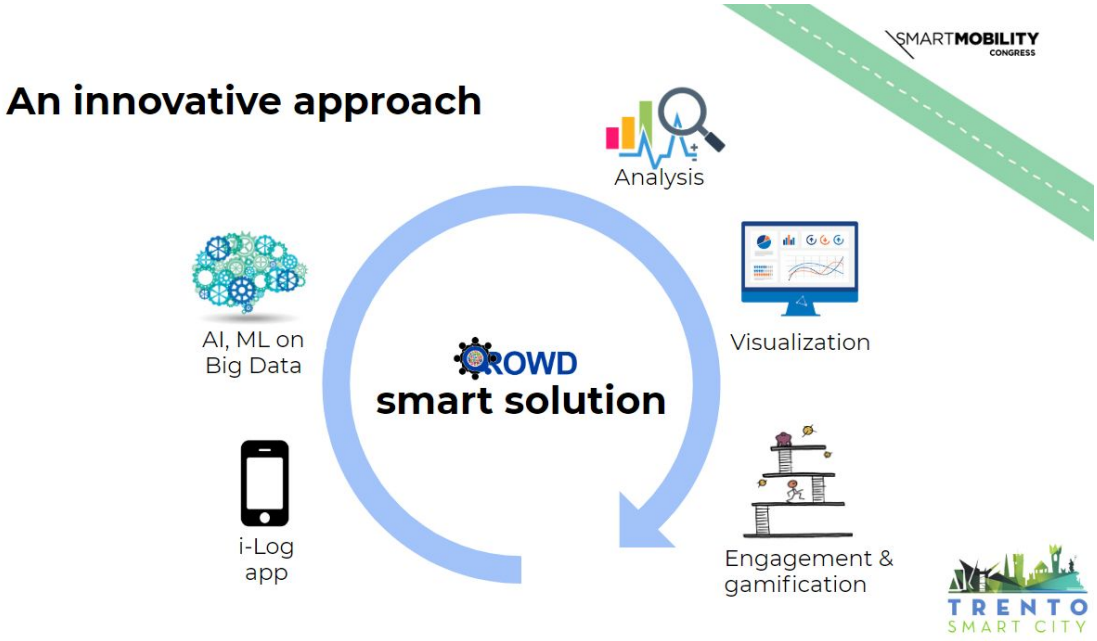

Figure 1: QROWD solution to calculate the modal split

These tools and processes were extensively through six QROWDLab studies before running the “official” computation with citizens engaged in an open manner, both internally and with the help of the citizens that participated in the QROWDLab (that was intentionally set up to engage the citizens in the testing process). More details about the QROWDLab can be found in section 12.

The official study took place in October 2019, it involved 149 users and led to the computation of the official modal split. According to the data, 40.4% of people moved by car car while 59.5% used sustainable transport means on the official day of the computation. The employees of the Municipality can now access the official modal split data on the Municipality dashboard (more details about the Municipality dashboard can be found in section 6).

Figure 2: Official Modal Split of the Municipality of Trento

As far as this use case is concerned, all the objectives defined in D2.2 have been reached. The Municipality of Trento has a clear overview of the urban mobility and is able to take informed decisions for future policies.

4 PARKING AVAILABILITY USE CASE (mandatory)

This use case aimed to provide information about the location and availability of parking spots using real-time data (where available) and historical analysis of parking probabilities (when real-time data was unavailable). Since no real-time data could be accessed during the project, location and availability of parking spots has been assessed based on:

- TomTom data about historical parking probabilities
- Static data owned by the Municipality

All these data sources have been integrated to increase coverage and accuracy.

The Municipality prioritized bike racks and on-street paid and unpaid parking areas.

The resulting maps have been imported in the Municipality and in the Citizen dashboard (more details about the Citizen dashboard can be found in section 8).

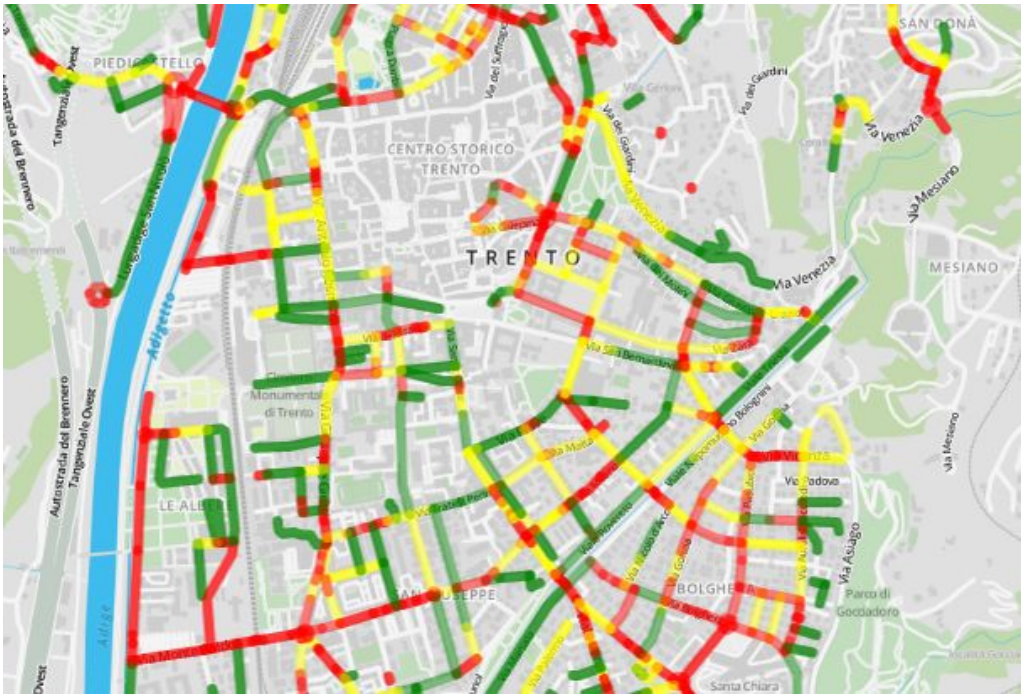

Figure 3: Car parking availability

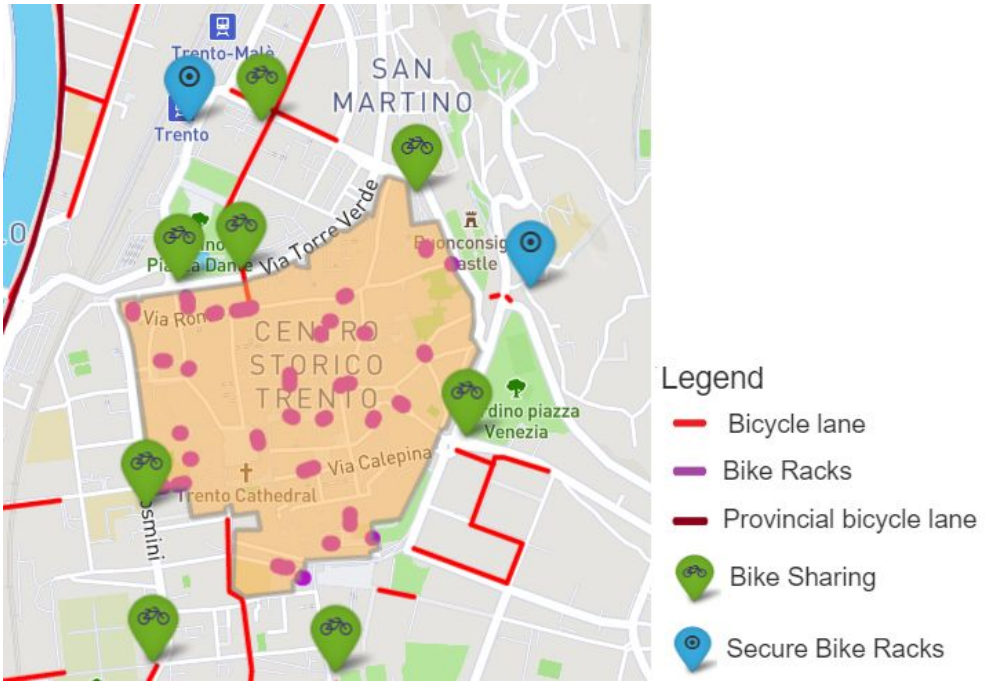

Figure 4: Bike racks location

5 COMPLETING INFORMATION ABOUT URBAN MOBILITY INFRASTRUCTURE THROUGH SPATIAL CROWDSOURCING (mandatory)

This use case focused on collecting information about the location of urban mobility items through crowdsourcing. We focused on two types of items: bike racks and yellow parking spots.

For bike racks, we used two crowdsourced datasets, from Open StreetMaps, and one generated with the Virtual City Explorer (D3.5). Using the tools for data fusion developed in WP5, we created a fusioned dataset that was integrated in the dashboard.

For yellow parking spots, we used a challenge managed through the i-Log app. The challenge asked participants the following questions:

1. What kind of parking spot is this? Choose among:
    a. freight load/unload
    b. disabled
    c. taxi
2. How many individual parking spots are there?

401 unique yellow parking spots were identified.

6 MUNICIPALITY DASHBOARD USE CASE (mandatory)

The Municipality dashboard[1] shows the information collected in the context of the previous use cases in the following order:

- **Modal Split (table)** - aggregated data from the studies run during the project (see QROWDLab) and aggregated data about the official computation
- **Information for drivers (map)**
  - Location of:
    - large car parking areas (underground and on-street)
    - parking spots for disabled people
    - parking meters
    - electric vehicle charging stations
    - car sharing parking spots
  - Probability to find a parking spot
- **Information for cyclists (map)**
  - Location of:
    - bike lanes
    - bike racks
    - secured bike parking areas
    - location and availability of bike sharing stations
- **Citizens (map)** - location of facilities such as libraries, sport facilities, schools, post offices

Furthermore, the **homepage** displays weather forecast, air quality and TomTom city - a map with real time traffic in Trento and in the surrounding area.

All requirements defined in D2.2 have been met and the dashboard provides the Municipality with a comprehensive overview of mobility in Trento.

7 PERSONAL MODAL SPLIT USE CASE (mandatory)

The personal modal split provides the citizens who took part in the QROWDLab with a general report about how they move around the city.
Information about the personal modal split have been shared with each of the users which can see the percentage of the means of transport used) about how they moved around the city of Trento on the days of the official computation.

[1] Link to the Municipality dashboard:
http://municipalitydashboard.qrowd.aksw.org/qrowdDashboard/

8 CITIZEN DASHBOARD USE CASE (mandatory)

The Citizen dashboard[2] is similar to the Municipality dashboard but does not include the “Modal split” section - which is only available to the Municipality employees.

The Citizen dashboard shows information useful to the citizens in the following order:

- **Homepage** - weather forecast, air quality and TomTom city - a map with real time traffic in Trento and in the surrounding area
- **Information for drivers (map)**
  - Location of:
    - large car parking areas (underground and on-street)
    - parking spots for disabled people
    - parking meters
    - electric vehicle charging stations
    - car sharing parking spots
  - Probability to find a parking spot
- **Information for cyclists (map)**
  - Location of:
    - bike lanes
    - bike racks
    - secured bike parking areas
    - location and availability of bike sharing stations
- **Citizens (map)** - location of facilities such as libraries, sport facilities, schools, post offices

All the requirements set out in D2.2 have been satisfied and the citizens can access useful information concerning mobility, all in one place.

9 CUSTOMIZED TRAFFIC SERVICE (optional)

The aim of this use case was to provide dedicated services to the citizens such as a personalized service of traffic information to help them avoid wasting time in traffic and optimize their daily commute.

The requirements for this optional use case have not been met by the time of writing this deliverable because the effort was redirected to achieving the mandatory use cases, in particular the computation of the modal split.

[2] Link to the Citizen dashboard: http://citizendashboard.growd.aksw.org/growdDashboard/

10 SERVICES PROVIDED BY THE QROWD PLATFORM USE CASE (optional)

This use case aimed at making the services on the QROWD platform available so that businesses and citizens could query them (e.g. microservices) to develop new, valuable applications/services thus complementing and improving existing public services.

The open data that have been made available via the QROWD CKAN can be accessed via both the CKAN dashboard and the APIs or services provided by CKAN.

11 IDEAS COMPETITION

The ideas competition ran from August 2017 to March 2018. It was launched by the Municipality of Trento with the aim to incorporate ideas from the citizens in the business cases of the Trento pilot (see D2.2).

The competition targeted citizens from Trento and the surrounding areas, including participants from public administration, academia, local companies and social entrepreneurs.

The participants used the WeLive platform[3] to put forward 22 “needs” and 7 “ideas” for new mobility services in response to the “challenges” launched by the Municipality:

- New services to improve the mobility of disabled people
- A mobility map for Trento
- New services: information about motorcycle parking spots

All ideas were evaluated positively by the committee according to pre-fixed eligibility criteria; because of their relevance, innovation, and practicability to improve mobility in Trento, five of them have provided valuable input in shaping the business case requirements (see D2.2):

- “Dove parcheggio le 2 ruote?” - *Where can I park my two-wheeled vehicle?*
- MobiliMàpP TN - *MobilityMapP TN*
- Zero Barriere - *Zero barriers*
- Una mappa aperta - *An open map*
- Parcheggi per disabili - *Parking for people with disabilities*

Reference is made to “D2.1 Ideas competition” for a comprehensive account of the contest.

[3] Link to the WeLive platform: https://dev.welive.eu/overlay

12 QROWDLAB

The QROWDLab set out to engage the citizens in a series of studies to test the innovative tools and processes made available by the project.

More specifically, the citizens were asked to test the i-Log app to collect:

1. **Data about their daily trips (for the modal split computation)**

To test the modal split computation process, six studies have been run throughout the project involving a total of 75 participants.

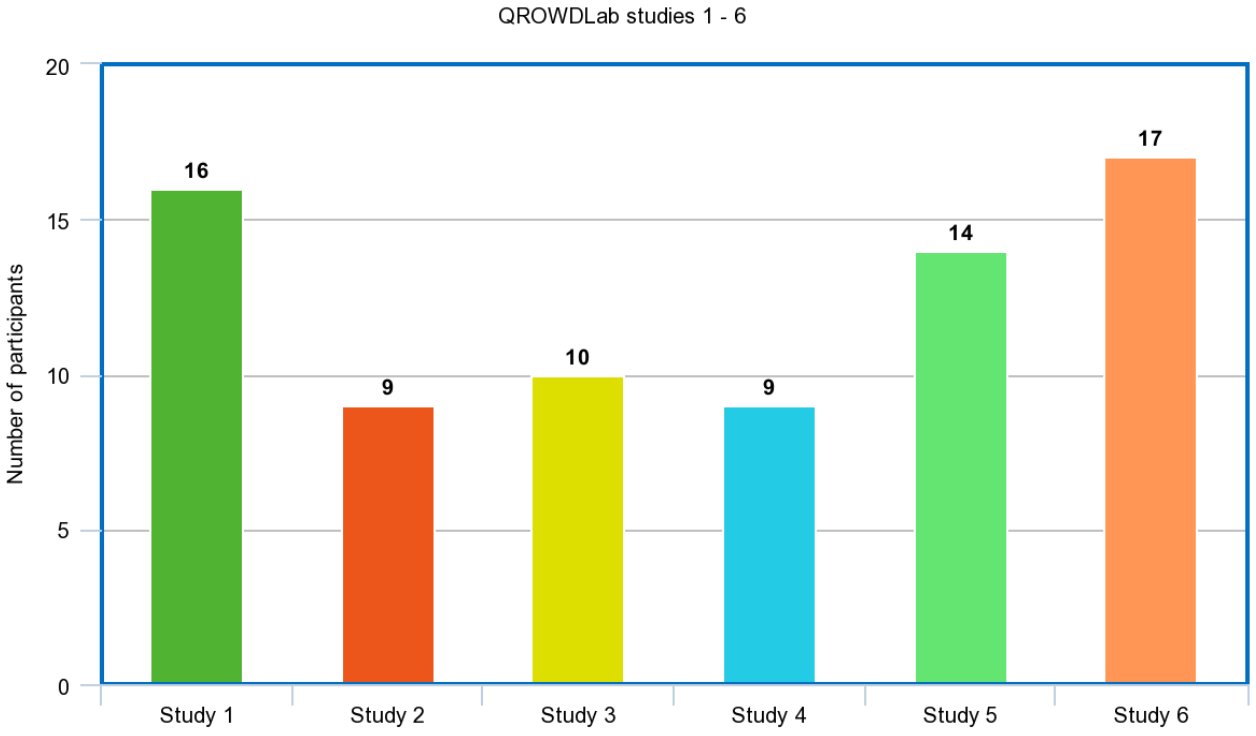

Table 2: Number of participants (studies 1 - 6)

The final pilot took place from October 2 to October 5. This pilot engaged 149 citizens and led to the official modal split computation.

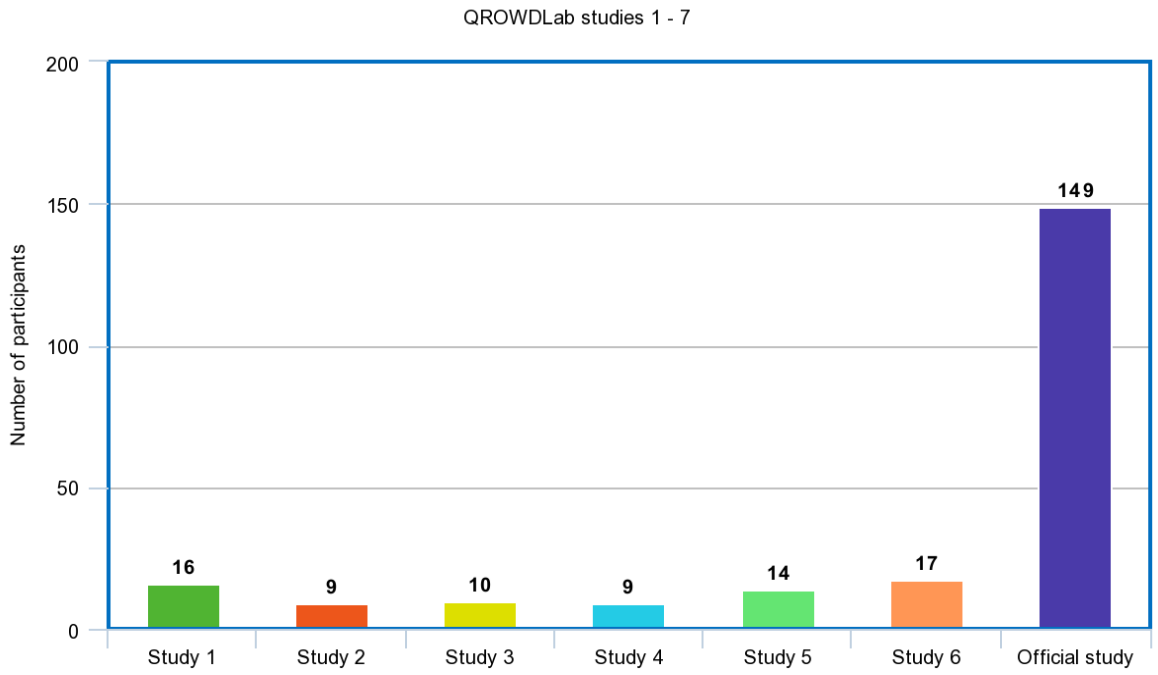

Table 3: Number of participants (studies 1 - 7)

2. **information about the bike racks and the yellow parkings**

Information about mobility items have been collected through crowdsourcing.

For bike racks, we used two crowdsourced datasets, from Open StreetMaps, and one generated with the Virtual City Explorer (D3.5).

For yellow parking spots, we used a challenge managed through the i-Log app (cf. D2.4). 401 unique yellow parking spots were identified.

13 KPIs

13.1 KPIs for Municipality Services

The following table reports on the KPIs for Municipality Services as defined in D2.2. The second-to-last column on the right describes the expected outcome for each entry while the very last column on the right (marked in yellow) reports on the results achieved. Comments on the KPIs can be found after the table.

	Name	Description	Before QROWD	After QROWD (expected)	After QROWD (real)
1	**Modal split / frequency of measure**	the frequency with which the modal split is measured	About once every ten years	Yearly (at least twice a year), possibly monthly	Yearly
2	**Modal split / cost**	cost of computing the modal split	Approximately 40.000€	Equal to engagement costs (approximately 30.000€)	Qrowdlab equipment Platform costs i-Log costs Dashboard costs
3	**Modal split / results**	Statistical representativeness of the results	Yes	Yes	Yes
		Accuracy of results (sample type)	Only resident citizens	Resident citizens and commuters	Resident citizens and commuters
		# of modal split computations	1	3	3 (1 official 2 unofficial)
		comparability with different (external) computations related to the modal split (*see UC#1)	0 (not comparable)	comparable with 2 previous computations	Comparable with 2 previous computations
4	**Coverage of car parking availability**	on-street paid car parking	No information	Historical probability of availability based on data from parking meters and data from BC1-UC#2 Parking	Historical probability of availability based on data from BC1-UC#2 Parking Services in D1.1 Datasets

				Services in D1.1 Datasets Release for Model Region	Release for Model Region
		on-street unpaid car parking	No information	Historical probability of availability for all types of on-street unpaid car parking based on data from BC1-UC#2 Parking Services in D1.1 Datasets Release for Model Region	Historical probability of availability for all types of on-street unpaid car parking based on data from BC1-UC#2 Parking Services in D1.1 Datasets Release for Model Region
5	**Coverage of motorcycle parking availability**	Historical probability of availability based on cameras + crowdsourcing	No information	2 parking areas	No info
6	**Coverage of bicycle parking availability**	Historical probability of availability based on cameras + crowdsourcing	No information	2 bike racks	No info
7	**Completing mobility infrastructure through crowdsourcing (static)**	Reports concerning the existence of mobility infrastructure	0	200	0
8	**Completing mobility infrastructure through crowdsourcing (static)**	New verified information concerning existence of mobility infrastructure based on reports	0	50	401
9	**Completing mobility**	Reports concerning	0	200	No info

	infrastructure through crowdsourcing (dynamic)	availability/occupancy of mobility infrastructure			

Table 4: KPIs for Municipality Services

1) Modal split / frequency of measure

Thanks to the QROWD project, the modal split can be computed on a yearly basis (whereas the last official computation took place in 2004).

2) Modal split / cost

The cost of the modal split with QROWD is equal to: cost of QROWDLab equipment (€26,500) + estimated cost of QROWD platform + estimated cost of i-Log + estimated cost of the dashboard.

Considering all these costs, the modal split with QROWD is potentially more costly than what was expected (€30,000). However, the benefits of a faster and more frequent computation outweigh the costs. In fact, most of the costs associated with the QROWD solution are one-time costs; once the process is set up, the only remaining cost is that associated with the engagement of the citizens. On the contrary, the municipality would have to bear the entire cost of computing the modal split using a traditional method every time it decided to do so.

3) Modal split / results

The modal split is statistically representative and comparable with 2 previous computations. In total, the dashboard displays information about 3 modal split computations: 2 unofficial (computed during the testing phase) and 1 official. The modal split refers to both resident citizens and commuters.

4) Coverage of car parking availability

The availability of on-street paid parking spots has been assessed based on Historical probability of availability based on data from BC1-UC#2 Parking Services in D1.1 Datasets Release for Model Region. Data from the parking meters have been made available at the end of the project only as historical data covering the years from 2017 to 2019 and have therefore not been included in BC1-UC#2 Parking Services.

5) Coverage of motorcycle parking availability

No information has been collected about motorcycle parking spots because the Municipality prioritized bike racks and on-street paid and unpaid parking areas. At the same time, there have been privacy reasons related to feeds from cameras (it was impossible to obscurate human faces).

6) Coverage of bicycle parking availability

No information has been collected about the availability of bike racks because crowdsourced information focused on the location of bike racks rather than on their occupation - knowing the exact location was more

important for the Municipality. At the same time, there have been privacy reasons related to feeds from cameras (it was impossible to obscurate human faces).

7 / 8) Completing mobility infrastructure through crowdsourcing (static)

We used a challenge managed through the i-Log app to collect new information about the yellow parking spots (location and type). 401 unique yellow parking spots were identified, thus exceeding the target for new verified information (50).

On the other side, no reports concerning the existence of mobility infrastructure have been generated. This is because the municipality prioritized the collection of new information rather than the validation of existing mobility points of interest - this task would have required several challenges with more resources involved and higher costs.

9) Completing mobility infrastructure through crowdsourcing (dynamic)

No information has been collected concerning the availability of mobility items because it was more important for the Municipality to know their precise location.

13.2 KPIs for Trento Citizens

The following table reports on the KPIs for Trento Citizens as defined in D2.2. The second-to-last column on the right describes the expected outcome for each entry while the very last column on the right reports on the results achieved. Comments on the KPIs can be found after the table.

	Name	Description	Before QROWD	After QROWD (expected)	After QROWD (real)
1	**Information provided to citizens through the citizen dashboard**	Number of information included in the citizen dashboard	0	7	Homepage: 3 Car: 8 Bike: 6 Citizen: 9 Total: 26
2	**Citizen satisfaction (0 to 5)**	Citizen satisfaction with the dashboard	0	3.5	3.5
3	**Personal modal split**	The modal split computed for an individual citizen	Only available as aggregate	Each user has his or her own	Each user

Table 5: KPIs for Trento Citizens

1) Information provided to citizens through the citizen dashboard

In total, 26 different pieces of information have been included in the dashboard such as: off-street parking availability, e-charge stations, bike lanes, bike racks, sports facilities, schools and libraries.

2) Citizen satisfaction

Citizen satisfaction with the dashboard has been assessed by submitting an online questionnaire. 14 citizens replied to the question “How useful is the citizen dashboard (0 - 5)?” and citizen satisfaction with the dashboard is 3.5.

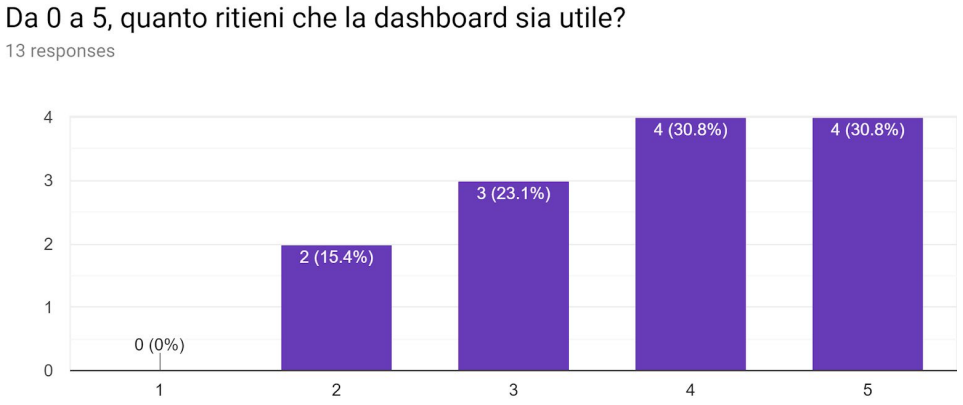

Figure 5: Citizen satisfaction

3) Personal modal split

Information about the personal modal split has been produced and shared with each of the users. The personal modal split provided the citizens with a report (percentage of the means of transport used) about how they moved around the city of Trento on the days of the official computation.

14 CONCLUSIONS

This deliverable assesses the overall impact of the QROWD system as well as the status of the business case implementation, including comparison with the previous status of the mobility services in Trento and assessment of the KPIs.

This deliverable assesses the results of each use case thus showing how most of the objectives set out in D2.2 have been successfully reached:

1. **Modal split (mandatory)** - the modal split has successfully been calculated.
2. **Parking availability (mandatory)** - the availability of parking spots has successfully been assessed based on data from BC1-UC#2

Parking Services in D1.1 Datasets Release for Model Region. This information is displayed in both the Municipality and the Citizen dashboards.

3. **Completing information about mobility infrastructure (mandatory)** - the location of mobility items such as bike racks and yellow parking spots has been determined by integrating different data sources (open data of the Municipality, data from OpenStreetMap, crowdsourced data: VCE & i-Log) .
4. **Municipality dashboard (mandatory)** - the Municipality dashboard has made it possible for the Municipality's employees to access data in a readable manner; most importantly, the employees can access the modal split data and apply filters to make useful analysis
5. **Personal modal split (mandatory)** - the personal modal split has been shared with each of the citizens who participated in the QROWDLab. The citizens now have a clear report about their mobility habits.
6. **Citizen dashboard (mandatory)** - the Citizen dashboard has made it possible for the citizens to access useful data related to urban mobility in a readable manner. On average, citizens are satisfied with the dashboard.
7. **Customized traffic service (optional)** - this optional use case is the only one that has not been fulfilled
8. **Services provided by the QROWD platform (optional)** - the open data that have been made available via the QROWD CKAN can be accessed via both the CKAN dashboard and the APIs or services provided by CKAN.

All mandatory use cases together with one of the optional use cases (Services provided by the QROWD platform) have been fulfilled. When deciding the priority of the use cases, the Municipality consulted with the partners that were directly involved to assess the actual level of effort required. For instance, the customized traffic service has not been provided since all the effort was redirected towards the computation of the general and personal modal split which required 6 studies before the official computation took place.

Quantitative evidence of having delivered most of the intended results can also be found in the analysis of the KPIs (see Section 13 - KPIs).

This deliverable shows that the following objectives of WP2 have been reached:

- Identification of the areas where the accuracy or extent of existing data needs improvement;
- Involvement of different stakeholder groups through ideas competition and crowdsourcing;
- Definition and modelling of the type of data to harvest through

crowdsourcing;
- Integration and adaptation of data acquisition, repair, and storage components developed in the corresponding work packages, including end-user applications for crowdsourcing;
- Development of a Dashboard application for data analytics, to be used by the local transport company as well as the municipality, that monitors raw, crowdsourced, and integrated data, and is capable of providing quantitative evaluation of the evolution of traffic;
- Execute a pilot run of the integrated system;
- The existing incomplete and non-performant systems and applications will be greatly improved by the QROWD platform that will thus replace them, which will assure the continued operation of the developed resources

In conclusion, this deliverable shows that the goal of WP2 to validate the QROWD platform by deploying its services to improve the urban mobility in Trento has been successfully met.